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APPENDIX.

APPENDIX I.

Appendix I.

Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

Letter of Instructions given by Referees.

29, Great George-Street, Westminster,
12 March 1857.

Gentlemen,

THE Referees appointed by the First Commissioner of Her Majesty's Works, &c., to investigate the above question, having found it necessary to secure your assistance to carry out an investigation of particular schemes submitted to them, involving a chemical view of the subject, desire me to communicate to you the following heads of inquiry on which they are anxious of having your opinion.

Without going into all the minute details of analysis of the various objects to which they will have to call your attention, I may state generally that they will require a statement of your views,—

1st. As to the influence of sewage upon the River, as represented by specimens taken under the direction of the Referees from various points at high and low water.

2d. As to the actual agricultural value of the London sewage, determined from specimens collected for that purpose.

3d. With reference to the manufacture of manure from sewage, which of the various methods proposed for treating it by chemical agents would be the best, considering it as a commercial undertaking, and whether the value of the manufactured article, after paying all expenses, would enable it to compete with the ordinary forms of manure. And the Referees will here particularly call your attention to the importance of rendering a comparison of the most practical character, and adopting as a standard of value some well known manure, as guano, for instance, or farm-yard manure.

4th. As to whether the value of sewage is such as to be likely to lead to its employment for purposes of irrigation on the lines of any main outfall sewers, in the general direction indicated by Mr. Bazalgette's plan.

5th. As to the manufacture of manure from sewage, in a sanitary point of view; and as to the effect, which extensive works for the conversion of the London sewage (say 100 millions of gallons per day), into manure, would exercise on the health and comfort of the neighbourhood.

6th. With regard to the several modes of deodorization, simply as such, which of them would be the most efficacious, and how far the influence of temperature or other natural agencies would interfere with the useful effect of the processes; also whether the deodorisation of the sewage matter would remain permanent, or the sewage, after treatment, be liable to undergo further decomposition; and as to the propriety of discharging the supernatant water into the River within the Metropolitan boundary; and, with reference to the above considerations, as to the expediency of any partial or complete deodorisation of the sewage, (independently of utilisation), before its being discharged into the River.

I am, &c.
Herbert C. Saunders.

A. W. Hofmann, Esq., L. L. D., F.R.S.
H. M. Witt, Esq., F.C.S.

Appendix I.

Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

Museum of Practical Geology,
28 July 1857.

Gentlemen,

In transmitting to you the accompanying Report of Chemical Investigations relating to the Metropolitan Main Drainage question, we hope that it may afford you some little assistance in bringing to a successful conclusion this important work, with which during the last few years the public mind has been so much engaged.

The many discrepant views which the discussion of this subject has brought to light, sufficiently evince the difficulties in which the solution of the question is involved.

These difficulties have been gradually removed by the large number of investigations elicited by this discussion, and carried out with untiring energy and great skill by many able inquirers.

With the light which these researches have shed upon the subject, and with the elucidation of some points previously not sufficiently elaborated, which we have endeavoured to establish experimentally ourselves, the question of the Metropolitan Main Drainage assumes a simpler form.

Everybody admits the necessity of removing the daily excreta of so vast a population as that of the metropolis; of removing them rapidly, completely, and beyond the limits within which their decomposition would spread discomfort and disease.

All admit, moreover, that the excreta of which we have to rid ourselves possess a very considerable value in an agricultural point of view, and that it would be highly desirable to recover the valuable matter.

These points being granted, the question resolves itself into this,—Have we the means of accomplishing the latter desideratum, whilst satisfying the former condition?

An inquiry into the nature of the valuable matter carried off in our sewers, an attentive examination of the chemical properties of the constituents, together with the consideration of the extraordinary and constantly increasing degree of dilution in which they exist, cannot fail to impress the chemist, on purely theoretical grounds, with the magnitude of the difficulties which oppose themselves to the successful accomplishment of the task.

Nor do these difficulties diminish if the question be submitted to the test of experiment.

Notwithstanding the numerous proposals which have been made—notwithstanding the variety of patents which have been taken out,—we have no hesitation in stating our conviction that the *problem of profitably recovering the valuable constituents of sewage remains up to the present moment altogether unsolved*; and very faint indeed are the hopes that the progress of chemical discovery will supply the means of so doing. The valuable constituents of sewage are like the gold in the sand of the Rhine; its aggregate value must be immense, but no Company has yet succeeded in raising the treasure.

Nevertheless, on considering the immense value of the matter, thus annually lost, and remembering that it nearly equals that of the whole quantity of guano imported annually into the United Kingdom, it would be unwise rashly to abandon this source of wealth without the most strenuous efforts to save at least a portion of it.

The only chance that remains of accomplishing so desirable a result would appear, so far as we can at present judge, to consist in employing the whole or a portion of the London sewage for the purposes of irrigation.

In devising, therefore, means for rapidly and effectually ridding the Metropolis of the sewage, it is desirable that they should not exclude the possibility of giving this mode of utilisation a fair trial.

We have pressed the claims of the irrigation scheme in the accompanying Report, *not* because we are sanguine as to its success, but because of the numerous propositions which have been made for the profitable disposal of the London sewage, it appeared to us the only one which deserves seriously to be entertained.

If a more thorough examination of this scheme should lead to its rejection—and we almost fear this will be the case—if we have to give up the idea altogether of recovering the valuable constituents which are carried off in our sewers, then the Metropolitan Main Drainage Question, divested of one its principal elements of complication, resolves itself into a problem, the solution of which belongs to the engineer alone.

We have &c.
(signed) *A. W. Hofmann.*
Henry M. Witt.

To Captain Douglas Galton, R. E.
James Simpson, Esq., C. E.
Thomas E. Blackwell, Esq., C. E.

Appendix I.

Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

REPORT of Chemical Investigations relating to the Metropolitan Main Drainage Question, by *A. W. Hofmann*, LL.D., F.R.S., Chemist to the Museum of Practical Geology; and *Henry M. Witt*, F.C.S., Assistant Chemist to the Museum of Practical Geology.

Gentlemen,

Museum of Practical Geology, July 1, 1857.

The series of experiments on the composition and utilisation of sewage, and several allied questions, which you have submitted to our consideration in your letter dated the 12th of March 1857, being now terminated, we beg to report to you the conclusions at which we have arrived.

In communicating to you the results of this inquiry, which has engaged our attention for the last four months, we cannot but regret that the time which you could allow us for the completion of our experiments was comparatively limited. The question at issue presents unusual difficulties, touching as it does, on the one hand, operations upon a scale of colossal magnitude, and dealing, on the other hand, with quantities so minute as almost to escape the grasp of the inquirer. Few investigations ramify into so great a variety of directions, few involve such an extraordinary number of variable elements, which are capable of influencing the main features of the case. Add to this the importance of the interests at stake; on the one hand, the health of the population of the Metropolis, and, on the other, the expenditure of the very large capital required for the construction of works the nature of which may possibly be influenced by this inquiry, and you cannot fail to appreciate the diffidence with which we place before you the results of experiments which we should have liked to multiply and to confirm still further.

But, although we have been compelled to leave unconsidered many questions which have suggested themselves in the course of the inquiry, we hope that the results which we have obtained, and the elaboration of which has been greatly facilitated by the untiring support and assistance which we have received at your hands during the progress of our experiments, may aid you in accomplishing the important task with which you have been entrusted.

In drawing up this Report we have endeavoured, as far as possible, to exclude all speculation, and to be satisfied with the simple conclusions suggested by the experiments. We have, moreover, for the sake of perspicuity, divested our statements of all chemical details which are not absolutely necessary for the comprehension of the results. We have thought it, however, important to unite in a copious Appendix all the analytical numbers upon which our results are based, so that any one may examine and interpret for himself the foundations of our statements. From this Appendix it will be seen that, with few exceptions, the numbers set forth in the Report are the mean of two well concordant experiments.

In accordance with the suggestions contained in your letter, we propose to treat the subject under the following heads:

I.—*Influence of the Sewage on the Composition of the Water of the Thames.*

II.—*Mean Composition and Agricultural Value of the Sewage of London.*

III.—*Utilisation of Sewage for Agricultural Purposes. Manufacture of a Manure from Sewage—*

(A.) *By treatment with Lime.*

(B.) *By treatment with a mixture of Lime, Sulphate of Alumina, and Charcoal.*

(C.) *By treatment with Charcoal:*

1. By filtration through Charcoal.
2. By agitation with Charcoal.

(D.) *By treatment with a Salt of Magnesia.*

IV.—*Utilisation of Sewage in the Liquid Form. Irrigation with Sewage.*

V.—*Consideration of the Manufacture of Sewage from a Sanitary point of view.*

I.—Influence of the Sewage on the Composition of the Water of the Thames.

In order to gain some insight into the manner in which the discharge of the London sewage into the river affects the composition of the Thames' water, a number of specimens, taken by the referees at different points of its course, were submitted to an analysis, in which the total amount of solid matter, the quantity of mineral, and the quantity of organic matter, were carefully determined. The description of the method and the details of the experiments are given in the Appendix (I. 1.) The results of the experiments are embodied in the following Table, which gives likewise the date on which the samples were collected, and the locality whence they were derived. The localities are, moreover, marked on the accompanying map. It deserves to be mentioned, that the samples were delivered to us by the referees simply labelled with the letters (likewise recorded in the Table), so that the places whence they were taken were not known to us at the time the experiments were performed.

TABLE

Appendix I.

Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

TABLE A.

ANALYSES of the WATER OF THE THAMES, taken at different Points of its Course.

Label of Sample	A. 1, 2, 3, & 4.	B. 5, 6, 7, & 8.	C. 9, 10, 11, & 12.	D. 13, 14, 15, & 16.	E. 17, 18, 19, & 20.	F. 21, 22, 23, & 24.	H. 29, 30, 31, & 32.	K. 43, 44, 45, & 46.	L. 47, 48, 49, & 50.	M. 51, 52, 53, & 54.	O. 55, 56, 57, & 58.	P. 59, 60, 61, & 62.	Q. 63, 64, 65, & 66.	S. 71, 72, 73, & 74.	T. 79, 80, 81, & 82.	V. 75, 76, 77, & 78.	W. 83, 84, 85, & 86.
Point whence taken	- - Half a mile below Richmond Bridge.	- - Above Teddington Lock and Weir.	- - Half a mile below Kew Bridge.	- - Half a mile below Hammersmith Bridge.	- - Half a mile below Hammersmith Bridge.	- - Half a mile below Kew Bridge.	- - Wandle River, Wandsworth, below the mill and sewer.	- Opposite Wandsworth Lock.	- Opposite Wandsworth Lock.	- Westminster Bridge, under the fifth arch.	- London Bridge, centre arch.	- Westminster Bridge.	- London Bridge, centre arch.	- Opposite Victoria Docks, Blackwall.	- Opposite Victoria Docks, Blackwall.	- Rainham Creek.	- Rainham Creek.
Date	14 March, 5.5 p.m.	14 March, 6.35 p.m.	10 March, 2.0 p.m.	10 March, 3.5 p.m.	10 March, 4.35 p.m.	10 March, 5.20 p.m.	18 March, 12.0 noon.	18 March, 6.0 p.m.	18 March, 6.0 p.m.	19 March, 6.30 a.m.	19 March, 1.15 p.m.	20 March, 2.0 p.m.	20 March, 0.45 a.m.	20 March, 1.20 p.m.	21 March, 8.20 a.m.	21 March, 10.50 a.m.	21 March, 6.0 p.m.
Depth of Water	High water, 5 feet.	High water, 7 feet.	Low water, 5 feet.	Low water, 7 feet.	High water, 13 feet.	High water, 10 feet.	Low ebb.	Low water, 14 feet.	High water, 10 feet.	High water, 21 feet.	Just before flood, 12 feet.	Just at flood, 8 feet.	High water, 24 feet.	Low water, 14 feet.	High water, 30 feet.	High water, 30 feet.	Low water, 14 feet.
SUSPENDED MATTER: (*Grains per Gallon*)																	
Mineral	- - -	- - -	3·62	2·56	2·20	- - -	- - -	- - -	5·48	3·23	4·40	1·83	2·52	3·44	7·42	44·37	37·81
Organic	- - -	- - -	0·71	0·52	0·60	- - -	- - -	- - -	1·48	0·92	1·03	0·55	0·00	0·70	1·40	0·24	5·07
TOTAL	0·57	0·30	4·03	3·08	2·80	0·04	0·77	0·81	6·06	4·15	5·43	2·38	3·48	4·23	8·82	53·61	43·78
DISSOLVED MATTER: (*Grains per Gallon*)																	
Mineral	19·03	10·40	10·75	18·40	17·92	17·98	22·18	21·44	18·10	20·20	19·27	17·81	20·37	22·21	44·20	127·65	126·04
Organic	0·99	1·43	1·13	0·87	1·30	0·85	1·40	1·17	0·88	1·02	1·16	0·94	1·32	1·24	0·88	3·63	1·48
TOTAL	20·02	17·02	20·88	19·27	19·22	18·23	23·58	22·61	19·07	21·28	20·43	18·75	21·69	23·45	45·08	130·08	127·52
TOTAL Amount of Solid Matter Suspended and Dissolved: (*Grains per Gallon*)																	
Mineral	- - -	- - -	23·07	20·96	20·12	- - -	- - -	- - -	23·67	23·40	23·67	20·64	22·89	25·65	51·62	172·02	163·85
Organic	- - -	- - -	1·84	1·39	1·90	- - -	- - -	- - -	2·36	1·94	2·19	1·40	2·28	2·03	2·28	12·67	7·45
TOTAL	20·50	18·28	24·91	22·35	22·11	18·87	24·35	23·42	20·09	25·43	25·86	21·13	25·17	27·68	53·90	184·69	171·30

Appendix I.

Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

In glancing at the results contained in the Table it is at once obvious that the amount of suspended matter contained in the different specimens of water cannot possibly be considered as representing the degree of sewage-pollution of the river.

The mere *amount of mud* affords no evidence of the extent of contamination with sewage; all rivers necessarily carry along large quantities of mud, which, if the water be agitated in consequence of the current, or by the traffic of steamboats, is prevented from settling and renders the water turbid. When the bottom of the Thames is stirred up at Kew or Richmond, the water becomes as thick and opaque as at London Bridge; in fact our analyses show that at Rainham Creek, which the London sewage probably never reaches, the river at the time the sample was taken was more muddy than at any other point in its course.

It is rather the *chemical nature of the mud*, and especially the percentage of *organic matter* and of *nitrogen*, from which the contamination with sewage within certain limits can be inferred. We have not determined the amount of nitrogen in the mud, but even the percentage of organic matter is sufficiently characteristic of its nature.

TABLE.—PERCENTAGE of ORGANIC MATTER in the Mud at different Points in the River's Course.

(Calculated from the relative Proportion of Mineral and Organic Matter given in the preceding Table.)

At Kew Bridge. C.	At Hammersmith Bridge. D.	Wandsworth Lock. M.	Westminster Bridge (High Water). L.	Westminster Bridge (Flood). P.	London Bridge (High Water). Q.	London Bridge (Flood). O.	Victoria Dock (LowWater). S.	Victoria Dock (High Water). T.	Rainham Creek (High Water). V.	Rainham Creek (LowWater). W.
17·61	16·91	21·32	22·14	23·09	27·69	19·00	18·69	15·88	17·22	13·63

This Table speaks for itself; the maximum being at London Bridge, and the proportion of organic matter in the mud steadily declining in either direction.

The analyses further show that, much as has been said about the *dissolved* organic matter introduced into the Thames by the sewage, diffused as it is through the large volume of the river, its amount is, after all, but very small; for, excluding the samples of water taken from Rainham Creek from the consideration, on account of their large commixture with sea water, and comparing all the other analyses, it will be seen that the smallest quantity is 0·85 grains in the gallon, the largest being 1·43 grains. It would appear, in fact, that at different states of the tide the amount of dissolved organic matter in Thames water fluctuates between these extremes at all the different places, not containing any very decidedly larger quantity at Westminster or London bridges than at Kew or Richmond; *e.g.*, at Westminster Bridge, at low tide, it was below the average, viz., 0·94, and even at Blackwall 0·88; whilst, on the other hand, it was above the average, at Teddington Lock 1·43, at Kew Bridge 1·13, at Hammersmith Bridge 1·30, and at Wandsworth 1·40.

Nevertheless, when a very large number of analyses is made extending over long periods, and a mean taken of these, as might be expected, there is found to be a somewhat larger quantity of dissolved organic matter where the London sewers empty themselves into the river.

In illustration of this point, we may quote some experiments made by one of us last year upon this subject.* On comparing the composition of the river at Kingston and at Chelsea throughout the year, it was found that the mean composition for the whole year at these two points was as follows:—

Mean

* H. M. Witt. On the Variations in the Composition of the Thames Water during the year, between May 1855 and May 1856.—Phil. Mag., July 1856.

	Mean Annual Composition of Thames Water. (*Grains per Gallon.*)		
	At Chelsea.	At Kingston.	Excess at Chelsea above Kingston.
Total suspended matter - - -	30·15	3·03	27·12
Dissolved matter - Mineral - - -	36·62	19·40	17·22
Dissolved matter - Organic - - -	1·16	1·05	0·11
Total dissolved matter - - -	37·78	20·45	17·33
Total amount of solid constituents - - -	67·93	23·49	43·44

It is remarkable that although there was so large an excess of suspended matter and of dissolved mineral matter at Chelsea, still the excess of dissolved organic matter was extremely small.

The preceding analyses of Thames water then show that the amount of dissolved organic matter in it is comparatively small, and varies moreover between narrow limits. Similar results have been obtained in former years, as may be seen by glancing at the following Table, which gives the amount of soluble organic matter existing in the Thames water supplied to the Metropolis by the several water companies in 1851* and 1856.†

Name of Water Company.	Place whence Supplied.	Organic Matter. (*Grains per Gallon.*)	
		1851.	1856.
Grand Junction - - - - -	Kew - - - - - - -	3·07	1·38
West Middlesex - - - - -	Barnes - - - - - -	2·75	0·96
Chelsea‡ - - - - - -	Red House, Battersea - - -	2·38	1·42
Southwark and Vauxhall - -	Red House, Battersea - - -	1·51	1·37
Lambeth - - - - - -	- - Lambeth, 1851; Thames Ditton, 1856.	2·59	1·33

Since the *quantity* of dissolved organic matter is so small, the unwholesome character which it imparts to the water must arise chiefly from the peculiar *condition* in which it exists in the water. The opinions of chemists are divided as to the manner in which it exerts a deleterious effect upon the animal economy; but it is now generally admitted that the substances which constitute the organic matter of water act injuriously by no means in consequence of being poisonous themselves, but by undergoing those still imperfectly understood processes of transformation called *decay* and *putrefaction*, to which all animal and vegetable matter is subject when no longer under the control of vitality, in animals or in plants. These putrefactive processes either give rise to the formation of poisonous bodies, or—and this is far more probable—they act simply as ferments, exciting similar processes of decomposition in the substances composing the living animal organism. Decay and putrefaction are remarkably accelerated and facilitated by heat, and it is, in fact, during the comparatively short season of hot weather that the inconvenience arising from the presence of dissolved organic matter in the river water is particularly felt. The small amount of this matter, which is scarcely perceived in winter, and which during spring and in

* Report on the chemical quality of the supply of water to the metropolis, addressed to Sir George Grey, Bart., by Professors Graham, Miller, and Hofmann.

† Report on the chemical quality of the supply of water to the metropolis, addressed to the Right Hon. William Cowper, President of the General Board of Health, by Professor Hofmann and Mr. Blythe.

‡ In the beginning of 1856, when these analyses were made, the new works belonging to the Chelsea Waterworks Company at Kingston were not quite complete; but at present this as well as the Lambeth Company derive their supply from that source.

in the early part of summer is perfectly harmless, becomes decidedly mischievous soon after the hot weather has set in.

The share which the dissolved organic matter has in the generation of those deleterious emanations which rise from the river during the hot season cannot be doubted. A portion of Thames water which has been allowed to deposit all the suspended matter, which has been filtered through sand or paper, or even animal charcoal, or which has been treated with lime, and thus been rendered transparent, colourless, and inodorous, when exposed to the air for a day or two during the hot weather rapidly undergoes putrefaction, which in the first place manifests itself in the exhalation of an offensive odour, and gradually exhibits all the well-known appearances presented by putrefying substances, not unfrequently with the development of some of the lower forms of organised beings which generally attends these processes. The water gradually becomes slightly turbid, and after a time a quantity of insoluble matter collects at the surface in the shape of a thin froth. The water has now become clear again, every trace of colour and taste, or odour, has disappeared; the process of putrefaction is accomplished.

The phenomena to which we allude here are well known to those engaged in storing Thames water on board ship, where this putrefactive fermentation and subsequent purification of the water is frequently observed.

Processes of a perfectly analogous character, and following each other in similar succession, are accomplished throughout the entire river and during the whole year, but more particularly so during the hot summer months. We have already pointed out the fact that numerous analyses by very different observers, and extending over a considerable period, have undoubtedly proved that the amount of this dissolved matter is *extremely small*. It has been shown, moreover, that its amount is not very perceptibly greater at London or Westminster Bridge, where the water of the river looks so dirty, than at Kingston, Kew, or Richmond, where it presents so beautifully clear and inviting an appearance. Why then is it, we may ask, that the effects of these putrefactive decompositions become so intolerable on the banks of the Thames, in the immediate neighbourhood of London, when compared with those perceptible in the higher portions of the river?

It is obvious that the greater surface of the river as it traverses the metropolis, together with the agitation to which it is constantly subjected by the navigation, but especially by the steam-boat traffic, as well as its tidal movements, must considerably facilitate and accelerate the progress of putrefaction; it is also evident that the quantity of soluble matter which, in consequence of the increased rapidity of putrefaction, is constantly being removed from the water is as quickly and constantly replaced by the discharges of the sewers. These conditions alone would be sufficient enormously to increase the intensity of the process of putrefaction in this part of its course, and consequently to multiply the quantity of offensive emanations to an intolerable and dangerous degree.

But the river in the neighbourhood of London contains an additional and even more formidable element of mischief in the black mud which subsides from the sewage, and which, in spite of the tidal movements of the river, has accumulated to a considerable degree, and is daily more and more accumulating in the bed of the river, so much so, indeed, that the continuation of the process would lead to the formation of deposits which, in future geological ages, might prove a source of manure scarcely less valuable than our beds of coprolites, phosphorite, and even of guano itself. This black mud contains a very considerable quantity of organic matter of a most putrescible kind. Alternately immersed in water, and exposed to the action of the air, which, in consequence of its porous condition, it absorbs in large proportions, this mud unites all the conditions favourable for the most active putrefactive fermentation, evolving not only most offensive gaseous emanations, but diffusing also a large amount of putrescible soluble matter through the river, which supplies additional material to the process of decomposition which is going on in the water itself.

We cannot but emphatically insist upon it, that the formation of this mud deposit in the river appears to us by far the most serious evil which results from the discharge of the London sewage into the river. We cannot too strongly urge this point upon public attention. The evil is not confined to the river; it would appear that similar deposits are forming also in the sewers themselves, notwithstanding the improvement which has taken place of late in the construction, cleansing, in fact, in the whole management of the sewers. We had an opportunity of obtaining some information upon this subject during experiments which were made on the composition of the sewage discharged from the Savoy-street sewer after the sudden and heavy fall of rain on the night of Friday, June 19. These experiments will be given in detail hereafter, but it may be even here mentioned, that notwithstanding that the volume of water running through the sewer had risen to six times the maximum flow of that particular hour, still instead of (as might have been expected) the sewage water being proportionately diluted, it contained more than twice the quantity of total solid constituents, and especially of insoluble matter, present under normal circumstances, so that the sewer actually discharged more than 20 times as much solid matter as usual in dry weather.

The amount of dissolved mineral substances which exist in the Thames is of little importance in a sanitary point of view, when compared with the organic matter. The

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variation which the influx of the sewage must induce in the amount of this class of bodies is not very strikingly shown by our analyses, the minimum amount being 16·49 grains in the gallon at Teddington Lock, and the maximum (excluding the samples from Rainham Creek, which contained a very considerable proportion of sea water) 22·21 grains at Blackwall (and even here the increase may be partially due to sea water), the mean between the two extremes being 19·35 grains.

When, however, a much larger number of analyses is made, extending over the whole year, this point comes out more forcibly. On comparing the quantity of dissolved salts at Kingston and Chelsea, observed during the whole year 1855-6*, it was found that their mean quantity at Kingston was 19·404 grains in the gallon, and at Chelsea, 36·62 grains, showing an excess of no less than 17·216 grains at Chelsea.

It appears, in fact, that the most obvious effect of sewage upon the composition of Thames water, as respects the constituents in solution, is to increase the quantity of salts, and especially of common salt, as might have been anticipated *à priori*. With the view of elucidating this point, in the experiments, extending over a whole year, to which we have before alluded, determinations were made of the quantity of common salt (chloride of sodium) in each case, in the water at Chelsea and at Kingston, and it is certainly remarkable how the quantity increased where the large sewers fall into the river, as compared with the amount which is present in the river above Teddington Lock.

The following are some of the results:—

Grains per Gallon.

	At Chelsea.	At Kingston.	Excess at Chelsea above Kingston.
"Chlorine - - - -	6·403	1·213	5·190
Common salt - - - -	10·551	1·998	8·553
Sulphuric acid - - -	3·225	2·633	0·592
Lime - - - - -	8·196	7·884	0·312"

The large amount of common salt introduced into the water by the sewage has induced some chemists to infer, from the amount of salt found on analysis, the extent of contamination with sewage; but this method of estimation must be adopted with caution, more especially when applied to a tidal river.

II.—Mean Composition and Agricultural Value of London Sewage.

Mode of collecting the Samples.

Since it was found that the composition of the sewage varied considerably at different hours of the day, containing a much larger amount of fecal matter at from 8 to 12 A.M. than at any other portion of the 24 hours, and being extremely dilute between 12 at night and 5 or 6 o'clock A.M., it was found convenient, in order to arrive at a knowledge of the mean composition, to collect samples of equal volume at every hour during the 24, to mix these together, and then analyse this mixture.

It is obvious that the results obtained in this manner must represent pretty accurately the average quantity of solid constituents present in a given volume of sewage during the 24 hours. To assume that it represents also the average composition of the whole quantity of sewage discharged during the 24 hours, would involve the further assumption that the rate at which the sewage was discharged had remained constant during this space of time. This is, however, far from being the case, as may be readily seen by a glance at the Table No. 2, given in the Appendix, which shows the gaugings of the Savoy-street sewer during the 24 hours, on both the occasions on which our experiments were made. In order to arrive at a correct knowledge of the total quantity of solid matter discharged by the sewer during the 24 hours, it would have been necessary to make separate analyses of every sample, and at the same time to gauge the flow of the sewer. In this manner data would have been obtained for approximatively determining the amount of solid constituents voided by

* H. M. Witt, paper before quoted.

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by the sewer during each hour, and for calculating from these the total amount discharged during the 24 hours; and then, by dividing by the number of gallons, we should have arrived at the correct mean composition of the gallon of sewage. The short time at our disposal, however, precluded the possibility of this mode of proceeding.

The referees considered that the Savoy-street sewer would best represent the average of the London sewers, and, therefore, this sewer was selected for our experiments.

Samples of equal volume were taken from the outfall of this sewer at every hour during the 24 hours, commencing at 6 A.M. on the morning of the 13th May 1857; they were mixed in the manner above described, and analyses made of the mixture, with the following results, the details of which are given in the Appendix, No. 3:—

1st. Analysis of Mean Sewage (from the Savoy-street Sewer), 13th May 1857:

		Grains per Gallon.
Suspended matter - -	Mineral - -	10·58
	Organic - - -	8·35
		18·93
Dissolved matter - -	Mineral - - -	55·60
	Organic - - -	20·17
		75·77
Total solid constituents -	Mineral - - -	66·18
	Organic - - -	28·52
	Total - - -	94·70

2d. Analysis of Mean Sewage (from the Savoy-street Sewer), 11th June 1857. (Details in Appendix No. 4.)

		Grains per Gallon.
Suspended matter -	Mineral - - -	19·23
	Organic - - -	13·55
		32·78
Dissolved matter - -	Mineral - - -	58·89
	Organic - - -	19·33
		78·22
Total solid constituents -	Mineral - - -	78·12
	Organic - - -	32·88
	Total - - -	111·00

Comparison of two previous Analyses.

		May 13.	June 11.	Mean.
Suspended matter	Mineral -	10·58	19·23	14·90
	Organic -	8·35	13·55	10·95
	Total - -	18·93	32·78	25·85
Dissolved matter	Mineral -	55·61	58·89	57·29
	Organic -	20·17	19·33	19·75
	Total - -	75·78	78·22	77·04
Solid constituents	Mineral -	66·18	78·12	72·15
	Organic -	28·52	32·88	30·70
	Total - -	94·70	111·00	102·85

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The results of these two experiments agree as well as could be expected in a case of this kind; in fact, the quantities of dissolved matter in the two experiments almost coincide. Nevertheless, we are fully aware how desirable it would have been to have our calculations based upon a broader experimental foundation. Considering, however, that the object of this inquiry was nothing more than to obtain a general idea of the value of sewage, we believe that we were not very far from the truth in adopting the mean of the two experiments given above, as a starting point for calculation. We shall have an opportunity in the latter part of this chapter of uniting in a Table a number of analyses of sewage water, which in the prosecution of this inquiry were made for different purposes. It will be found that a correct interpretation of these experiments leads to nearly the same result. We shall also quote a number of observations made by other inquirers, which, with a few local exceptions, are likewise in favour of the number deduced from our experiments.

Calculation of Value of Mean Sewage as a Manure.

In estimating the value of sewage for agricultural purposes, it may be useful to glance for a moment at the composition of sewage matter. Considering the origin of this matter, the composition of the urine, and of the solid fæces of man and animals, we can form a pretty correct idea of the nature of this mixture, even without experiments. It is obvious that the solid portion of the sewage must in a great measure have the composition which chemical analysis has assigned to the solid portion of animal excrement, whilst the liquid part must correspond with that of urine, the urea of which, in consequence of putrefaction, has mostly been converted into carbonate of ammonia;—making due allowance for the accession of matters from other sources, such as the washings of the granitic pavement of the London streets, the refuse of various chemical and other factories, &c.

In consequence of the multifarious character of these sources of additional solid matter, it becomes very interesting to examine the results which have been obtained by actual experiment. The following Table gives the composition of the sewage from the sewer in Dorset-square. This analysis we quote from Mr. Thomas Way, the well-known Chemist to the Royal Agricultural Society of England, whose important researches we have had frequent opportunities of consulting. We have re-arranged the results of the analysis, which is given in full in the Appendix, No. 5.

COMPOSITION of the Solid Sewage Matter from Dorset-square.

		Grains per Gallon.
Valuable Constituents of Sewage Matter.	Nitrogen	14·79
	Phosphoric acid	4·17
	Potash	3·32
	Organic matter, free from nitrogen	65·53
Comparatively Unimportant Constituents of Sewage Matter.	Sulphuric acid	3·91
	Carbonic acid	12·57
	Lime	15·77
	Magnesia	0·07
	Sesquioxide of iron and alumina	2·66
	Chloride of sodium	29·37
	Soluble silica	13·25
	Sand, &c.	45·28
	TOTAL	209·70

We have placed at the head of this Table the constituents of sewage, on which its value for agricultural purposes almost exclusively depends; and which alone need be taken into consideration in estimating the commercial value of sewage matter. All the rest, although of a certain value, perhaps, in special cases, are quite subordinate, and may be altogether disregarded.

Nitrogen.

The nitrogen in sewage matter is present chiefly in two forms; viz., either as carbonate of ammonia, and other ammoniacal salts, or in combination with the organic matter. In order not to lose the former, the sewage matter was evaporated to dryness with hydrochloric acid, and the residue thus obtained used for estimation.

Phosphoric Acid.

The phosphoric acid in sewage matter is likewise present in two different forms; viz., as insoluble phosphates (phosphate of lime and phosphate of magnesia), and as soluble phosphates (phosphates of soda and ammonia). The soluble phosphates have a much higher value than the insoluble ones. We have calculated all the phosphates as lime-salts.—(*See* Appendix, No. 7.)

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Potash.

We have not estimated the potash experimentally, since we had sufficient data for calculating its amount; partly from the known composition of urine, which is one of the principal sources of the potash in sewage, partly from the analytical results of others.—(*See* No. 8, in the Appendix.)

Organic Matter.

It was determined by incineration. We have neglected the small error arising from the volatilisation of ammoniacal salts, since the amount is not large, and the value of the organic matter (after deducting the nitrogen) is so small, when compared with that of nitrogen and phosphoric acid, that this could not possibly exert an appreciable influence on the estimation.

We thus arrived at the following quantities of valuable constituents in the gallon of London sewage:—

	Grains per Gallon.		*Grains per Gallon.*
Nitrogen	6·76	corresponding to	8·21 of ammonia.
Phosphoric acid	1·85	„	4·01 of phosphate of lime (bone phosphate).
Potash	1·03		
Organic matter	30·70		

(For details, *see* Appendix, Nos. 6 and 7.)

or 100 parts of the solid residue, as it might be obtained by evaporating the whole sewage water with hydrochloric acid, in order to fix the ammonia, correspond to

Ammonia	7·98
Phosphate of lime (Insoluble)	1·27
Phosphate of lime (Soluble)	2·63
Potash	1·00
Organic matter	30·11

In estimating the commercial value of the available constituents of sewage, we should not arrive at a correct conclusion if we were to base such a calculation upon the prices at which the individual components, such as ammoniacal salts, phosphates, potash-salts, &c., can be separately bought in the market. In order to arrive at a practical result, it is necessary to ascertain the value of these substances in a commercial article which is extensively used as a manure. The most convenient standard that suggests itself is doubtless guano, which owes its efficacy to exactly the same constituents.

The price of guano fluctuates considerably, not only on account of its variable composition; but time, locality, and other elements exert considerable influence upon the value of this article. It is therefore not quite easy to arrive at average numbers, representing the value of the several constituents available as agricultural products. If we compare the statements of different authors, we find, in fact, that these numbers fluctuate between extremes rather widely separated.

In the following calculation, we have availed ourselves of the values adopted by Mr Way, whose experience on all subjects connected with agricultural chemistry leads us to think that they may be considered as the average values of the present time.—(*See* Appendix, No. 10.)

These numbers are as follow:

	Per Ton. £.	*s.*	*d.*
Ammonia	56	–	–
Phosphate of lime (Insoluble)	7	–	–
Phosphate of lime (Soluble)	32	–	–
Potash	31	–	–
Organic matter	1	–	–

(*See* Appendix, No. 11.)

100 tons of the solid constituents of the mean sewage accordingly have the following value:—

	£.	*s.*	*d.*
7·982 tons of ammonia, at 56 *l.* per ton	446	19	10
1·269 tons of insoluble phosphate of lime, at 7 *l.* per ton	8	17	8
2·631 tons of soluble phosphate of lime, at 32 *l.* per ton	84	3	10
1·0 ton of potash, at 31 *l.* per ton	31	–	–
30·11 tons of organic matter, at 1 *l.* per ton	30	2	2
Value of 100 tons	£. 601	3	6
Value per ton	£. 6	–	3

This number represents the value of a ton of the dry sewage constituents, including those which exist both in the soluble and in the insoluble condition. It appeared, however, for the

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the purposes of this inquiry, of very considerable interest to ascertain also the relative values of the soluble and of the insoluble portions of the sewage matter. For this purpose the nitrogen, phosphoric acid and organic matter were each separately determined in the insoluble matter. The potash-salts are chiefly present in the liquid portion.

Quantity of valuable Insoluble Constituents in the Gallon of London Sewage.

	Grains per Gallon.			Grains per Gallon.
Nitrogen	0·906	corresponding to	ammonia	1·10
Phosphoric acid	0·15	„	phosphate of lime	0.33
Organic matter	10·95			

Or 100 parts of this insoluble matter correspond to—

Ammonia	4·26
Phosphate of lime	1·27
Organic matter	55·89

(For details, *see* Appendix, Nos. 7 and 8.)

100 tons of this insoluble sewage matter accordingly have the following value:

	£.	s.	d.
4·264 tons of ammonia, at 56 *l.* per ton	238	15	8
1·269 of insoluble phosphate of lime, at 7 *l.* per ton	8	17	8
55·89 tons of organic matter, at 1 *l.* per ton	55	17	9
Value of 100 tons	£. 303	17	9
Value per ton	£. 3	–	8½

Remembering that the ratio of the suspended to the dissolved matter in the gallon of sewage is as 26 to 77, the proportional value of the suspended and dissolved matter in the sewage may be thus stated:—

	£.	s.	d.
Suspended matter (26 tons)	78	18	–
Dissolved matter (77 tons)	540	7	9
TOTAL value of 103 tons of the solid matter of sewage	£. 619	5	9

Or of the ton of total solid residue:—

	£.	s.	d.
Suspended matter	–	15	3
Dissolved matter	5	5	–
TOTAL value of one ton of the solid matter of sewage	£. 6	–	3

This result, which a knowledge of the sources of the solid matters of sewage enabled us to anticipate, is of considerable importance. It shows that at least six-sevenths of the constituents of sewage, valuable for agricultural purposes, exist in the soluble portion, the suspended matter having a comparatively very small value.

From these data we readily ascertain the money value of a certain weight or volume of the sewage itself.

100 tons of sewage contain,—

	Lbs.	Per Ton.		Value.
Suspended matter	82·72	at £.3. 0*s.* 8½*d.*	=	2*s.* 2½*d.*
Dissolved matter	245·95	„	=	15*s.* 4½*d.*
TOTAL	328·67	„ £.6. 0*s.* 3*d.*	=	17*s.* 7*d.*

Value of 100 tons.

For details, *see* Appendix, No. 11, 12, 13.

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Money Value of Total Sewage of London.

We learn from the Referees that the average quantity flowing into the river per day may be roughly stated at 95,000,000 of gallons. About 220 gallons weigh a ton, or 95,000,000 about 431,850 tons.

These, at 17*s.* 7*d.* for 100 tons, give as the—

	£.
Daily value of the London sewage	3,796
Annual value	1,385,540

It appeared of interest in some measure to control this number, which, it need not be repeated, must be received merely as a distant approximation to the truth, by calculating the amount of valuable constituents annually excreted in the form of urine and fæces by the entire metropolitan population. This calculation (for details *see* Appendix, No. 14) shows that the annual value as manure of the valuable constituents of the urine and fæces voided by a population of 2,600,000 persons, amounts to 1,444,177 *l.*

This close coincidence of numbers is certainly remarkable, for it is well known that not nearly the whole population drain into the sewers; again, the calculation assumes the whole population to be adults, which is very far from being the case, these errors render our number above the truth; but, on the other hand, valuable matters are washed into the sewers from various other sources; the dung of horses and cows, dogs, and other animals; fatty acids from soap; the washings and *debris* of the granitic pavement of the streets, &c. &c.; these all have the opposite tendency of raising the value; so that we cannot help thinking that the close accordance of the results obtained by two methods of calculation so different, may be fairly taken as representing the broad facts of the case.

Still, we must never lose sight of the uncertainty of the data upon which a calculation of this kind naturally rests. We have already pointed out how desirable it would have been to have analysed each of the individual samples taken during the 24 hours at the Savoy-street sewer, instead of the mixture, and to multiply the sets of experiments; in fact, to continue the observations during a far longer period. In this manner a pretty correct notion of the average amount of solid constituents discharged by the Savoy-street sewer would have been obtained. But even thus we should have made but little progress towards the solution of the problem, unless the same method had been applied to all the other sewers. A moment's reflection shows the endless number of experiments and gaugings involved in such a mode of proceeding, quite out of proportion with the value of the knowledge that would have been thus attained.

Now, although all such determinations cannot possibly be more than rough averages, it appeared, nevertheless, of some interest to see the foundation of our calculation confirmed by additional experiments of our own, and by the observations of others.

We have in the course of this inquiry, for a variety of purposes, determined the total amount of solid constituents contained in the gallon of sewage from several of the other metropolitan sewers.

The results of these experiments, to which we shall have more than one opportunity of referring in the subsequent chapters of this Report, are united in the following Table B, in which, for the sake of comparison, we give also once more the results obtained at the Savoy-street sewer.

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TABLE B.—ANALYSES OF SEWAGE (for Details *see* Appendix, No. 15.)

TITLE OF SAMPLE.	1. 1st Mean Sewage, (Savoy-street.)	2. 2nd Mean Sewage, (Savoy-street.)	3. Mean of two previous Analyses.	4. Savoy-street Sewer, after Storm.	5. I. 33, 34, 35, & 36. Falcon Brook.	6. R. 67, 68, 69, & 70. Earl Sewer.	7. N. 37, 38, 39, & 40. The Fleet.	8. C. The Fleet before Rain.	9. D. The Fleet after Rain.	10. G. 25, 26, 27, & 28. King's Scholars' Pond.	11. G. King's Scholars' Pond before Rain.	12. H. King's Scholars' Pond, after Rain.	13. Northumberland-street Sewer.	14. Northumberland-street Sewer.	15. Northumberland-street Sewer.
Whence taken	Savoy-street sewer.	Savoy-street sewer.	- -	Savoy-street sewer.	York Gate, at the front gates.	St. George's Stairs.	Mouth at Blackfriars Bridge.	- -	- -	Pimlico -	- -	- -	At outfall on Northumberland Wharf, Strand.		
Date	May 13, 1857.	June 11, 1857.	- -	June 20, 1857, at 2.15 A.M., after heavy thunder storm.	Mar. 19, 1857 1.25 P.M.	Mar. 20, 1857 11.10 A.M.	April 10, 1857, 12.15 P.M.	April 10, 8.45 P.M.	April 9, 11 A.M.	March 18, half ebb, 10 A.M.	April 8, 7.45 P.M.	April 9, 10 A.M.	May 10, 1857, 10 A.M.	May 28, 1857, 10 A.M.	June 13, 1857, 10 A.M.
Flow in the sewer at the time	Normal flow, 54 cubic feet per minute.		- -	1,060 cubic feet per minute, increase 19 to 20 times.	Low-water -	Depth of water 4 feet.	Low-water 2,269 feet.	1,144 cubic feet per minute.	5,360 cubic feet per minute.	1,620 cubic feet per minute.	970 cubic feet per minute.	5,170 cubic feet per minute.	503 cubic feet per minute.	753 cubic feet per minute.	511 cubic feet per minute.
Suspended matter (*grains per gallon*) - -	10·58 8·35	19·23 13·55	14·90 10·95	- - - - - -	1·94 1·60	1·46 1·42	19·30 10·86	9·18 6·20	110·54 35·46	14·59 12·04	25·91 15·19	110·48 30·85	16·09 36·40	21·48 35·42	14·44 25·04
TOTAL - - -	18·93	32·78	25·85	- - -	3·54	2·88	30·16	15·38	146·00	26·63	41·10	141·33	52·49	56·90	39·48
Dissolved matter (*grains per gallon*) - -	55·61 20·17	56·89 19·33	57·29 19·75	- - - - - -	38·21 2·38	44·65 1·32	32·00 5·26	50·90 8·20	58·14 4·36	32·64 5·71	43·34 7·07	34·57 5·13	55·24 52·36	57·02 30·09	67·26 41·19
TOTAL - - -	75·77	76·22	77·04	- - -	40·60	45·97	37·26	59·10	62·50	38·35	50·41	39·70	107·60	87·72	108·45
Total solid constituents (*grains per gallon*).	66·18 28·52	78·12 32·88	72·15 30·70	188·49 108·48	40·15 3·99	46·11 2·74	51·30 16·12	60·08 14·40	168·68 39·82	47·23 17·75	69·24 22·26	145·05 35·98	71·33 88·76	79·11 65·51	81·70 66·23
TOTAL - - -	94·70	111·00	102·85	296·97	44·14	48·85	67·42	74·48	208·50	64·98	91·50	181·03	160·09	144·62	147·93

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The preceding Table gives the results obtained at different times at the Falcon-brook sewer, the Earl sewer, the Fleet sewer, the King's Scholars' Pond sewer, and the Northumberland-street sewer, the experiments being made partly under ordinary circumstances, and partly after heavy rains which, as has been pointed out already, induce an abnormal condition in the composition of the sewage. The Table shows that the variations in the composition of the sewage water are very great indeed, not only at the different hours of the day, but also at different seasons, the minimum quantity of solid constituents being as low as 44·14 grains (in the Falcon Brook sewer); whilst on one occasion, after the thunderstorm in the night of Friday, June 19, 1857, the total solid matter in the Savoy-street sewer rose to 296·97 grains in the gallon, of which 188.49 were mineral and 108·48 organic matter. But if we exclude the observation made under these last-mentioned circumstances from consideration, and limit ourselves merely to the experiments made under normal conditions (viz. those in the columns 5, 6, 7, 8, 10, 11, 13, 14, and 15), we arrive at average numbers which agree with those we have adopted, as well as may be expected.

	Mean of Experiments on the Savoy-street Sewer.	Mean of all the Rest.
	Grains per Gallon.	*Grains per Gallon.*
Suspended matter - - -	25·85	29·8
Dissolved matter - - -	77·04	65·2
	102·89	95·0
Mineral matter - - - -	72·15	62·0
Organic matter - - - -	30·69	33·0
	102·89	95·0

The average numbers of these experiments are somewhat lower than the numbers on which our calculations are founded.

On the other hand, the results obtained by Mr. Versmann,* late assistant to Professor Graham, in the analyses of several London sewers, are somewhat higher than our numbers. (*See* details of his results in the Appendix, No. 16.) An abstract of the results, together with his determinations of nitrogen and phosphoric acid, are placed in juxtaposition with our numbers, in the following Table:

	Mean of Experiments made at the London Bridge and St. Paul's Sewers. F. Versmann.	Mean of Experiments made at the Savoy-street Sewer. H. & W.
	Grains per Gallon.	*Grains per Gallon.*
Total of solid constituents -	129·7	102·9
Nitrogen - - - -	7·88	6·76
Phosphoric acid - - -	1·08	1·89

All these results have been obtained by the analysis of samples taken at the outfall of the sewers. If, however, the sewage be examined when taken from a point in the sewer at a distance from the river, owing to local circumstances, doubtless much greater discrepancies are observed. This is strikingly illustrated by the analyses made by Mr. Way of the sewage from the sewers in Dorset-street and Barrett's-court. In the first, to which allusion has already been made, he found not less than 209·7 grains (per gallon) of solid matter, whilst in the sewage from Barrett's-court the quantity actually rose to nearly 500 grains (492·26). *See* Appendix, No. 17.

In

* These analyses, together with several other interesting results, are taken from an able Report addressed by Mr. Versmann to Fothergill Cooke, Esq.; and we are greatly indebted to Mr. Cooke for the truly liberal and public-spirited manner in which he has placed this valuable document at our disposal.

Appendix I.

Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

In conclusion, it may be interesting to compare the average composition of London sewage with the results of the analyses of the sewage from other towns. For this purpose we will quote the analysis of the Leicester sewage, by Mr. Versmann, and that of Edinburgh, by Dr. Anderson, although we are ignorant of the particular circumstances (place, time, and state of the weather) under which the samples were taken. Mr. Versmann found in the gallon of Leicester sewage 106·61 grains of solid constituents, which nearly coincides with our numbers. Dr. Anderson found in the Edinburgh sewage somewhat more, viz. 132·71. (*See* Appendix, Nos. 18 and 19.)

For the sake of comparison, we tabulate all the various results:

ANALYSES OF THE SEWAGE.	Amount of Solid Matter contained in Sewage.	Analysis.
	Grains per Gallon.	
Savoy-street sewer; mean of two experiments -	102·9	H. & W.
Falcon Brook sewer, Earl sewer, Fleet sewer, King's Scholars' Pond sewer, Northumberland-street sewer; mean of experiments - - -	95·0	H. & W.
London Bridge and St. Paul's sewer - - -	129·0	Versmann.
Leicester sewage - - - - - - -	106·6	Versmann.
Edinburgh sewage - - - - - - -	132·7	Anderson.

III.—Utilisation of Sewage for Agricultural Purposes.

The processes which have been proposed at different times for the deodorisation of sewage, and for the preparation of a manure from it, are very numerous. An excellent historical sketch of the successive plans which have been adopted for this purpose is to be found in a lecture delivered to the members of the Chemical Society by Mr. Dugald Campbell, and published in the "Engineer" journal. The several patents are likewise described by Mr. Austin,* in his report to the President of the Board of Health; and moreover, an excellent summary is to be found in the "Abridgments of Patents relating to Manures." Published by Her Majesty's Commissioners of Patents.

Of the vast number of processes which have been proposed, there are but few which offer any reasonable prospect of success. The referees directed our attention more particularly to the following:

(A.)—Treatment of sewage with lime.

(B.)—Treatment of sewage with a mixture of lime, sulphate of alumina, and charcoal. (Stothert and Gotto's process.)

(C.)—Treatment of sewage with charcoal. (Jasper Rogers' and Richard Dover's processes.)

1. Filtration of sewage through charcoal.
2. Agitation of sewage with charcoal.

(D.)—Treatment of sewage, with a magnesian salt. (Sir James Murray's process.)

* "Report on the Means of Deodorising and Utilising the Sewage of Towns; addressed to the Right Hon. the President of the General Board of Health. By Henry Austin, C.E., Chief Superintending Inspector of the Board. London. 1857."

Appendix I.

Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

(A.)—Treatment of Sewage with Lime.

This appears one of the most promising of the many processes for obtaining from sewage a deposit which, when dry, may be employed as a manure.

The idea would appear to have been originally suggested by Dr. Clark, of Aberdeen,* but has been extensively adopted by various persons in different places, by more than one of whom it has been patented.

In London it has been chiefly carried out by Mr. Higgs, at Tottenham, who obtains a manure which has been extensively sold under the name of "Tottenham Sewage Guano," and by whom an analysis of the product has been published, which will be found in the Appendix, No. 20.

No where has the lime-process been carried out on so large a scale as at Leicester by the Patent Solid Sewage Manure Company, working Mr. Wicksteed's patent, under the auspices of Mr. Fothergill Cooke; moreover the mechanical appliances adopted at the Leicester Works are described as very perfect and efficient. Analyses of the "Leicester bricks" (for this is the name under which the manure is sold), are given in the Appendix; viz. No. 21 by Dr. Voelcker, and No. 22 by Mr. Versmann.

Mr. Blackwell, of Bristol, after consulting one of us (Dr. H.) on the subject, has adopted this process for deodorising the sewage of the Clifton Union. At Clifton it was found that the deodorisation was tolerably complete. The amount of excrement being limited, this treatment could be regularly effected every day before the sewage had undergone putrefactive decomposition, and comparatively little inconvenience was experienced even during the process of mixing. It is scarcely necessary to state, that the sewage discharged from a London sewer exhibits a perfectly different deportment. Here the organic matter, in consequence of having been carried along in the sewage water through a considerable distance, has undergone a thorough change, the urea is entirely converted into carbonate of ammonia, and together with the latter a number of other apparently similar bodies are produced, which are set free by the action of an alkaline substance like lime. Ordinary London sewage indeed evolves an offensive odour during the performance of the mixing operation.

The analysis of the deposit obtained at the Clifton Union is given in the Appendix, No. 23.

Our experiment with London sewage was made on the 16th of May 1857, upon the sewage discharged at the mouth of the Northumberland-street sewer, on the Northumberland Wharf, in the Strand, in the presence of the referees.

A sample of the sewage in its original state was taken, and subsequently submitted to analysis.

Forty gallons of this sewage were placed in a capacious vessel; then 800 grains, (*i. e.* in the proportion of 20 grains to the gallon, the quantity specially suggested by the Referees),† of "common gray Dorking lime" were slaked with a pint or so of the sewage, and finally very intimately mixed and agitated with the whole quantity of sewage; and then the whole allowed to remain perfectly quiet, to facilitate the subsidence of the insoluble matter.

This took place in about an hour; but, that it might have a fair chance, it was allowed to remain for altogether three hours. The supernatant fluid was then syphoned off; a sample of it was preserved for analysis, and also a sample of the deposit itself was taken.

The supernatant fluid was still opalescent, the whole of the suspended matter had not been completely removed by the process, and it certainly was by no means perfectly deodorised.

Our impression at the time, so far as we could judge from the experiments, was, that the action of lime on sewage essentially differs with recent sewage, and with sewage that has already undergone putrefactive changes. A great deal of the feculent matter which exists in recent sewage appears to be of an acid character, and capable of uniting with the lime. In cases like that of the Clifton Union, a great portion of this matter is, in fact, carried down in a sort of chemical combination with the lime. If the sewage is allowed to undergo putrefaction, the acid character of the feculent matter is more and more changed, and then the lime appears simply to facilitate and to accelerate the subsidence of the suspended matter, which would have been deposited by itself, if the liquid had been allowed to stand for a longer period. In a special experiment made for this purpose, we observed that the supernatant fluid from the deposit obtained by simple subsidence was not to the eye perceptibly more turbid than that from the deposit obtained by the lime, though the subsidence took place as completely with lime in one hour, as it did in four hours without it.

Composition

* "A new mode of rendering certain waters (the water of the Thames being among the number) less impure, and less hard for the supply and use of manufactories, villages, towns, and cities." 1841.

† Mr. Fothergill Cooke, in his lecture "On the Utilisation of the Sewage of Towns," delivered before the Society of Arts, 12 December 1856, states, "that from 2 to 16 grains of lime are used to the gallon of water."

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Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

Composition of Sewage used.

(For details of Analysis, *see* Appendix, No. 13.)

		Grains per Gallon.
Suspended matter	Mineral	16·09
	Organic	36·40
	TOTAL	52·49
Dissolved matter	Mineral	55·24
	Organic	52·36
	TOTAL	107·60
Total solid constituents	Mineral	71·33
	Organic	88·76
	TOTAL	160·09

Effect of Treatment with Lime.

(Deduced from comparison of Analyses of the Original Sewage with the Analysis of the Supernatant Fluid after Separation of the Deposit.)

	Total Amount of Solid Constituents originally present. (*Grains per Gallon.*)	Composition of Supernatant Fluid. (*Grains per Gallon.*)	Amount Separated. (*Grains per Gallon.*)	Amount Separated. *Percentage Ratio of the Quantity originally present.*
Organic Matter	88·76	40·34	48·42	54·55
Mineral, ditto	71·33	55·68	15·65	21·94
TOTAL	160·09	96·02	64·07	40·02

N. B.—These 64·07 grains doubtless contain the greater part of the 20 grains of lime.

COMPARISON of the Amount Separated with the Quantity of Suspended Matter present, in order to show the Quantity of Dissolved Matter carried down from solution with the Suspended Matter.

	Amount Separated. (*Grains per Gallon.*)	Suspended Matter present. (*Grains per Gallon.*)	Amount of Dissolved Matter separated. (*Grains per Gallon*)	Amount of Dissolved Matter separated. *Percentage of Quantity originally present.*
Organic Matter	48·42	36·40	12·02	22·94
Mineral, ditto	15·65	16·09	—	—
TOTAL	64·07	52·49	—	—

This result shows that a small quantity of suspended mineral matter must have escaped separation by the liming process. It does not follow from this that the deposit does not contain any of the mineral matter originally dissolved in the water. On the contrary, it is very probable that a portion of this mineral matter has been separated in the insoluble form and replaced by the lime which has been added.

As to the efficiency of the lime treatment at Leicester, *see* Mr. Versmann's Results, in the Appendix, No. 24.

In

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In order to ascertain the money value of the deposit produced by the treatment of sewage with lime, determinations were made of the nitrogen, phosphoric acid, and organic matter present in it.

Analysis of the Deposit.

100 parts contain,

Nitrogen	1·55, corresponding to Ammonia		1·88
Phosphoric acid	2·93, corresponding to Phosphate of Lime		6·35
Organic matter	43·95.		

Note.—For the details of this Analysis, which was made on the absolutely dry substance, *see* Appendix, No. 25.

Calculation of Money Value of Lime Deposit.

100 tons correspond to,—

			£.	s.	d.
1·88 tons ammonia	at 56 *l.* per ton		105	5	7
6·348 „ phosphate of lime (insoluble)	at 7 *l.* „		44	8	8½
43·95 „ of organic matter	at 1 *l.* „		43	19	–
Value of 100 tons		£.	193	13	3½

Value per ton 1 *l.* 18 *s.* 8¾ *d.*

It may be interesting to introduce here, for the sake of comparison, the money values of the Leicester bricks deduced from Mr. Versmann and Dr. Voelcker's analyses; also of the lime deposit prepared at the Clifton Union.* Both Mr. Versmann's and Dr. Voelcker's analyses give a small amount of potash, which we have not taken into consideration in calculating the money value of the Leicester bricks, for it must have been in the insoluble, and therefore comparatively unavailable state, since the brick consists of the matter deposited from a dilute solution.

Calculation of the Money Value of the Leicester Bricks.

Of the Dry Substance, as deduced from Mr. *Versmann*'s Analysis,

100 tons correspond to,—

			£.	s.	d.
0·708 ton of ammonia	at 56 *l.* per ton		39	12	11½
2·43 tons of phosphate of lime (insoluble)	at 7 *l.* „		17	–	2
27·45 „ of organic matter	at 1 *l.* „		27	8	7
Value of 100 tons		£.	84	1	8½

Value per ton 17 *s.*

Of the Dry Substance, as deduced from Dr. *Voelcker*'s Analysis,

100 tons correspond to,—

			£.	s.	d.
0·804 ton of ammonia	at 56 *l.* per ton		45	–	5¾
2·586 tons of phosphate of lime (insoluble)	at 7 *l.* „		18	2	–¼
13·92 „ of organic matter	at 1 *l.* „		13	18	4¾
Value of 100 tons		£.	77	–	11

Value per ton 15 *s.* 5 *d.*

Money

* Dr. Hofmann's Report on the Deodorisation of Sewage of the Clifton Union, addressed to Thomas E. Blackwell, Esq.

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Money Value of the Lime Deposit from the Clifton Union.

Of the Dry Substance, as deduced from Dr. *Hofmann*'s Analysis,

	£.	s.	d.
100 tons correspond to,—			
0·75 „ of ammonia, at 56 *l.* - - - - - -	42	–	–
3·08 „ of phosphate of lime (insoluble), at 7 *l.* - -	21	11	2
20·12 tons of organic matter, at 1 *l.* - - - - -	20	2	4¾
Value of 100 tons - - - £.	83	13	7

Value per ton - - - 16 *s.* 9 *d.*

At the first glance it may excite some surprise that the deposit obtained in our experiments had so much higher a value than either the Leicester bricks or the lime deposit from the Clifton Union; this may arise partly from the fact, that the London sewage upon which we operated was actually richer;* but it is certainly also to a great extent due to the circumstance, that experiments of this kind are more successfully performed on the small scale, when every care can be bestowed upon them, than when carried out as manufacturing operations.

However this may be, we are inclined to believe that the results of our experimental trials on the liming process, as well as upon the various other processes for preparing manures from sewage, have been made under the most favourable conditions for obtaining products probably of the maximum value.

(B.)—Treatment of Sewage with a Mixture of Lime, Sulphate of Alumina, and Charcoal (Messrs. *Stothert* & *Gotto's* Process.)

The next process for the preparation of sewage manure submitted to us by the referees was that of Messrs. Stothert and Gotto. They propose† "to precipitate the more substantive parts of sewage water," by "a combination of animal or vegetable charcoal with fresh caustic lime and sulphate of alumina, or sulphate of zinc." They further remark that "the charcoal might be obtained by distilling the precipitated sewage matter or night soil."

The object of the mixture of lime and sulphate of alumina is evidently to give rise to a dense precipitate, throughout the fluid, of sulphate of lime on the one hand and of alumina on the other, by which the suspended matter would be mechanically carried down; the object of the charcoal is, obviously, to act as a deodoriser. The capabilities of charcoal, when mixed with water, of performing this office will be hereafter fully considered, we need not, therefore, enter upon this subject at present.

No analysis having been hitherto published, so far as we are aware of, of the precipitate obtained by this process, it became necessary for us to make an experimental trial, which was done at the same time and in the same place as that of the lime-process before described, *i. e.*, on the 16th of May 1857. At the mouth of the Northumberland-street sewer, 40 gallons of the sewage were measured into a capacious vessel, and with this 5 oz. of lime and 10 oz. of a mixture of charcoal and sulphate of alumina were intimately mixed; these are the proportions recommended by the patentees, who had the kindness to supply us with the necessary materials for performing the experiment.

The addition of the lime alone caused a considerable aggregation of the insoluble matter; but the effect subsequently of the addition of the sulphate of alumina was most striking; it was followed by an immediate coagulation and separation of the suspended matter present in the form of a dense precipitate, which rapidly sank to the bottom.

The clear supernatant fluid still contained a large amount of organic matter in solution, which could be easily inferred from its deep yellow colour; the liquid certainly had not been deodorised.

Samples were taken of the sewage before treatment, of the supernatant fluid which was syphoned off after it had been allowed to subside for three hours; and, lastly, of the precipitate obtained.

Since

* The Leicester sewage operated upon by Mr. Versmann contained 106·6 grains of total solid matter in the gallon; whilst the Northumberland-street sewage used in our experiment contained 160 grains in the imperial gallon.

† Abridgments of the Specifications relating to Manures. London, 1857. Page 22; A. D. 1852, April 17. No. 14073.

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Since the experiment was made side by side with the treatment by lime alone, it was impossible to refrain from making a comparison of the apparent relative efficacy of the two processes.

Whoever witnessed the operation could not entertain the slightest doubt that the deposition of the precipitate took place far more quickly, and that a larger amount of the suspended matter was removed from the sewage by Stothert and Gotto's mixture than by the addition of lime alone; but then it must be remembered that the quantity of material used was about eight times greater than that employed in the liming process.

The sewage employed was the same as that used in the liming experiment, so that it is only necessary to refer to the analysis there given (Appendix, Table B., col. 13).

Effect of Treatment with the Mixture of Lime, Sulphate of Alumina, and Charcoal.

(Deduced from a Comparison of the Analysis of the original Sewage with the Analysis of the Supernatant Fluid after Separation of the Deposit).

	Total Amount of Solid Matter originally present. *Grains per Gallon.*	Composition of Supernatant Fluid. *Grains per Gallon.*	Amount separated. *Grains per Gallon.*	Amount of Total Matter separated. *Percentage Ratio of Quantity originally present.*
Mineral matter - -	71·33	50·17	21·16	29·66
Organic ditto - - -	88·76	37·56	51·20	57·68
Total - - -	160·09	87·73	72·36*	45·19

* It is obvious that these 72·36 grains of sewage matter removed are mixed with a great part of the 180 grains of the mixture added.

Comparison of the Amount separated with the Quantity of Suspended Matter present, in order to show the Quantity of Dissolved Matter carried down from Solution with the Suspended Matter.

	Amount separated. *Grains per Gallon.*	Suspended Matter present. *Grains per Gallon.*	Amount of Dissolved Matter separated. *Grains per Gallon.*	Amount of Dissolved Matter separated. *Per Centage of Quantity originally present.*
Mineral matter - -	21·16	16·09	5·07	9·18
Organic ditto - - -	51·20	36·40	14·80	28·26
Total - - -	72·36	52·49	19·87	18·46

These results fully confirm the impression produced at the time of performing the experiment, that the mixture of lime and sulphate of alumina is capable of removing a larger quantity of matter from sewage than lime alone, and much more quickly. In fact, a glance at the last table shows that this process not only removes the whole of the suspended matter, but also a considerable quantity of dissolved matter, both mineral and organic; while with the lime-process a minute quantity even of suspended mineral matter is left unremoved.

For the purpose of ascertaining the money value of the deposit produced by this process, the nitrogen, phosphoric acid, and organic matter in it were determined.

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Analysis of the Deposit obtained from London Sewage by the addition of the mixture of Lime, Sulphate of Alumina, and Charcoal.

100 parts contain:—

Nitrogen - - - - -	1·21	corresponding to ammonia - - - - -	1·44
Phosphoric acid - - -	3·97	„ phosphate of lime - -	8·60
Organic matter - - -	35·97		

For details of analysis, *see* Appendix No. 26.

Calculation of the Money Value of the Deposit produced by the Mixture of Lime, Sulphate of Alumina, and Charcoal.

100 tons correspond to,—	£.	s.	d.
1·44 ammonia, at 56 *l.* per ton - - - - -	80	12	9½
8·60 of insoluble phosphate of lime, at 7 *l.* per ton -	60	4	–
12·47 of organic matter, at 1 *l.* per ton - - -	12	9	5
57·0 of sulphate of lime, at 1 *l.* per ton - - -	57	–	–
Value of 100 tons - - - £.	210	6	2½

Value per ton - - - - - 2 *l.* 2 *s.*

This shows a very slightly higher value for this deposit than for that obtained by the use of lime alone.

It may be interesting to compare these results with those furnished by an analysis made by Dr. Penny (*see* Appendix, No. 27), of the deposit obtained from the sewage of Edinburgh, by treating it with a somewhat similar mixture of animal charcoal, alum (or alum sludge and gypsum), under the superintendence of Mr. Manning.

Calculation of Money Value of this Deposit.

100 tons correspond to--	£.	s.	d.
2·22 tons of ammonia, at 56 *l.* - - - -	124	6	5
2·05 „ phosphate of lime, at 7 *l.* - - -	14	7	–
43·72 „ organic matter, at 1 *l.* - - -	43	14	5
Value of 100 tons - - - £.	182	7	10

Value per ton - - - - £. 1. 16 *s.* 5½ *d.*

Treatment of Sewage with Charcoal.

Charcoal has been long known to possess certain peculiar powers of *surface-attraction*, due to its highly porous structure, which have earned for it a well-merited reputation as a *disinfectant* or *deodoriser*. They manifest themselves chiefly in two ways:—

1st. By the absorption of gases.

2d. By removing organic, and even saline bodies, from solution in water.

De Saussure, many years ago, pointed out that different gases were absorbed in varying proportions by charcoal. His often-quoted experiments with boxwood charcoal showed that this substance absorbed of—

Ammonia gas - - - - -	90 times its own volume.
Hydrochloric acid - - - -	85 „
Sulphuretted hydrogen - - -	81 „
Carbonic acid - - - - -	35 „
Oxygen - - - - - -	9·25 „
Nitrogen - - - - - -	7·5 „
Hydrogen - - - - - -	1·75 „

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Its extraordinary avidity for ammonia and sulphuretted hydrogen gases, suggests at once its application for absorbing the effluvia given off during the treatment of sewage with lime, or by any of the other processes.

Besides absorbing these gases, it is believed by Dr. Stenhouse to possess a specific power of oxydising them, in consequence of the oxygen of the air already contained within its pores: however this may be, it is found to act most efficiently as a deodoriser when recently ignited.

It must, however, not be forgotten that if its pores be already filled, it cannot absorb anything else into them, exactly as we find that a sponge saturated with water is not capable of absorbing an additional quantity; and therefore charcoal when wet (the pores being filled with water) can absorb gases only by the solvent action of water. This consideration is frequently neglected in the application of charcoal.

The extraordinary powers of charcoal have not failed to arrest the attention of numerous practical men engaged in applying the results of science to the purposes of daily life.

As early as 1848, Mr. Jasper Wheeler Rogers first suggested* to mix peat charcoal with sewage, for the purpose, at one and the same time, of deodorising it and of making a manure from it; and he has since been frequently agitating the question by the delivery of lectures, publication of pamphlets, &c., &c. †

The use of charcoal is likewise involved in a process for the manufacture of a manure by Mr. Richard Dover.

This process consists in treating sewage with various acids and salts, and filtering it afterwards through charcoal, clay, gypsum, &c., in order to obtain a manure. ‡

The proposed utilisation of charcoal for separating from sewage the constituents valuable for agricultural purposes, depends upon its power of removing organic and saline bodies from solution in water.

We thought that the elucidation of the question would be best secured by adopting two different modes of proceeding, viz.:

1. Simple Filtration of the Sewage through Charcoal.

2. Agitation of the Sewage with Charcoal.

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1. *Filtration of Sewage through Charcoal.*

It appeared of some interest to compare the effect of charcoal as a filter with that of another filtering material, which is generally considered to exert, exclusively, a mechanical action.

For this purpose two filters were constructed in wooden cisterns, of similar form and size, having each an area of four square feet; the one composed of sand, one foot in depth, supported on thin layers of fine and coarse gravel; the other of peat charcoal, kindly supplied by Mr. Jasper Rogers for the purpose, also one foot deep, with an area of four square feet.

As nearly as might be, the same quantity of sewage was poured into each filter; allowed to run through at the same rate by regulating an exit tap, and continued for the same length of time; in fact, both filtrations were performed in a similar manner, and side by side.

The experiments were commenced at 10 o'clock in the morning of the 28th of May. The extraordinary powers of the charcoal began soon to be evident, for whilst, on the one hand, the liquid, after passing through the *sand*, had obviously lost the grosser part of the suspended matter, it nevertheless was decidely turbid, and scarcely less offensive in smell

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* 1848, June 1 (No. 12,169), Jasper Wheeler Rogers. The title of the patent is as follows: "Certain improved methods and machinery for the preparation of peat as a fuel, and in combination with certain substances, as a compost or manure." The second part of this invention "refers to the manufacture from peat of granulated charcoal, and to the admixture thereof with animal excrement, for the purpose of deodorising the same, and making a dilute inodorous manure." The charcoal is "to be added in such quantities as will be sufficient to absorb the aqueous and volatile products of the excrement, and destroy the effluvium."—Abridgments of the Specifications relating to Manures, 1857.

† "Facts and Fallacies of the Sewerage System of London," &c., &c. By Jasper W. Rogers, C.E. London: Atchley & Co., 106, Great Russell-street, Bedford-row.

‡ Richard Dover's patent is dated 16 October 1856. The title of the patent is, for "Treating Sewage with an acid or acids, either alone or together, with a salt or salts, or other chemical agents, for the purpose of depriving it of its putrescent qualities; and also obtaining certain products therefrom."

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smell than the original sewage. The filtered solution from the *charcoal*, on the other hand, was clear, transparent, colourless, almost odourless, and even nearly tasteless, although, as was subsequently proved by analysis, it still contained sewage matter in solution. Even at 12 o'clock, two hours after commencing the experiment, the filtered solution from the charcoal remained as clear and transparent as at the commencement, whilst the filtrate from the sand had not altered in character.

Samples were then taken of the original sewage used and of the filtered solutions from the charcoal and sand, in order to ascertain by the analysis of these liquids the comparative powers possessed by charcoal and sand respectively.

The experiment was not interrupted, but allowed to go on, for the purpose of ascertaining how long it would be before the charcoal began to lose its powers, and it was observed, that at two o'clock, (after the duration of the experiment for only four hours) the filtrate from the charcoal began to become perceptibly turbid, whilst that from the sand had undergone no appreciable alteration. It might have been desirable to continue the experiment still longer, to ascertain at what rate the charcoal continued diminishing in activity; yet, for the purposes of this inquiry, it was sufficient to have experimentally confirmed once more the fact of the rapid diminution of the absorbent power of charcoal for substances dissolved in water.

The quantities of charcoal and sand employed have been given above.

The total quantity of sewage sent through the charcoal was 77·76 gallons (or 21,562 cubic inches).

The total quantity of sewage sent through the sand was 80·61 gallons (or 22,354 cubic inches).

The speed at which the sewage passed through the charcoal was 6·3 oz. per minute.

Whilst it was passed through the sand at the rate of 8 oz. per minute.

In the following table we give the results, not merely of the analysis of the sewage before and after filtration, but also the mean composition of the charcoal before and after employment as a filter. The sample of the charcoal, after use as a filter, was obtained by intimately mixing the whole mass of residual charcoal together, and taking an average specimen of the whole.

The details of experiment have already been given in the Table of Sewage Analyses. (*See* Table B., col. 14, and Appendix, No. 15.)

Composition of Sewage.

		Grains per Gallon.
Suspended Matter	Mineral	21·48
	Organic	35·42
	TOTAL	56·90
Dissolved Matter	Mineral	56·08
	Organic	28·13
	TOTAL	84·21
Total Solid Constituents	Mineral	77·56
	Organic	63·55
	TOTAL	141·11

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Effect of Charcoal Filtration after Two Hours.

	Total Amount of Solid Constituents originally present. — Grains per Gallon.	Amount present in Filtered Liquid. — Grains per Gallon.	Amount Separated. — Grains per Gallon.	Amount Separated. — Percentage of Quantity originally present.
Mineral Matter	77·56	48·31	29·25	37·71
Organic Matter	63·55	12·57	50·98	80·22
TOTAL	141·11	60·88	80·23	56·85

These numbers, as might have been expected, show that, when at its point of maximum efficacy, a larger amount of matter was separated from the sewage by filtration through charcoal than by precipitation, either by lime or by a mixture of lime and sulphate of alumina; since it is not merely the *suspended*, but also a fair percentage of the *dissolved matter* that is removed by the charcoal, as shown by the following Table:

	Amount of Matter Separated. — Grains per Gallon.	Suspended Matter originally present. — Grains per Gallon.	Dissolved Matter removed. — Grains per Gallon.	Dissolved Matter removed. — Percentage of the Quantity originally present.
Mineral matter	29·25	21·48	7·77	13·85
Organic ditto	50·98	35·42	15·56	55·31
TOTAL	80·23	56·90	23·33	27·70

Unfortunately this state of efficiency did not long continue; even after two hours further duration (four hours in all) it had ceased to remove the suspended matter entirely, and in fact the liquid passed through visibly turbid.

Effect of Charcoal Filtration after Four Hours.

	Total Amount of Solid Constituents originally present. — Grains per Gallon.	Amount present in Filtered Liquid. — Grains per Gallon.	Amount Separated. — Grains per Gallon.	Amount Separated. — Percentage of Quantity originally present.
Mineral matter	77·56	63·77	13·79	17·78
Organic ditto	63·55	34·76	28·79	45·35
TOTAL	141·12	98·53	42·59	30·18

	Amount Separated. — Grains per Gallon	Suspended Matter present. — Grains per Gallon.	Suspended Matter which passed through. — Grains per Gallon.
Mineral matter	13·79	21·48	7·68
Organic ditto	28·79	35·42	6·62
TOTAL	42·59	56·90	14·31

No less than 14·31 grains of the suspended matter now passed through, showing to what a state of inefficiency, as a merely mechanical filter, the charcoal had arrived in the short space of four hours; but it must not be supposed that on that account it had altogether lost its peculiar powers of removing dissolved matter; in all probability it had not; this could of course have been ascertained by determining the proportion of dissolved and suspended matter *in the filtered liquid*, but it had very little bearing on the present inquiry, and therefore was omitted.

Before proceeding to the conclusions to be drawn from these results, we will compare the effects of the charcoal filter with those of a filter of ordinary sand.

After the filtration of the same sewage through sand had been going on at the same speed as nearly as may be for two hours, side by side with the charcoal, the filtered liquid was analysed, with the results contained in the following Table:

Effect of Sand Filtration after Two Hours.

	Total Amount of Solid Constituents originally present. — *Grains per Gallon.*	Amount present in the Filtered Liquid. — *Grains per Gallon.*	Amount Separated. — *Grains per Gallon.*	Amount Separated. — *Percentage of Quantity originally present.*
Mineral Matter - - -	77·56	51·14	26·42	34·07
Organic ditto - - - -	63·55	32·11	31·44	49·46
TOTAL - - -	141·12	83·25	57·87	41·00

In the case of the filtration through charcoal, the amount of dissolved matter removed was obvious, since the filtered liquid was perfectly clear and free from suspended matter; but in this case the whole of the suspended matter was never removed, and it therefore became necessary to determine the proportion of suspended to dissolved matter in the filtered liquid, in order to bring out this interesting point.

COMPARISON of the Composition of the Sewage before and after Filtration through *Sand* for Two Hours to show the Amount both of *Suspended* and *Dissolved* Matter removed by the Process.

		Composition before Filtration. — *Grains per Gallon.*	Composition of the Filtered Liquid. — *Grains per Gallon.*	Amount Separated. — *Grains per Gallon.*	Amount Separated. — *Percentage of the Quantity originally present.*
Suspended Matter	Mineral	21·48	0·66	20·82	96·90
	Organic	35·42	1·62	33·80	95·43
TOTAL - - -		56·90	2·28	54·62	95·98
Dissolved Matter	Mineral	56·09	50·48	5·610	10·02
	Organic	28·13	30·49	nil *	—
TOTAL - - -		84·25	80·97	—	—
Total - - -	Mineral	77·57	51·14	26·43	34·07
	Organic	63·55	32·11	31·24	49·46
TOTAL - - -		141·12	83·25	57·87	41·00

* In fact, some little amount of the organic matter which had been previously removed from solution was released from its state of combination with the sand, probably by the superior attraction for the suspended or mineral matter presented to it in the later stages of the experiment.

Effect of Sand Filtration after Four Hours.

	Total Amount of Solid Constituents originally present. — *Grains per Gallon.*	Amount present in Filtrate. — *Grains per Gallon.*	Amount Separated. — *Grains per Gallon.*	Amount Separated. — *Percentage of the Quantity originally present.*
Mineral matter - - -	77·57	58·29	19·28	24·86
Organic ditto - - - -	63·55	32·18	31·37	49·36
TOTAL - - -	141·12	90·47	50·65	35·89

	Amount Separated. — *Grains per Gallon.*	Suspended Matter originally present. — *Grains per Gallon.*	Suspended Matter which passed through. — *Grains per Gallon.*
Mineral matter - - - -	19·28	21·48	2·20
Organic matter - - - -	31·37	35·42	4·05
TOTAL - - -	50·65	56·90	6·25

It was not considered necessary in this case to determine the amount of dissolved matter removed.

On comparing the results of filtration through sand with those through charcoal it is obvious, that though charcoal possesses the peculiar property of molecular attraction in a far higher degree than sand, yet, that it loses its power of this kind, as well as its efficacy in arresting suspended matter, far more quickly.

The general conclusions which we would draw from the results of these experiments upon the effect of charcoal when used in the form of a filter for depriving sewage of valuable constituents as compared with that of an ordinary mechanical filter (sand) are the following:—

1st. That charcoal possesses the power of removing *organic matter* from sewage to a far greater extent than sand: the largest percentage removed by the charcoal being 80·22, whilst the sand only removed when in maximum action 49·46 per cent. of the organic matter originally present, from the same sample of sewage. This is quite in accordance with the statements of other observers.

2d. That charcoal possesses also the power of removing *mineral matter* from sewage to a somewhat greater extent than sand: the largest percentage removed by charcoal being 37·71 per cent., whilst the sand removed, when in maximum action, only 34·07 per cent. of the mineral matter originally present.

3d. That charcoal is likewise capable of removing even *dissolved* mineral and organic matter from solution to a far greater extent than sand; the largest percentage removed by the charcoal being, of dissolved organic matter 58·31 per cent., and 13·85 per cent. of dissolved mineral salts; whilst sand removed, when in maximum action, no organic matter at all, and only 10 per cent. of dissolved mineral matter.

4th. That the superior efficacy of charcoal is obviously due to its more porous structure, enabling it to expose a more extended surface; for though charcoal possesses both these powers in a far higher degree than sand, yet it very soon loses its intensity, whilst the sand continues to exert its more feeble action for a much longer period.

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The results detailed in the foregoing paragraphs, although elucidating the general deportment of *charcoal* with reference to sewage, are not sufficient for determining the money value of a manure manufactured by filtering sewage through charcoal. In order to arrive at this knowledge, it became necessary to analyse the charcoal before and after its action upon the sewage. The details of these analyses are given in No. 28 of the Appendix.

Analysis of Charcoal before Use as a Filter.

Organic matter (carbon)	95·72
Ash	4·28
	100·00

It also contained ·055 per cent. of phosphoric acid.

Analysis of Charcoal after Use as a Filter.

100 parts contain—

Nitrogen	2·032	corresponding to	ammonia	2·467
Phosphoric acid	0·12	„	phosphate of lime	0·26
Organic matter, including the charcoal	94·069			

It deserves to be noticed that these analyses show us, in 100 parts, the amount of matter valuable for agricultural purposes, which the mass of peat charcoal used in our experiments, and which had an area of four square feet and a depth of one foot, removed from 77·76 gallons of sewage, and not the amount that it is possible to accumulate in charcoal, by continuing the treatment with sewage until saturation. But when the large volume of sewage had been passed through the charcoal, its peculiar powers were to a very considerable extent exhausted, and it would have afterwards acted chiefly as a merely mechanical agent for arresting suspended matter.

In taking the above numbers as a basis of calculations, it is but right to mention that they by no means represent the most favourable conditions for the manufacture of a manure from sewage by the agency of charcoal. If it be remembered that the effect of charcoal, both upon suspended and upon dissolved matter, is essentially the result of a surface-action, it would be obviously objectionable to waste the energy of its attraction for the valuable dissolved matter by clogging its pores with mud of much inferior value. In our experiments, which essentially represent the method hitherto adopted, a certain, although small, amount of the force was actually spent in this manner. By far the best chance for this process would be to allow the sewage to subside, to remove the valuable dissolved matter by treatment with charcoal, and to mix the saturated charcoal with the sewage deposit obtained by simple subsidence.

Calculation of Money Value of Charcoal after use as a Filter.

		£.	s.	d.
2·467 tons of ammonia	at 56*l.* per ton	138	3	–½
0·26 of phosphate of lime (insoluble)	at 7*l.* „	1	16	5½
1·5 tons of organic matter	at 1*l.* „	1	10	–
Value of 100 tons	£.	141	9	5½

Or, per ton 1*l.* 8*s.* 3½*d.*

2. *Agitation of Sewage with Charcoal.*

The experiments made with reference to the use of charcoal as a filter for sewage furnish a general idea of this subject; but it appeared desirable specially to examine the capabilities of charcoal when used, not as a filtering medium, but when mixed with the sewage, and allowed to subside from it together with the mud; although, obviously, the two methods of using the charcoal are only modifications of the same process. An examination of this kind promised not only to elucidate more fully the nature of the action of charcoal, but it also afforded a direct comparison of the powers of charcoal upon sewage with the now very frequently adopted method of treating sewage with lime.

For this purpose, on Saturday, June 13, an experiment was performed of shaking sewage with powdered peat charcoal from the same sample used in the previous experiments, in the proportion of 20 grains of charcoal to the gallon of sewage, this being the proportion of lime generally employed in the lime-process before discussed. The same sewer as before was selected. viz., the Northumberland-street sewer, the trial being made at its mouth, on about 10 gallons of sewage.

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The charcoal was violently agitated with the sewage in a closed vessel for half an hour; the whole then allowed to remain at rest, to facilitate the subsidence of the insoluble portion; and at the expiration of two hours, the supernatant fluid was removed by means of a syphon, and samples, both of the original sewage, of the supernatant fluid, and also of the deposit obtained, were preserved for analysis.

The experimental numbers are contained in the Table of the Sewage Analyses (Table B. Col. 15.) *See* also Appendix, No. 15.

Composition of Sewage.

Suspended Matter	Mineral	14·64
	Organic	25·04
	Total	39·68
Dissolved Matter	Mineral	67·26
	Organic	41·19
	Total	108·45
Total Solid Constituents	Mineral	81·90
	Organic	66·23
	Total	148·13

Effect of Agitation with Powdered Peat Charcoal.

	Total Amount of Solid Matter originally present. *Grains per Gallon.*	Amount of Solid Matter in Supernatant Fluid. *Grains per Gallon.*	Amount of Solid Matter Separated. *Grains per Gallon.*	Amount of Solid Matter Separated. *Percentage of the Quantity originally present.*
Mineral Matter	81·70	59·63	22·08	27·02
Organic Matter	66·23	31·93	34·30	51·93
Total	147·93	91·56	56·38	38·10

Suspended Matter.

	Quantity originally present. *Grains per Gallon.*	Quantity contained in the Filtered Liquid. *Grains per Gallon.*	Amount separated. *Grains per Gallon.*	Amount Separated. *Percentage of Quantity originally present.*
Mineral matter	14·44	5·09	9·35	64·75
Organic matter	25·04	9·31	15·73	62·81
Total	39·48	14·40	25·08	63·52

Dissolved Matter.

Mineral matter	67·26	54·54	12·72	18·92
Organic matter	41·19	22·62	18·57	45·07
Total	108·45	77·16	31·29	28·80

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Analysis of the Deposit obtained by agitating Sewage with Powdered Charcoal.

100 parts contain—

Nitrogen	3·63	corresponding to - ammonia	4·40
Phosphoric acid	1·103	„ phosphate of lime,	2·389
Organic matter	41·83		

Calculation of Money Value of Deposit.

			£.	s.	d.
4·40	tons of ammonia	at 56 *l.* per ton	246	8	–
2·389	„ phosphate of lime (insoluble)	at 7 *l.*	16	14	5½
15·83	„ organic matter,	at 1 *l.* per ton	15	16	7
	Value of 100 tons		£. 278	19	–½

Value per ton - - - - - 2*l.* 15*s.* 9¼*d.*

(D.)—Treatment of Sewage with Magnesian Salts.

Sir James Murray proposes to separate the phosphoric acid and ammonia from sewage in the form of ammonio-phosphate of magnesia, by the addition of sulphate of magnesia, or chloride of magnesium to the sewage.

The ammonio-phosphate of magnesia has been long known as a most valuable manure; and a mineral was imported a short time since from the Falkland Islands, under the name of Guanite, for sale, as a manure which possessed the same composition.

The salt in question is well known to chemists as one of the less soluble phosphates. Its percentage composition is as follows, supposing it to be dry and free from water of crystallisation:

Magnesia	28·9
Ammonia	12·3
Phosphoric acid	52·2
Water of constitution	6·6
	100·0

From its composition we readily calculate the money value of this salt as a manure.

100 tons correspond to—

		£.	s.	d.
12·3 Ammonia	at 56 *l.* =	688	1	7
115·1 Phosphate of lime	at 7 *l.* =	805	14	–
Value of 100 tons		£. 1,493	15	7
Or, per ton		14	18	9

Since the sewage contains both phosphoric acid and ammonia, it would appear only to be necessary to add a magnesian salt, in order to supply the ingredients for the formation of this compound.

Indeed the idea of separating the ammonia and phosphoric acid from sewage in this way has suggested itself to the minds of many chemists, and would be probably superior to all the methods discussed previously, were it not for the large volume of water with which these compounds are mixed in the sewage.

The process is devoid of certain objections which apply to the others; *e. g.*, treatment with lime expels some of the ammonia, instead of fixing it; whereas it might be anticipated that the magnesia process would carry down the whole both of the phosphoric acid and ammonia. Then, again, the mixture of lime and sulphate of alumina has but little effect on the phosphates in solution; and although peat charcoal possesses a peculiar power of removing, in addition to organic matter, even saline bodies from solution, yet this power is limited, and therefore the quantity of phosphoric acid which it can remove in this way must be very small.

But the great obstacles to the use of the magnesia-process are the difficulties of its practical application, and the costliness of the materials. The referees did not think it necessary for us to submit this process to an experimental trial; in fact, a simple calculation will be sufficient to elucidate the subject.

The practical difficulties in carrying it into practice will be at once understood if we remember that, after all, the ammonio-phosphate of magnesia is by no means an insoluble salt,

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salt, being even moderately soluble, excepting under certain conditions. The solubility of this salt, which is of considerable interest to the analytical chemist, has been determined some years ago with great care by Dr. Fresenius. From his experiments it results that the solubility of ammonio-phosphate of magnesia varies considerably, according to the nature of the liquid in which it exists, one part of the salt requiring about 45,000 parts of water containing a good deal of free ammonia, about 15,000 parts of pure water, but only about 7,000 parts of water containing sal-ammoniac or other ammoniacal salts.

From the analyses which have been given in the preceding paragraphs, it is seen that a gallon of London sewage contains on an average about 1·65 grains of phosphoric acid in the soluble, and 0·2 grains in the insoluble condition; so that the total quantity does not amount to two grains. But let us, for the sake of simplicity, assume that a gallon of London sewage contains about two grains of phosphoric acid, capable of being converted into ammonio-phosphate of magnesia. Two grains of phosphoric acid would yield about four grains of the salt. Now, this quantity would be produced in a gallon of water containing ammoniacal salts, which is capable of retaining in solution not less than 10 grains of ammonio-phosphate of magnesia. It is obvious that *no precipitate could be formed*, even if we attribute to the sewage water as great a solvent power for the salt in question as is possessed by pure water.

But we have heard it elsewhere suggested that it might be possible to reduce the solubility of the ammonio-magnesian phosphate to a minimum (that is, to 1 part in 45,000 of liquid), and to cause the formation of a precipitate, by adding free ammonia to the liquid. No practical chemist could for a moment entertain such an idea.

A simple calculation will render evident the chances of such a proposal being adopted. From data given in the Appendix (No. 30), we find that if enough ammonia were added to diminish the solubility of the ammonio-magnesian phosphate to the proportion of 1 part in 45,000 of liquid, it would be necessary to liberate in a ton of sewage the ammonia from 141 lbs. of sal ammoniac, worth 1*l.* 12*s.* (at the rate of 68*l.* per ton), and what would be the benefit derived? Merely that, of the 1·2 lbs. of ammonio-magnesian phosphate which would be formed in one ton of sewage (for each gallon is capable of producing only 2 grains), 0·8 lbs. would be precipitated, the value of which would be about 4*d.* (at the rate of 17*l.* per ton).

Now, leaving all working expenses, &c. out of the question, and assuming for a moment even that the solubility of the ammonio-magnesian phosphate might be reduced to the desired extent, by employing a solution of ammonia containing not more than one-tenth of the ammonia present in the liquid employed in Dr. Fresenius' experiments, we should have to expend by this process, in materials alone, 3*s.* 2*d.*, in order to precipitate a quantity of the ammonio-magnesian phosphate having no greater value than 4*d.*

Comparison of the Money Values of the Manures obtained from Sewage by the several Processes.

In the preceding paragraphs we have given a detailed description of the experiments made by us on a small scale, in order to arrive at the knowledge of the respective values of the manures prepared by the lime process, by the use of a mixture of lime, sulphate of alumina, and charcoal, and by each of the two different methods of employing charcoal alone for this purpose.

The results of our experiments are united in the following Table:—

Method of preparing the Manure.	Value per Ton.			Value per 100 Tons.		
	£.	s.	d.	£.	s.	d.
By the lime process	1	18	8 ¾	193	13	3 ½
By Stothert & Gotto's mixture	2	2	–	210	6	2 ½
By charcoal:						
(*a.*) Used as a filter	1	8	3 ½	141	9	5 ½
(*b.*) Agitated with the sewage	2	15	9 ¼	278	19	–½

These numbers represent the value, expressed in money, of the fertilising constituents of the several products, with reference to guano, the mean value of which is estimated at 11*l.* per ton. In order, however, to obtain a definite view regarding the real value of these manures, we have to take into consideration the cost of their production,—to estimate, in fact, both the value of the materials used, and also the expenses of working the several processes. There is no difficulty in arriving at the former of these points, whilst the latter admits only of a very approximative calculation.

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COMPARISON of the Values of the Manures, with the Cost of the Materials used in their Production.

IT has been shown in the preceding analysis, that

100 tons of lime-deposit contain 23 tons of lime.

100 tons of the deposit, obtained by Stothert & Gotto's mixture, 71 tons of the mixture.

100 tons of the manure, obtained by filtration of sewage through charcoal, 95 tons of charcoal.

100 tons of the deposit, obtained by agitation of sewage with charcoal, 26 tons of charcoal.

VALUE of 100 Tons of each of the Manures, after deducting the Cost of the Materials.

	Of Lime Deposit.	Of Deposit by the Mixture of Lime, Charcoal, and Sulphate of Alumina.	Of Charcoal after Use as a Filter.	Of Deposit obtained by Agitation with Charcoal.
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Original value - -	193 13 3½	210 6 2½	141 9 5½	278 19 –½
Cost of materials - -	11 10 – (23 tons of lime, at 10s.) *	177 – – (71 tons of the mixture, at 2l. 10s.)	285 – – (95 tons of charcoal, at 3l.)	78 – – (26 tons of charcoal, at 3l.)
Value, after deducting cost of materials -	182 3 3½	33 6 2½	—	200 19 –½

With respect to process 2 (Messrs. Stothert & Gotto's), it is obvious that the cost of the materials employed, irrespectively of working expenses, nearly equals the money value of the manure produced; whilst in process 3 (filtration through charcoal) the cost of the materials very considerably exceeds the money-value of the manure obtained (as compared with guano at 11 l. per ton).

These processes cannot therefore be entertained if the object be to manufacture a manure as a commercial speculation.

We may therefore confine our attention to the lime-process, and to the plan of agitating the sewage with powdered peat charcoal.

The question now presents itself, what is the expense of producing 100 tons of the lime deposit and of the charcoal-manure? A calculation of this kind is almost beyond our province, for there are so very many elements which enter into it (such as the purchase of the land; construction of the subsiding reservoirs, the cost of the works, machinery, &c.; an estimate of the expenses of pumping and other labour, patent, legal and office expenses, &c.), so that it must necessarily be extremely difficult to arrive at anything more than a merely approximative result. It is, therefore, only with diffidence that we venture the following calculation, which is chiefly based upon some statements of Mr. Wicksteed's, in his letter before referred to.

Mr. Wicksteed is the proprietor of two patents for the use of the liming process; † and under his superintendence, this process has been carried out on a large scale in Leicester, by the "Patent Solid Sewage Manure Company."

In the letter to Mr. Bazalgette, which has been already quoted, Mr. Wicksteed gives some statements of the probable cost of Metropolitan Works for the treatment of sewage according to his process. Adopting his data, but making the necessary additions for items not included in his estimate, we arrive (by a calculation the details of which are given in the Appendix, No. 32) at the result, that one ton of the lime-deposit can be produced at an outlay (for cost of materials, working expenses, &c.) of 12s. 8½d.

According

* In stating this *extremely low* price of lime, we quote the estimate of Thomas Wicksteed, Esq., C.E., of the Patent Solid Sewage Manure Company, at Leicester, in a letter to I. W. Bazalgette, Esq., C.E., communicated to us by the referees. The price of Messrs. Stothert & Gotto's mixture was supplied by these gentlemen to the referees; the price of peat charcoal is published by Jasper Wheeler Rogers, Esq., C.E., in his pamphlet, and was communicated moreover to the referees.

† Wicksteed, Thomas. A.D. 1854, January 26. No. 193. "For precipitating the fertilizing matter from sewage water by mixing it with lime and finely divided charcoal," &c.

A.D. 1854, January 26. No. 192. "For moulding into hollow blocks, or bricks of any convenient form, or into blocks or bricks perforated through with holes, the fertilizing matter precipitated from sewage by means of lime, either alone or together with other substances."—*Abridgments of the Specifications relating to Manures.* London, 1857.

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According to this calculation, we should succeed in manufacturing by an outlay of 12s. 8½d., a manure, the fertilising power of which would be equivalent to a quantity of guano costing 1l. 18s. 8¾d., leaving a net profit to the manufacturer of 1l. 6s. 0¼d. per ton.

In glancing superficially at these figures, the manufacture of manure from the London sewage by the lime-process would appear to be a most profitable investment. This favourable aspect, however, changes on a closer examination. The possibility of realising a profit of 1l. 6s. 0¼d. per ton, involves the assumption that the farmer would feel inclined to pay for a certain quantity of fertilising substances, diluted by four times their weight of inert matter, exactly the same price at which he can purchase a similar amount of fertilising matter in the concentrated form in guano. How far this is probable will be obvious by looking at the increased cost of carriage and spreading over the land of so bulky an article as the lime-deposit. We are informed by the referees that the cost of loading and carriage for a mile, may probably be estimated on an average at 1s. per ton, to which must be added the further expense of spreading, which, according to the same authorities, would amount to not less than 9d. per ton. Now, taking the value of guano at 11l. per ton, and that of the lime-deposit at 1l. 18s. 8¾d., it is obvious that, in order to supply to a field the same amount of really valuable fertilising constituents that are contained in one ton of guano, it would be necessary to use not less than six tons of the lime-deposit, supposing the works to be situated on the banks of the river where the guano is disembarked at the price above mentioned. But let us compare the cost at which the fertilising power corresponding to a ton of guano could be imparted to a field at different distances from the works in the form of guano, on the one hand, and in the form of sewage-lime-deposit, on the other.

	IN THE FORM OF GUANO.		IN THE FORM OF LIME-DEPOSIT.	
		£. s. d.		£. s. d.
In the immediate neighbourhood of the works.	1 ton of guano - -	11 – –	6 tons of lime-deposit -	11 – –
	Spreading - - -	– – 9	Spreading - - -	– 4 6
	Total - - £.	11 – 9	Total - - £.	11 4 6
At a distance of 5 miles from the works.	1 ton of guano - -	11 – –	6 tons of lime-deposit -	11 – –
	Carriage, &c. - -	– 5 –	Carriage, &c. - -	1 10 –
	Spreading - - -	– – 9	Spreading - - -	– 4 6
	Total - - £.	11 5 9	Total - - £.	12 14 6
At a distance of 10 miles.	1 ton of guano - -	11 – –	6 tons of lime-deposit -	11 – –
	Carriage, &c. - -	– 10 –	Carriage, &c. - -	3 – –
	Spreading - - -	– – 9	Spreading - - -	– 4 6
	Total - - £.	11 10 9	Total - - £.	14 14 6
At a distance of 15 miles.	1 ton of guano - -	11 – –	6 tons of lime-deposit -	11 – –
	Carriage, &c. - -	– 15 –	Carriage, &c. - -	4 10 –
	Spreading - - -	– – 9	Spreading - - -	– 4 6
	Total - - £.	11 15 9	Total - - £.	15 14 6
At a distance of 20 miles.	1 ton of guano - -	11 – –	6 tons of lime-deposit -	11 – –
	Carriage, &c. - -	1 – –	Carriage, &c. - -	6 – –
	Spreading - - -	– – 9	Spreading - - -	– 4 6
	Total - - £.	12 – 9	Total - - £.	17 4 6
At a distance of 25 miles.	1 ton of guano - -	11 – –	6 tons of lime-deposit -	11 – –
	Carriage, &c. - -	1 5 –	Carriage, &c. - -	7 10 –
	Spreading - - -	– – 9	Spreading - - -	– 4 6
	Total - - £.	12 5 9	Total - - £.	18 14 6

These figures require no long comment on our part. It is obvious from them, that supposing the manufacturer to sell the article at the price of 1l. 18s. 8¾d. per ton, it would be *cheaper*

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cheaper even in the immediate neighbourhood of the works to employ guano, on account of the greater cost of spreading the more bulky manure; and the saving effected by its use, as compared with the lime-manure, would rise rapidly with the increase of distance from the works.

The selling price of the manure must therefore be reduced; at what rate will be seen, if, taking an extreme case, we ascertain at what price the lime-deposit must be offered for sale in order to induce the farmer to use it at a distance of 25 miles from the works. If 12*l.* 5*s.* 9*d.* be the price at which he can manure with a ton of guano, no farmer would think of employing the lime-manure unless he could incorporate it into his field at a price certainly not exceeding that sum.

The cost of carriage to this distance, and of spreading, being 7*l.* 14*s.* 6*d.*, the manufacturer cannot hope to realise at the works, for six tons of the lime-deposit, more than 4*l.* 11*s.* 3*d.*, (*i. e.*, 12*l.* 5*s.* 9*d.* minus 7*l.* 14*s.* 6*d.*), or per ton more than 15*s.*, which is, in fact, 2*s.* 3½*d.* more than the cost of its production, viz., 12*s.* 8½*d.*

Then, again, it must not be forgotten that the value of a ton of the lime-deposit was determined by an experiment made upon a comparatively small scale, and at the mouth of a London sewer discharging sewage probably much more concentrated than that which would be operated upon in the subsiding reservoirs of any proposed sewage manure works. Our experiments, therefore, in all probability indicate the maximum value of the lime-manure. But let us see what is likely to be the result of operating on a large scale.

It would be impossible to select a more favourable example than the works of the Solid Sewage Manure Company at Leicester. These works are under the skilful management of Mr. Wicksteed, C.E., to whom great credit is due for the perfect manner in which he has elaborated the lime-process, and from whose statement the working expenses adopted above have in a great measure been calculated. All those who visited the Leicester works agree that the mechanical arrangements are most perfect. The state of concentration of the Leicester sewage appears also, from Mr. Versmann's analysis, before quoted,* to be very similar to that of the London sewage, at least to its mean composition for the 24 hours. The comparison, therefore, seems fair enough. But what is the value of the lime-manure manufactured at Leicester?

The "Leicester bricks" have been repeatedly analysed. According to Dr. Vœlcker's analysis (given in the Appendix, No. 21), their value is 15*s.* 5*d.*; whilst from Mr. Versmann's experiments, the value of 17*s.* per ton may be deduced.† (*See* Appendix, No. 22.)

For the sake of simplicity, let us assume that their value is 18*s.* per ton, so that 12½ tons of these Leicester bricks would be requisite to produce the same fertilising effect as one ton of guano. If, then, 18*s.* be taken as the average value of lime sewage manure per ton, when manufactured on a large scale, the net profit becomes very much smaller, being, in fact, reduced to 5*s.* 3*d.* per ton (*i. e.*, 18*s.* the value, minus 12*s.* 8½*d.* the cost, of its production). But let us go a little further, and see how the cost of spreading and carriage increases the cost of manuring with Leicester bricks as compared with that of guano.

	IN THE FORM OF GUANO.	£.	s.	d.	IN THE FORM OF LEICESTER BRICKS.	£.	s.	d.
At the factory	1 ton of guano	11	–	–	12½ tons of Leicester bricks	11	–	–
	Spreading	–	–	9	Spreading	–	9	9
	Total £.	11	–	9	Total £.	11	9	9
At a distance of two miles.	1 ton of guano	11	–	–	12½ tons of Leicester bricks	11	–	–
	Carriage, &c.	–	2	–	Carriage, &c.	1	5	–
	Spreading	–	–	9	Spreading	–	9	9
	Total £.	11	2	9	Total £.	12	14	9
At a distance of five miles.	1 ton of guano	11	–	–	12½ tons of Leicester bricks	11	–	–
	Carriage, &c.	–	5	–	Carriage, &c.	3	2	6
	Spreading	–	–	9	Spreading	–	9	9
	Total £.	11	5	9	Total £.	14	12	3

From

* The amount of total solid constituents of the mean sample of London sewage for the 24 hours is 102·85 grains in the gallon, whilst Mr. Versmann found the Leicester sewage contained 106·6 grains. (*See* Appendix No. 18.)

† With these numbers the results obtained by one of us in the analysis of the lime-deposit from the sewage of the Clifton Union Workhouse singularly coincide, the value being 16*s.* 9*d.* per ton (*see* Report, p. 18), although these experiments were made quite independently of this inquiry—in fact, long before the subject was brought under our notice.

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From this it is evident, that in order to find for a sewage-lime-manure similar to the Leicester bricks a market at a distance of five miles from the works, 12½ tons of it must be offered to the farmer at the same price as one ton of guano, plus the cost of the spreading —*i. e.*, at 11*l.* 5*s.* 9*d.* The manufacturer must therefore be satisfied, at the works, with 7*l.* 13*s.* 6*d.* (*i. e.*, 11*l.* 5*s.* 9*d.* minus 3*l.* 12*s.* 3*d.*); that is with 12*s.* 3*d.* per ton, which is 5½*d.* less than the cost of its production (12*s.* 8½*d.*).

In other words, the use of the lime-deposit as a manure will be impossible even at so small a distance as five miles from the works; and if the manufacturer were satisfied with the most moderate profit, the sale of the manure would be limited to an area of two miles radius.* It need scarcely be mentioned that the quantity of lime-manure that would necessarily be produced if the whole sewage of London were submitted to this process, would be far greater than could possibly be consumed within so limited a surface.†

In the foregoing comparison we still assume that, with the exception of the inconvenience arising from the greater bulk of the lime-deposit, which, as we have shown, would re-act considerably upon its money value, one ton of guano and 12½ tons of the lime-manure, to which chemical analysis has assigned the same value, as respects the total quantity of fertilising constituents, have in every other respect equal chances in the market. But would this really be the case? Might not the agriculturist hesitate, in many cases, to apply to his field, together with the valuable fertilising constituents, so large a quantity of inert matter, lime for instance, and might not this large quantity of useless matter prove, moreover, positively injurious, or at all events likely to obstruct the process of disintegration, and the diffusion of the manure throughout the soil? Would not the farmer frequently prefer the guano, not only on account of its greater concentration, but also because of its containing a portion of its valuable constituents, phosphates especially, in a soluble state, whilst the lime-deposit presents them in the insoluble condition? Would it not be far easier to control, by chemical estimations, the composition of the guano and concentrated artificial manures in general, than the large quantity of bulky and weak lime-manure, the value of which by the use of an undue quantity of lime might, in fact, be reduced to a mere nothing? And lastly, would it not be infinitely more difficult to adjust the lime-manure according to the requirements of a special piece of land, or of a given crop, than the far more manageable guano?

We are no farmers, and many of the difficulties attending and the objections to the use of the lime-manure which present themselves to the chemical mind, may appear less important in practice; nevertheless, we do not think that we deceive ourselves in assuming, that if the farmer have the choice of applying to his land, at the same cost, an equal amount of fertilising matter (as determined by chemical analysis), on the one hand, in the form of guano, and, on the other, as lime-manure, he will unhesitatingly prefer the former, and will not be induced to purchase the latter, unless it could be offered to him at a very considerably lower price.

Add to this the uncertainty of the data upon which our calculation of the cost of manufacturing the lime-deposit is founded; that, in fact, the expense of its production is doubtless even here underrated,‡ and would become gradually much greater on account of the constantly increasing dilution of the sewage, by reason of the daily augmenting consumption of water in the metropolis;§ and we believe that we have fixed the point of view from which the chances of manufacturing manure from sewage by means of lime must be regarded with respect to the prospect of its becoming a remunerative commercial speculation.

It remains now to consider briefly the proposal to separate the valuable constituents of the London sewage in the form of a deposit by means of charcoal. All the considerations which we have so fully developed in the case of the lime-deposit, apply with more or less force to this process. The absolute value of the deposit obtained by shaking the sewage with a quantity of charcoal equal to that of the lime employed in the process before alluded to, and then allowing the whole to subside, is higher than that of the lime-deposit. In fact, according to our analysis, this product is worth 2*l.* 15*s.* 9*d.* per ton, whilst the value of a ton of the lime-deposit is 1*l.* 18*s.* 8¾*d.*

A moment's reflection, however, shows that the hope of realising a profit by the employment of charcoal as an agent for manufacturing a manure from sewage is altogether an illusion, and that the chances of carrying out this process as a commercial speculation of even moderate success are even inferior to those offered by the lime-process. The value of the charcoal manure is certainly greater than that of the lime-deposit, and, on this account, the inconvenience arising from bulk, and the presence of so large an amount of inert matter, which we have urged as attending the lime-process, are diminished to a certain extent.

But

* At a distance of two miles the lime manure could not be sold at a higher price than 15*s.* per ton, which would reduce the net profit to 2*s.* 3½*d.* per ton.

‡ On this point we may quote Mr. Austin's (Report, p. 24) remarks, "that the price of the dried manure of the Company (*i. e.* the Leicester Sewage Manure Company) was a few months ago fixed at 40*s.* per ton. There having been little or no demand for it, and a large and increasing accumulation at the Company's works, it has been recently offered at 25*s.* per ton;" and we have been informed that since then a still further reduction in price has taken place.

‡ In the estimate given above, the cost of lime is taken at 10*s.* per ton, the price given by Mr. Wicksteed; but we are informed that lime cannot be bought in the neighbourhood of London on an average for less than 12*s.* 6*d.* per ton.

§ The Referees estimate that whilst the present flow of the whole sewage of London is estimated at 95,000,000 of gallons per day, the prospective flow, when the proposed works shall be completed, will be not less than 130,000,000 of gallons.

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But let us consider what are the means, and the cost of producing a given quantity, say a ton, of this manure. We have but few data from which we are enabled to estimate the expense. If, however, we take as a basis the cost of producing the lime-deposit, simply raising it in proportion to the value of the charcoal which it contains in the place of the lime—(for details, *see* Appendix, No. 31)—we arrive at the result that the manufacture of one ton of charcoal deposit costs 1*l.* 6*s.* But it is scarcely necessary to state that this calculation by no means includes all expenses which have to be taken into consideration.

There are two elements in the manufacture of the charcoal-manure which do not enter into the preparation of the deposit produced by lime. The formation of a deposit by mixing charcoal with the sewage takes place much more slowly than by the use of lime; *e. g.*, in our experiment the charcoal, and the matter which it is capable of carrying down with it, had not so completely subsided after four hours as had the lime-deposit in the course of one hour. It is evident therefore that the use of this process involves the construction of subsiding reservoirs of at least four times the dimensions of those requisite for carrying out the liming process, in order to produce a given weight of deposit in the same time.

But this is not the only cause of additional outlay. The charcoal has a very low specific gravity; it floats on the sewage, and will sink into it, in order to be brought into perfect contact with the fluid, only after the air contained in its pores has been displaced by water. To effect this, agitation is required, and, indeed, very violent and continuous agitation, even in experiments on a small scale, which, when operating upon so gigantic an amount of sewage-water as would be the case if the whole sewage of London were to be thus treated, would involve a very large expenditure for mechanical power.

The exact amount of this expenditure we have no accurate data to estimate; but we have no hesitation in stating our conviction, that few persons would feel inclined to engage in the manufacture of a charcoal-sewage-manure, in the manner above indicated, after they had once made themselves acquainted with the difficulties attending the carrying out of the process, even by experiments upon a small scale, and after considering the enormous outlay which its practical execution on a large scale would entail.

IV.—Utilisation of Sewage in the Liquid State. Irrigation with Sewage.

In the section on the "Mean Composition and Agricultural Value of London Sewage," we have fixed the relative proportions of soluble and insoluble constituents agriculturally valuable in the sewage. The experiments, respectively, on the action of lime, of lime sulphate of alumina and charcoal, and of charcoal alone, upon sewage, described in subsequent sections of this Report, show how much of the valuable constituents remain in solution after treatment by both of these processes.

These results are embodied in the following table, which gives the value of the insoluble and soluble matters contained in 100 tons of the several liquids.

AGRICULTURAL VALUE of the Insoluble and Soluble Constituents in 100 tons of Sewage.

	In its original State.	After Treatment with Lime.	After Treatment with Stothert & Gotto's Mixture.	After Filtration through Charcoal.	After shaking with Peat Charcoal.
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Valuable insoluble matter	– 2 2½	nil.	nil.	nil.	nil.
Valuable soluble matter -	– 15 4½	– 11 11	– 12 5	– 11 1½	– 10 11¼
TOTAL - - - £.	– 17 7	– 11 11	– 12 5	– 11 1½	– 10 11¼

From these numbers it is obvious that 6-7ths of all the fertilising constituents of sewage are in the soluble form, and that in the liquid which results from the deodorising processes, by means of lime and charcoal, a very considerable proportion of these soluble fertilising agents of the original sewage remain unremoved.

In the presence of such facts, the question naturally suggests itself, is it possible to apply the valuable constituents of the sewage, in their original liquid condition, to the land?

The beneficial influence of irrigation with sewage on meadow land is an admitted fact. Mr. H. Austin, in his valuable Report, before quoted, has gone very fully into this subject; he gives numerous illustrations of the results obtained by this mode of utilising sewage, amongst which the Craighentinny meadows near Edinburgh, and the land in the neighbourhood of Milan, may be specially mentioned.

Independently of the advantage derived from the copious supply of water, which in hot countries, as in Lombardy, must act very beneficially, it is obvious that a more favourable mode of manuring cannot be imagined than the constant but very gradual application of the most appropriate food of plants, in the most favourable form (viz., in the liquid condition), and

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and in quantities so small, with reference to the liquid in which they are dissolved, as to ensure the complete absorption of the valuable constituents by the soil, and their immediate appropriation by the plant.

The success of irrigation involves, however, one condition, namely, that of employing very large quantities. This will be intelligible by a glance at the table given above, which shows the degree of dilution, expressed in shillings and pence, in which the valuable constituents exist in sewage water. If it be remembered that to impart to a meadow the fertilising power of one ton of guano, it is necessary to apply 1,250 tons or 310,000 gallons of sewage water, the necessity of employing a constant and most ample supply requires no further comment; and in fact, wherever remarkable results have been achieved by sewage-irrigation, it has always been by the use of enormous quantities. In the case of the Craigentinny meadows, Mr. Austin informs us* (Report, p. 44) that "the area in question consists in all of about 260 Scotch acres, the Scotch acre being rather more than 1¼ acres English. They are irrigated with the waters of the 'Foul Burn,' into which about half the city of Edinburgh is imperfectly drained. The quantity of water discharged over the low-lying lands in the course of the year must be enormous. The superintendent informed me that it is never allowed to run to waste except in times of excessive flood."

And with reference to the neighbourhood of Milan, we read (Report, p. 52): "It can easily be conceived what must be the fertilising quality of the *Vettabia*,† as it carries off all the filth of a city of 150,000 inhabitants; and the quantity of fertilising matter borne along by its waters raises in such a manner the surface of the meadows it irrigates, as to render it necessary that from time to time the deposit should be removed from the meadow, in order to preserve the level of irrigation."

Notwithstanding these remarkable results, it is extremely doubtful whether any profitable use can be made of the *London sewage* for the purpose of *irrigation.*

The question whether the use of the London sewage for irrigation would or would not be a profitable investment, involves so many elements of consideration which belong rather to the province of the engineer or the agriculturist than the chemist, that we offer the following remarks, rather as an attempt to fix the point of view from which the subject, in our opinion, should be regarded, than as an endeavour to solve the problem. It appears, from a calculation furnished to us by the referees (see Appendix No. 34), that the works which it would be necessary to carry out, in order to distribute the ordinary daily flow of the metropolitan sewage over an area of 100,000 acres in 23 separate plots, and at an average distance of 15 miles from London, would involve an expenditure of not less than 7,400,000 *l.*, or 74 *l.* per acre. Taking simply the interest of so enormous a capital, without making any addition for the daily management requisite for so extensive a system of irrigation, which cannot but be considerable, the annual expense incurred in irrigating an acre of land, under the circumstances above mentioned, would be nearly 4 *l.* (3 *l.* 16 *s.*); for this sum, supposing the whole sewage of London (the value of which, for this purpose, may be taken in round numbers at 1,100,000 *l.* per annum) discharged over the area of 100,000 acres, each acre of land would receive an amount of sewage constituents annually equal to the amount of fertilising matter contained in one ton of guano, of a money value of 11 *l.*, leaving a profit of 7 *l.* per acre, or a return of 175 per cent. of the cost.

How far this considerable advantage will be reduced by the expenses of working, which are not included in this estimate? Whether an area of 100,000 acres would really be sufficient‡ to receive the whole sewage of London? Whether a sufficient area of meadow land suitable for irrigation, upon an appropriate geological formation being found, the successful elaboration of a gigantic irrigation scheme, might not be very much retarded and obstructed by the unwillingness on the part of some of the landowners to share the advantages, and the inconveniences (even though imaginary) arising from such a scheme? Whether, or not, all these causes might not combine in diminishing, or actually annihilating, the chances of such a scheme as a commercial enterprise? These are questions which we have no materials at our disposal to answer.

The failure of the Metropolitan Sewage Manure Company, established some eight or nine years ago, for the distribution, through pipes, of a part of the sewage over the market gardens near Fulham, cannot be adduced as an argument against the use, for irrigation purposes, of the sewage of large towns in general.

Mr. Austin, whilst very lucidly explaining the causes of this failure has given a most interesting account of the distribution of the sewage of the town of Rugby over the land of Mr. G. H. Walker, of Newbold-grange, as an illustration of the successful, profitable, and unobjectionable application of the sewage of a small town for the purpose of irrigation (Report, p. 62). It would appear that at an expense of 1 *l.* per annum, including interest

* Mr. Austin's Report, p. 51, quoted from a description by Count Arrivabene, appended to the Report of the first General Board of Health.

† The name of the canal into which the sewage of Milan is discharged.

‡ On Mr. Walker's estate the acre receives 446 tons of sewage (Mr. Austin's Report, p. 65), which, assuming the mean value of sewage, which we have established, would contain an amount of fertilising matter worth 3 *l.* 18 *s.* On the other hand we calculate, from indirect statements likewise made by Mr. Austin (Report, p. 45, *see* also Appendix, No. 35), that an acre of the Craigentinny meadows, near Edinburgh, receives annually at least a quantity of 8,400 tons of sewage, containing an amount of valuable constituents worth 74 *l.* 12 *s.*; and, therefore, equivalent to 6⅔ tons of guano. This would explain, to a certain extent, how an acre of this land is capable of producing annually, four and five crops of hay, amounting in weight in some instances it is said (Report pp. 74 and 75) to 80 tons, and of enabling the tenant to pay as high a rent as 30 *l.* per annum.

interest on capital expended in the construction of works, rent for the sewage, coals, labour, and all expenses, the acre of land on Mr. Walker's estate receives annually 446 tons of sewage, having a value of 3 *l.* 18 *s.*, leaving a profit of 2 *l.* 18 *s.* per acre, or a return of 290 per cent. of the cost; if we assume for the Rugby sewage a composition similar to that of the mean of the London sewage.

In endeavouring to form an idea of the probable cost of works for the distribution of the London sewage for the purpose of irrigation, we have been frequently led to compare the sewage with another material which we are in the daily habit of distributing in tubes over considerable areas, though certainly not over distances comparable with those over which it would be necessary to carry the London sewage. We allude to the distribution of the coal-gas, which circulates in our large cities. It is not necessary to be an engineer in order fully to appreciate the different conditions involved in the distribution of gas and sewage; nevertheless, if we consider the stupendous works which we are constantly in the habit of constructing for the manufacture of coal-gas, if we bear in mind the extent of pipes required for its distribution (the length of mains in the London streets being estimated at more than 2,000 miles), the question naturally presents itself, What is the value of the material for the sake of which we incur such expense, as compared with the value of sewage?

By instituting such a comparison of the value of equal volumes of coal-gas and sewage, we find that the latter has, in fact, a slightly higher value than the former; 1,000 cubic feet of sewage being worth 5 *s.* (see Appendix, No. 37), whilst coal-gas is now delivered by most of the London companies at 4 *s.* 6 *d.* per 1,000 cubic feet. Moreover, the sum paid by the inhabitants of London for the total amount of gas consumed in the metropolis during the year exceeds but slightly the value of the fertilising constituents which we lose annually in the sewage; the former calculated from an estimate kindly furnished by George Lowe, Esq., C. E. (see Appendix, No. 38), being 1,700,000 *l.*, whilst the latter is about 1,300,000 *l.*, as deduced from our calculations.

Having carried the inquiry to this stage, we are sorry to find that we have no additional data for the further elucidation of the subject. But, however imperfect and unsatisfactory may be the state in which we have to leave the question, we feel no hesitation in expressing our opinion, that of all the schemes proposed for the utilisation of the sewage of London, with which we have become acquainted, the proposal of using it for the purpose of irrigation is *the one which appears to us to be the most promising*; and we would even go a step further, and say, that it appears to us the *only one that has a moderate chance of success as a commercial undertaking.*

In the liquid portion of the sewage we have 6-7ths of the whole of the constituents valuable in agriculture; they are present in the form most appropriate for offering them to the roots of the plant. They there exist ready for use, without the necessity for the performance of any manufacturing operation; it is true they are in a very bulky form; but, nevertheless, in a form which physically admits of the cheapest carriage. The question that remains is, what would be the cost of this carriage?

In elaborating a complete scheme for the removal of the sewage of the metropolis, *would it not be possible* (even if the idea of its general application for irrigating purposes were, after a more minute investigation, abandoned) *to devise a plan which would admit of the utilisation of the sewage in the country, through which it will have to be carried, partially and locally for the purpose of irrigation;* would it not be possible in this way to recover part, at all events, of the valuable matter which would otherwise be withdrawn for ages from useful circulation? and could we not raise in this manner from the sewage itself a contribution, however inadequate, towards the vast expenditure which we have to incur in getting rid of it?

V.—Consideration of the Manufacture of Manure from Sewage in a Sanitary Point of View.

Hitherto we have exclusively examined the commercial prospects of the manufacture of a manure from sewage; we may now glance at the sanitary bearings of the question.

For this purpose we will compare the agricultural value of the charcoal-manure with the value of the deposit which settles from sewage without the addition of any chemical agent.

	£.	s.	d.
Value of insoluble matter of sewage (alone)	3	–	8½
Value of lime deposit	1	18	8¾
*Value of charcoal deposit	2	15	9¼

These numbers show what must be the real object of the addition of lime or of charcoal to the sewage. If it be possible to prepare from sewage, by simple subsidence, a manure worth 3 *l.* 0 *s.* 8½ *d.* per ton, nobody would think of manufacturing a charcoal-manure of a somewhat smaller value, but containing 26 per cent (*i. e.* 15 *s.* worth) of charcoal, or a lime-manure of little more than one-half the value, and containing moreover 23 per cent. (3 *s.* 3½ *d.* worth) of lime, unless it was for the purpose of deodorisation. If it were possible to collect the whole sewage into a large subsiding reservoir, and allow it to deposit alone, the product would be more valuable than any of the other sewage-manures which it has

* The fact that the charcoal deposit, although mixed with 23 per cent. of charcoal, is not very far inferior in value to the unmixed deposit, is due to the absorbent power which charcoal exerts upon some of the soluble constituents of sewage. *Vide ante.*

has been proposed to prepare. It is only in order to accelerate and by deodorisation to render possible this operation, which by itself would be an intolerable nuisance, that consent is given to the dilution of the deposit with either lime or charcoal.

Having thus established the real function of the lime and charcoal to be deodorisers, the question next to be answered is,—How far do they fulfil this object?

As respects the deodorisation proper of sewage, we have already stated that in three out of the four experiments which we have described, the deodorisation of the sewage was by no means complete. In the experiment in which the sewage was filtered through peat charcoal, the nearest approach to perfect deodorisation was obtained; but in all the other experiments, the smell, though certainly to a greater or less extent diminished, was by no means altogether removed.

We have had the opportunity of witnessing the operation of deodorisation by lime, under various circumstances, and we have found that whilst the separation of the deposit is at all times rapid, the supernatant fluid which runs off, containing, as it still invariably does, a large amount of sewage matters, although in cold weather almost entirely devoid of smell, yet in the summer months gives rise to most offensive exhalations.

Similar results appear to have attended the adoption of the liming process in other establishments. Mr. Austin, describing in his "Report to the President of the General Board of Health (pp. 22 & 24)," his visit to the Tottenham Works, states that "the whole establishment was perfectly free from noxious and unpleasant odour;" and with regard to the Leicester establishment, that "an offensive odour pervaded the buildings at the time of my visit, which evidently escaped from the sewage deposit, as it was raised from the bottom of the reservoir. On opening the chamber in which the Jacob's ladder works the effluvium was intolerable, but this might be very readily dealt with, and all nuisance obviated."

We are led to infer from these statements, as well as from our own experience, that generally the liming works, when carried out on a moderate scale, would be harmless, but that occasionally, and especially in hot weather, they are likely to create a nuisance.

The objectionable character of the fluid run off from the lime-deposit, will receive further elucidation by a glance at the following table, in which we compare the proportion both of soluble and insoluble organic matter originally present in the London sewage, with that found in the fluid after removal of the deposit produced by lime,—by the mixture of lime, sulphate of alumina, and charcoal,—and by charcoal alone.

	Grains per Gallon.	*Percentage of Quantity originally present.*	*Grains per Gallon.*	*Percentage of Quantity originally present.*
	Original Sewage.		After Treatment with Lime.	
Insoluble Organic Matter	36·40	41·09	nil. (or nearly).	nil. (or nearly).
Soluble Organic Matter	52·36	59·00	40·34	77·04
Total	88·76		40·34	45·45
	Original Sewage.		After Treatment with a Mixture of Lime, Sulphate of Alumina, and Charcoal.	
Insoluble Organic Matter	36·40	41·09	nil. (or nearly).	nil. (or nearly).
Soluble Organic Matter	52·36	59·00	37·56	42·31
Total	88·76		37·56	42·31
	Original Sewage.		After Filtration through Charcoal.	
Insoluble Organic Matter	35·42	55·74	nil.	nil.
Soluble Organic matter	28·132	44·26	12·57	44·67
Total	63·55		12·57	44·67
	Original Sewage.		After Treatment with Charcoal.	
Insoluble Organic Matter	25·04	37·87	9·31	37·18
Soluble Organic Matter	41·19	62·19	22·624	54·92
Total	66·23		31·934	48·21

If we only consider the large quantity of organic matter which remains in solution in the supernatant fluid after treatment with lime (viz., 45 per cent. of the total quantity of organic matter originally present, and no less than 77 per cent. of the soluble organic matter), and also after treatment with a mixture of lime, sulphate of alumina, and charcoal, and after treatment with charcoal alone, we cannot possibly be mistaken as to the nature and deportment of such liquids. In cool weather they will exhibit no obvious signs of putrefaction; but, exposed to high temperatures, or accidentally coming in contact with decomposing substances, they will exhibit the same phenomena which are observed in the River Thames within the metropolitan boundary (and which have been so great a source of public complaint during hot summers), but of course increased in intensity in the same ratio, as they are more concentrated than the water of the Thames.

The only remedy is the mixing of these liquids, temporarily and partially deodorised, it may be, but nevertheless still putrescible in the highest degree, with a very large amount of water, and then removing them in this highly diluted state from the place of their production.

This may be practicable when the quantities operated upon are only moderate; but if experience teaches us that, even under these more favourable circumstances, the process of deodorisation cannot be entirely relied upon; if we find that, even in comparatively small establishments, with the most compact apparatus, with the most perfect mechanical contrivances, and a full command of water and mechanical power, the process, occasionally during the hot season, gives rise to serious inconveniences, are we justified in adopting this system for deodorising the enormous and daily increasing quantity of sewage discharged from the metropolis?

This question we have no hesitation in answering in the negative.

It is our opinion that the establishment in the immediate neighbourhood of the metropolis of colossal works for the deodorisation of the London sewage by the processes to which we have specially alluded, might, during the hot season, become a nuisance much less tolerable, and spreading its deleterious influence over a much wider area than does the river, polluted though it be, at the present moment; and we feel moreover that, if any such works were erected, the fluids from which the deposit produced by either lime or charcoal has been allowed to subside, when permitted to run into the Thames at any point in the neighbourhood of London, would be likely most seriously to affect the river, on account of the very large amount of soluble putrescible organic matter still retained by these fluids.

If, however, it be the object to deodorise the sewage independently of utilisation, it would be necessary to employ agents which are actually capable of destroying the organic matter of the sewage; true oxidising agents, such as the well-known disinfectants, chloride of lime, &c., or the manganates and permanganates, which have been lately proposed for this purpose by Mr. Condy. These last-mentioned substances certainly possess most extraordinary powers, and when employed in sufficient quantity will destroy effectually and permanently any trace of organic matter which may be held in solution; but we are of opinion that they will never be employed for the disinfection and deodorisation of the London sewage on a large scale; for, independently of the high price of these materials, we believe that few persons would seriously entertain the idea of erecting enormous works in the immediate neighbourhood of London merely for the purpose of rendering the sewage, by such a process, admissible to the river at a point in closer proximity to the metropolis; not to speak of the loss of the last chance of a profitable disposal of the sewage for the purpose of agriculture, which this method of proceeding would necessarily involve.

In conclusion, we may briefly allude to a question which has been frequently raised, viz., What would be the effect of irrigation with sewage in a sanitary point of view? Would not the distribution over a large area of a liquid, the putrefaction of which produces such deleterious effects, even after dilution with the river water, give rise to much greater inconvenience, and even danger, than we now actually experience under the present system? We believe that such would undoubtedly be the case, unless the distribution was effected with the necessary circumspection. Nevertheless, we believe that in practice the difficulties of accomplishing the distribution without injury to the health of the neighbourhood would prove, probably, less formidable than they appear at the first glance. The soil is, after all, the natural deodoriser, whose action is more powerful than that of any artificial process which has ever been suggested. The free exposure of the sewage over large surfaces to the influence of the air, which, diffused as it is through a porous soil, and hence exerting its oxidising powers with increased energy, cannot fail rapidly and effectually to remove a considerable portion of the organic matter, provided a certain limit be not passed, which will have to be ascertained by experience for the special soil which has to be irrigated.

Conclusions.

The principal Results of this lengthened Inquiry may be summed up as follows:—

I.—*Influence of the Sewage on the Composition of the Water of the Thames.*

(*a.*) Owing to the very great dilution of the sewage by the water of the Thames, chemical analysis indicates but a slight difference in the composition of the river-water before and after pollution.

(*b.*) Contrary to what might have been expected, the influence of the sewage scarcely increases the *quantity of dissolved organic matter.*

(*c.*) The presence of sewage perceptibly raises the proportion of mineral constituents, and especially of common salt.

(*d.*) The amount of *insoluble organic matter*, which is present in the *mud suspended* in the river, *steadily increases* with the degree of contamination.

(*e.*) The offensive character of the river water, the disengagement from it (especially during hot weather) of effluvia, not only highly offensive, but also exceedingly prejudicial to the health of the inhabitants of the districts lying along the river's banks, is *chiefly caused by the putrefaction of the organic matter, dissolved and insoluble*, which is diffused through the water.

(*f.*) The *intensity of this putrefactive decomposition* which the organic matter present in the water undergoes within the metropolitan area, arises from the constant supply of putrescible matter, partly *by the influx of the sewage*, but more especially by the *vast accumulation of the black sewage mud* which has gradually collected in the bed of the river.

II.—*Mean Composition and Agricultural Value of the Sewage.*

(*a.*) According to experiments made on specimens which represent its mean composition, the London sewage contains, on an average, 102·8 grains per imperial gallon of total solid constituents, of which 72·1 grains are mineral, and 30·7 grains organic matter.

(*b.*) In these 102·8 grains, the following quantities of substances valuable in an agricultural point of view, are present:—

Nitrogen	6·7
Phosphoric acid	1·8
Potash	1·0
Organic matter	30·7
Total	40·2

(*c.*) The *total solid matter*, when entirely separated from the water with which it is diluted, would have a money value of 6*l.* 0*s.* 3*d. per ton*; that of guano being taken at 11*l.*

(*d.*) Of the valuable matter, six-sevenths are present in the liquid portion, only *one-seventh* existing in the insoluble, or suspended form.

(*e.*) From the knowledge of the quantity of these valuable constituents contained in a given volume of sewage, it has been calculated that the *money value* of 100 *tons* of *sewage*, supposing all these bodies capable of separation, would be in its original condition 17*s.* 7*d.*, or 2*d.* per ton; and that therefore the whole sewage of London is worth 3,796 *l.* per diem, or 1,385,540*l.* per annum.

(*f.*) These numbers are, to a certain extent, confirmed by the calculation of the value of the solid and liquid excrements of the whole population of London.

(*g.*) The foundation of this calculation is, moreover, confirmed by the analyses of a variety of specimens of sewage, made on different occasions both by ourselves and by others.

(*h.*) The chemical composition of the sewage of Edinburgh, and also that of Leicester, differs but little from that of the London sewage.

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III.—*Utilisation of Sewage for Agricultural Purposes.*

Manufacture of a Manure from Sewage.

The following, among the many patented processes for the manufacture of manures from sewage, are those which, in accordance with the wishes of the Referees, were specially selected for examination, viz.

(A.) Treatment of sewage with lime.

(B.) Treatment of sewage with a mixture of lime, sulphate of alumina, and charcoal (Stothert & Gotto's process).

(C.) Treatment of sewage with charcoal (Jasper Rogers' and Richard Dover's processes):

1. Filtration of sewage through charcoal.
2. Agitation of sewage with charcoal.

We were also directed to report our opinion upon

(D.) Treatment of sewage with a magnesian salt (Sir James Murray's process).

The following are the conclusions at which we have arrived under this head:—

(*a.*) With respect to process (B.) (Messrs. Stothert & Gotto's), we find that the cost of the materials employed, irrespectively of working expenses, nearly equals the money value of the manure produced; whilst in process (C.) (1. Filtration through charcoal), the cost of the materials very considerably exceeds the money value of the manure obtained. These processes cannot, therefore, be entertained, if the object be to manufacture a manure as a commercial speculation.

(*b.*) The magnesia process was not experimentally examined: nevertheless our researches into the nature of sewage, together with the knowledge of the well-established chemical properties of the ammonio-magnesian phosphate, especially of its solubility in water and other menstrua, enable us to state that, owing to the extreme dilution of the sewage, the addition to it of a magnesian salt would produce either no precipitate of the ammonio-magnesian phosphate at all, or only of a most minute quantity; so that the manure produced by this process would essentially consist of the suspended matter of the sewage, which might as easily be collected by simple subsidence, and which contains only one-seventh of the valuable constituents of sewage.

(*c.*) With reference to the two remaining processes, viz., treatment with lime (A.) and agitation with charcoal (C. 2.), we find, from our experiments made on a small scale, that the value of the manure produced considerably exceeds the cost of the materials employed. However, on going minutely into all the conditions involved in the manufacture of a manure from the London sewage by the two processes above mentioned, we come to the conclusion that they offer no chance of success as commercial speculations.

We have been led to this conclusion by considerations, among which the following are the more important:

(1.) In estimating the commercial prospects of a process, it is safer to rely upon the results obtained in a manufacturing operation than on those furnished by experiments on a smaller scale. Now, analysis shows that the value of the article manufactured at the works at Leicester, where the liming process is used, is less than one-half of the value which experiment assigns to our manure obtained on a small scale.

(2.) In calculating the probable expense of manufacturing the sewage manure, the interest of the capital required for the erection of works, the actual cost of producing and the commercial expenditure, we have had but insufficient data, and they have therefore probably been estimated below what would be found to be the case in practice; all these circumstances prove that the profit resulting from the manufacture of sewage manure would be reduced to a very small amount.

3. The nature of the manure manufactured by either of these processes, its great bulk, containing as it does but a very small quantity of valuable constituents in a very large mass of inert matter, increases the cost of carriage and spreading, when compared with that of guano, to such an extent as to limit its application to a very small area. With reference to the liming process, for instance, taking the value of the Leicester bricks as representing the average value of the lime-manure, and starting from the calculation of the manufacturing expenses chiefly furnished by the estimate of Mr. Wicksteed, the patentee, we find that the profit on a ton of lime-manure sold at the works would be 5*s.* 3*d.*, whilst at a distance of only two miles from the works it could not realise more than 2*s.* 3*d.* profit, and when transported to a distance of five miles, the manure would have to be sold at a loss.

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IV.—*Utilisation with Sewage in a Liquid State. Irrigation with Sewage.*

In order fully to appreciate the proposal which has been made of using sewage for the purpose of irrigation (an application, the beneficial and advantageous results of which are established beyond a doubt), it is necessary to recollect that 100 tons of London sewage contain 2*s.* 2½*d.* worth of valuable constituents in the solid, and 15*s.* 4½*d.* worth in the liquid form; and that in order to supply a meadow with valuable matters corresponding in quantity to those contained in one ton of guano, it is necessary to irrigate with 1,250 tons, or 310,000 gallons of sewage.

A general consideration of the question points out the great expense which necessarily must attend a regular distribution in this way of the enormous quantities of sewage produced annually by the Metropolis; nevertheless, there are too many elements (engineering and agricultural) entering into the question to enable us, as chemists, to pronounce any very decided opinion as to whether the application of the sewage of the Metropolis in this way would, or would not, be a remunerative commercial speculation; but, so far as we have been enabled to ascertain, we believe that the proposal of using it in this way, is the *one which appears to us* to be the *most promising*; and we would even say, the *only one that has any chance of success as a commercial scheme*; and we would therefore suggest, that in devising means for removing the metropolitan sewage, they should not exclude the possibility of giving this method the trial which it merits.

V.—*Consideration of the Manufacture of Sewage Manure from a Sanitary Point of View.*

The several processes submitted to us for *deodorising and consolidating sewage into a manure* (viz., (A.) By means of lime; (B.) By the use of Stothert and Gotto's mixture; (C. 1.) By filtration through charcoal; and, (C. 2.) By shaking with charcoal), *all fulfil, to a certain extent, the office for which they were proposed.* At the same time, it is found that these several processes *leave a large quantity of putrescible organic matter in solution, which, especially in hot weather, is apt to undergo decomposition, and to give rise to the generation of effluvia of the most offensive and dangerous character;* and we believe that the *erection of works in the immediate neighbourhood of the metropolis,* for the deodorisation of the London sewage, *might prove very prejudicial* to the *health and comfort* of the inhabitants of London; and that, in the event of the establishment of such works, *the fluid run off from the sewage deposit, if discharged into the Thames in the vicinity of London, might very seriously affect the river.*

We have the honour to be,

Gentlemen,

Your obedient Servants,

A. W. Hofmann.
Henry M. Witt.

To Captain Galton, R. E.
James Simpson, Esq., C. E.
Thomas E. Blackwell, Esq., C. E.

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APPENDIX to Chemical Investigations relating to the Metropolitan Main Drainage Question, by *A. W. Hofmann*, LL.D., F.R.S., and *Henry M. Witt*, F.C.S.

I.—On the Influence of the Sewage on the Composition of the Water of the Thames.

It would have been superfluous to make complete analyses of the several samples of river water sent to us by the Referees for the purpose of ascertaining the extent of the contamination of the water of the Thames by sewage, even if the time at our disposal had permitted us to do this. All that was necessary, was to determine the amount of mineral and organic matter existing both in solution and suspension.

This was effected by passing a known weight of the water through a tared filter, then weighing the amount of total suspended matter thus separated, when carefully dried at 212° F. (100° C.); the filter with its contents was then ignited; and thus, after deducting the ash of the filter, the percentage of ash in the suspended matter was determined; by deducting this from the total suspended matter, the proportion of organic matter in the mud was ascertained.

The filtrate was next evaporated to dryness in a platinum capsule, with a known weight of carbonate of soda; the residue, when dried at 248° F. (120° C.), and weighed, after deducting the weight of the carbonate of soda added, gave the "total dissolved matter;" by igniting this residue so as completely to expel the organic matter, adding a little solution of carbonate of ammonia (for the purpose of recarbonating any lime which might have become caustic), again evaporating and drying at 248° F. (120° C.), and finally weighing it, the ratio of mineral and organic matter in the dissolved portion was ascertained.

Of course, the sum of the quantities of the matter, both mineral and organic, existing both in suspension and solution, furnished what we call the "total amount of solid matter."

No. 1.

TABLE (A).—*Details of Analyses of Samples of Thames Water.*

Label	A. 1, 2, 3, & 4.	B. 5, 6, 7, & 8.	C. 9, 10, 11, & 12.	D. 13, 14, 15, & 16.	E. 17, 18, 19, & 20.	F. 21, 22, 23, & 24.	H. 30, 31, 43, & 82.	K. 44, 45, & 46.	L. 47, 48, 49, & 50.	M. 51, 52, 53, & 54.	O. 55, 56, 57, & 58.	P. 59, 60, 61, & 62.	Q. 63, 64, 65, & 66.	S. 71, 72, 73, & 74.	T. 70, 80, 81, & 82.	V. 75, 76, 77, & 78.	W. 83, 84, 85, & 86.
Suspended Matter:																	
Grains per Gallon:																	
Mineral - -	- - -	- - -	3·32	2·56	2·20	- - -	- - -	- - -	5·48	3·23	4·40	1·83	2·62	3·44	7·42	44·38	37·81
Organic - -	- - -	- - -	0·71	0·52	0·00	- - -	- - -	- - -	1·48	0·02	1·03	0·55	0·06	0·79	1·40	0·24	5·97
Total - - -	0·57	0·30	4·03	3·08	2·80	0·04	0·77	0·81	6·96	4·15	5·43	2·38	3·48	4·23	8·82	53·62	43·78
Dissolved Matter:																	
Mineral:																	
In 1,000 Grains - I.	·2068	·2356	·2700	·2753	·2555	·24825	·32300	·2004	·2024	·2893	·2675	·25407	·20006	·3207	·6204	1·8404	1·7004
II.	·2708	- -	·2847	·2506	·2505	- -	·31060	·3220	·2575	·2895	·2546	·2543	·20177	·3130	·04281	1·8004	1·8108
Mean - -	·2718	·2356	·2821	·2629	·2500	·24825	·31680	·3062	·2500	·2894	·2611	·25404	·2010	·3173	·6315	1·8234	1·8006
Mean Grains per Gallon	19·03	10·40	19·75	18·40	17·92	17·98	22·18	21·44	18·20	20·20	10·27	17·81	20·37	22·21	44·20	127·65	120·04
Organic:																	
In 1,000 Grains - I.	·0142	·0204	·0102	·0115	·0188	·01215	·02004	·0107	·0142	·0137	·0179	·01293	·02004	·01619	·01150	·0476	·0212
II.	- -	- -	- -	·0133	·0185	- -	·02004	- -	·0108	·01542	·0154	·0146	·01773	·01927	·01349	—	—
Mean - -	·0142	·0204	·0102	·0124	·0180	·01215	·02004	·0107	·0125	·01460	·0166	·01340	·0188	·01773	·01252	·0479	·0212
Mean Grains per Gallon	0·00	1·43	1·13	0·87	1·30	0·85	1·40	1·17	0·87	1·02	1·16	0·94	1·32	1·24	0·88	3·33	1·48
Total Dissolved Matter:																	
I. - - -	·2810	·256	·2958	·2868	·2743	·2004	·3431	·30707	·2706	·30303	·2854	·2673	·3101	·3369	·6818	1·888	1·8116
II. - - -	·2010	- -	·3009	·2639	·2750	- -	·3307	·3388	·2683	·3060	·2700	·2089	·3005	·3332	·0568	1·854	1·832
Mean - -	·2860	·256	·2983	·2753	·2746	·2004	·3360	·3220	·27245	·304	·2777	·2081	·3008	·3350	·0440	1·871	1·8218
Mean Grains per Gallon	20·02	17·92	20·88	19·27	19·22	18·23	23·58	22·01	19·07	21·28	20·43	18·75	21·69	23·45	45·08	130·08	127·52
Total Solid Constituents:																	
Grains per Gallon:																	
Mineral - -	- - -	- - -	23·07	20·07	20·12	- - -	- - -	- - -	23·07	23·40	23·07	10·04	22·89	25·65	51·02	172·03	169·85
Organic - -	- - -	- - -	1·84	1·30	1·00	- - -	- - -	- - -	2·30	1·04	2·10	1·40	2·28	3·03	2·28	12·57	7·45
Total - - -	20·50	18·28	24·91	22·30	22·11	18·87	24·95	23·42	20·03	25·43	25·80	21·13	25·17	27·68	53·30	184·60	177·30

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II.—Mean Composition and Agricultural Value of London Sewage.

No. 2.—*Gaugings of Savoy-street Sewer.*

Time when Samples were taken.	Depth in Inches.	Discharge per Minute.	Time when Samples were taken.	Depth in Inches.	Discharge PerMinute.
		cubic feet.			*cubic feet.*
13 May - 6 p. m. -	5·5	152	11 June - 3 p. m. -	4·2	104
7 „ - -	7.0	228	4 „ - -	6·0	184
8 „ - -	5·5	152	5 „ - -	7·5	251
9 „ - -	3·9	86	6 „ - -	8·0	275
10 „ - -	3·5	74	7 „ - -	7·0	228
11 „ - -	3·1	62	8 „ - -	4·4	110
12 midnight -	3·5	74	9 „ - -	4·0	96
14 May - 1 a. m. -	2·9	56	10 „ - -	3·3	67
2 „ - -	2·8	53	11 „ - -	3·1	62
3 „ - -	2·8	53	12 midnight -	2·8	53
4 „ - -	2·7	50	12 June - 1 „ - -	2·8	53
5 „ - -	2·7	50	2 „ - -	2·7	50
6 „ - -	2·7	50	3 „ - -	2·7	50
7 „ - -	3·0	59	4 „ - -	2·7	50
8 „ - -	6·5	205	5 „ - -	2·6	47
9 „ - -	6·3	196	6 „ - -	2·5	45
10 „ - -	7·2	237	7 „ - -	3·3	67
11 „ - -	6·4	201	8 „ - -	6·3	196
12 noon -	7·0	228	9 „ - -	6·0	184
1 p. m. -	6·8	218	10 „ - -	7·8	265
2 „ - -	4·4	110	11 „ - -	10·0	378
3 „ - -	5·7	160	12 noon -	7·0	228
4 „ - -	5·8	164	1 p. m. -	7·5	251
5 „ - -	7·8	265	2 „ - -	4·4	110
Maximum - - -	7·8	265	Maximum - - -	10·0	378
Minimum - - -	2·7	50	Minimum - - -	2·5	45
Mean - - -	5·25	157	Mean - - -	6·25	211

No. 3.—*Analysis of Mean Sewage*, 13 *May* 1857.

				Grains.
Suspended Matter:				
In the Gallon - -	Mineral - - - -			10·58
	Organic - - - -			8·35
	TOTAL - - -			18·93
Dissolved Matter:				
Mineral -	In 1,000 Grains -	I. - -		·7827
		II. - -		·8062
		Mean - -		·7944
	Mean in the Gallon - -			55·60
Organic -	In 1,000 Grains -	I. - -		0·2910
		II. - -		0·2852
		Mean - -		0·2881
	Mean in the Gallon - -			20·17
TOTAL Dissolved Matter:				
In 1,000 Grains - -	I. - - -			1·0737
	II. - - -			1·0914
	Mean - -			1·0825
Mean in the Gallon -	- - - -			75·77

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TOTAL Solid Constituents:				
In the Gallon	Mineral - - -			66·180
	Organic - - -			28·517
	TOTAL - - -			94·697

No. 4.—*Analysis of Mean Sewage*, 11 *June* 1857.

				Grains.
Suspended Matter:				
In the Gallon - -	Mineral - - -			19·23
	Organic - - -			13·55
	TOTAL - - -			32·78
Dissolved Matter:				
Mineral -	In 1,000 Grains -	I. - -		·8408
		II. - -		·8413
		Mean - -		·8410
	Mean in the Gallon - -			58·89
Organic -	In 1,000 Grains -	I. - -		·2852
		II. - -		·2671
		Mean - -		·2761
	Mean in the Gallon - -			19·33
TOTAL Dissolved Matter:				
In 1,000 Grains - -	I. - - -			1·126
	II. - - -			1·1084
	Mean - -			1·1174
	Mean in the Gallon - -			78·22
TOTAL Solid Constituents:				
In the Gallon -	Mineral - - -			78·121
	Organic - - -			32·877
	TOTAL - - -			111·00

No. 5.—*Mr. Way's Analysis of the Sewage from Dorset Square.*

	Grains per Gallon.		
	Soluble.	Insoluble.	Total.
Organic matter and salts of ammonia - - -	57·32	23·00	80·32
Sand and detritus of the granite of the streets - -	0·78	44·50	45·28
Soluble silica - - - - - - -	1·16	12·09	13·25
Phosphoric acid - - - - - - -	2·53	1·64	4·17
Sulphuric acid - - - - - - -	0·28	3·63	3·91
Carbonic acid - - - - - - -	10·58	1·99	12·57
Lime - - - - - - - - -	7·40	8·37	15·77
Magnesia - - - - - - - -	0·07	trace	0·07
Peroxide of iron and alumina - - - - -	trace	2·66	2·66
Chloride of potassium - - - - - -	2·60	0·72	3·32
Chloride of sodium - - - - - -	27·27	2·10	29·37
	109·00	100·70	209.70

Ammonia.—In the soluble state - - 15·16 grains.
In the insoluble state - - 2·80 „
17·96

No. 6.

* Way. Journal of the Agricultural Society, XV., Part 1.

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No. 6.—*Details of Determinations of Nitrogen in the Residue obtained by Evaporating the Mean Sewage with Hydrochloric Acid.*

Experiment I.—14·12 grains of substance gave 12·75 grains of platinum-salt (NH_4Cl, $PtCl_2$) = ·951 grains of nitrogen, or 6·735 per cent.

II.—15·00 grains of substance gave 12·90 grains of platinum-salt (NH_4Cl, $PtCl_2$) = ·962 grains of nitrogen, or 6·413 per cent.

I.	III.	*mean.*	*mean.*
6·735	6·413	6·574 per cent. of nitrogen,	or 7·982 per cent. of ammonia.

No. 7.—*Details of Determinations of Phosphoric Acid in the Residue obtained by Evaporating the Mean Sewage with Hydrochloric Acid.*

N.B.—The following numbers refer to the ash.

Experiment I.—2·547 grains of the ash of the residue gave 0·110 grains of pyrophosphate of magnesia (2 MgO, PO_5), which corresponds to 2·76 per cent. of phosphoric acid (PO).

II.—2·3325 grains of the ash of the residue gave 0·088 grains of pyrophosphate of magnesia (2 MgO, PO_5), which correspond to 2·41 per cent. of phosphoric acid (PO_5).

Percentage of phosphoric acid in the ash:—

I.	II.	*mean.*
2·76	2·41	2·58

But since the residue contains 69·89 per cent. of ash, this will give 1·80 per cent. of phosphoric acid in the total residue, or 3·9 per cent. of phosphate of lime (3 Ca O, P O_5).

No. 8.—*Details of Calculation of Potash.*

The amount of potash in the sewage was not experimentally determined, but the fact that the nitrogen and the available potash is chiefly derived from urine, and the well-known average composition of this liquid enables us to calculate the amount of potash in the sewage. According to Berzelius (*see* No. 14 of this Appendix), the ratio of nitrogen to potash in urine is as 7 to 1; there are certainly other sources of nitrogen in sewage; the solid fæces contain an appreciable amount of nitrogen, but there are also additional sources of potash; the fæces contain potash, and a considerable quantity of potash (though chiefly in an insoluble form) is moreover furnished by the débris of the granitic pavements. In his analysis of the sewage from Dorset-square (*see* this Appendix, No. 5), Mr. Way gives the proportion of nitrogen to that of *soluble* potash as 7 to 1·23, which closely corresponds with the ratio of Berzelius's Analysis.

If we adopt the latter proportion, as representing the amount of soluble potash in the London sewage, which contains 6·67 per cent. of nitrogen, we arrive at 1·15 per cent. of potash. In the text we have adopted the number 1 per cent., which is rather below than above the truth.

No. 9.—*Details of Determination of Nitrogen, in the Suspended Matter (Mud) of the Mean Sewage.*

11·76 grains of the residue gave 5·54 grains of platinum-salt (NH_4Cl, $PtCl_2$) = ·413 grains of nitrogen, or 3·512 per cent., and corresponding to 4·26 per cent. of ammonia.

No. 10.—*Details of Determination of Phosphoric Acid, in the Suspended Matter (Mud) of the Mean Sewage.*

0·746 grains of the ash of this suspended matter gave 0·215 grains of pyrophospate of magnesia (2 MgO, PO), corresponding to 1·84 per cent. of phosphoric acid in the ash; but since this suspended matter contains only 44·11 per cent. of ash, this will equal 0·816 per cent. of phosphoric acid, or 1·269 of phosphate of lime (3 CaO, PO_5) in the total mud.

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No. 11.—*Money Value of the several Constituents of Sewage.*

In a most interesting paper "On the Value of Artificial Manures," Mr. Way arrives, by calculations from the market price of the commercial articles containing the various substances valuable as manures, at the following average numbers (Agricultural Journal, XVI., 533):—

Ammonia	56 *l.* per ton.
Potash	31 *l.* „
Phosphate of lime, insoluble	7 *l.* „
Ditto soluble	32 *l.* „
Organic matter	1 *l.* „
Sulphate of lime	1 *l.* „

And he had used similar numbers previously, in a paper "On the Composition and Value of Guano" (Agricultural Journal, X., 196).

With reference to the insoluble and soluble phosphates, it may be remarked, that in calculating the direct results of analysis we have, for the sake of simplicity, calculated also the phosphoric acid, which is in solution as phosphate of lime (3 Ca O, P O_5) although it can exist in solution only in this form either as 2 Ca O, H O, P O_5 or Ca O, 2 H O, P O_5. The results of the calculations are not affected by this assumption.

No. 12.—*Details of Calculation of Money Value of the Solid Constituents of* 100 *Tons of Sewage.*

The mean sewage contains in the gallon (of 70,000 grains):—

Suspended matter	25·85
Dissolved	77·04
TOTAL Solid Constituents	102·89

Or in 100 gallons (7,000,000 grains):—

Suspended	2585·00
Dissolved	7704·00
TOTAL	10289·00

The English ton = 15,680,000 grains, contains 23047·36 grains = 3·2867 lbs. of solid sewage matter; 100 tons contain therefore 328·67 lbs. This, at 6 *l.* 0 *s.* 3 *d.* per ton, gives 17 *s.* 7 *d.* for the value of the total solid matter in 100 tons.

No. 13.—*Details of Calculation of the Money Value of the Suspended and Dissolved Matter contained in* 100 *Tons of Sewage.*

The mean sewage contains in the gallon (70,000 grains) 25·85 grains of suspended matter, or in 100 gallons 2585·0 grains. The ton contains therefore 5790·4 grains = ·8272 lbs. of suspended sewage matter; or 100 tons contain 82·72 lbs. This, at 3 *l.* 0 *s.* 8½ *d.* per ton, gives 2 *s.* 2½ *d.* for the value of the suspended matter in 100 tons of sewage.

	s.	*d.*
Value of total solid constituents in 100 tons	17	7
„ suspended matter	2	2½
„ dissolved	15	4½

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No. 14.—*Calculation of Money value of the Excrements of the Entire Population of London.*

I. Liquid Excrement—Urine.

Berzelius's Analysis of Urine.

	In 1,000 *Grains.*
Urea	30·10
Lactic acid, extractive, &c.	17·14
Uric acid	1·00
Mucus, &c.	0·32
Common salt (Na Cl)	4·45
Sulphate of potash	3·71
Sulphate of soda	3·16
Phosphate of soda (2 Na O, H O, P O_5)	2·94
Phosphate of ammonia (2 N H_4 O, H O, P O_5)	1·65
Chloride of ammonium	1·50
Phosphate of magnesia and lime	1·00
Silica	0·03
Water	933·00
TOTAL	1000·00

1. *Nitrogen in* 1,000 *Grains of Urine.*

From the urea (C_2 H_4 N_2 O_2), (30·10 grains)	13·16	grains.
From the chloride of ammonium (1·5 grains)	0·40	„
From the phosphate of ammonia (2 NH_4O, HO, PO_5), (1·65 grains)	0·35	„
From the uric acid (C_{10} H_2 N_4 O_4, 2 HO), (1·0 grains)	0·33	„
TOTAL	14·24	„

2. *Phosphoric Acid in* 1,000 *Grains of Urine.*

From the phosphate of ammonia (2 NH_4 O, HO, PO_5), (1·65 grains)	0·89	grains.
——— phosphate of soda (2 NaO, HO, PO_5) (2·94 grains)	1·48	„
	2·37	„

3. *Potash in* 1,000 *Grains of Urine.*

From 3·71 grains of sulphate of potash — 2·00 grains.

4. *Organic Matter in* 1,000 *Grains of Urine.*

Urea (minus the nitrogen)	23·00	grains.
Lactic acid, extractive, &c.	17·14	„
Uric acid	1·00	„
Mucus	0·32	„
	41·46	„

Starting from the above analysis of urine, we find that 1,000 grains of the normal urine of an adult contain the following constituents, valuable in an agricultural point of view:

1. Nitrogen	14·24 grains,	corresponding to 1·729 grains of ammonia.
2. Phosphoric acid (in the form of soluble phosphates)	2·37 „	corresponding to 5·17 grains of phosphate of lime (3 Ca O, P O_5).
3. Potash	2·00 „	
4. Organic matter	41·46 „	
TOTAL Valuable Constituents in 1,000 grains	60·07 „	

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Starting from these data we find the following to be the value in money of urine for agricultural purposes:

100 tons correspond to—		£.	s.	d.
1·729 tons of ammonia, at 56*l.*		96	16	6
0·51 „ soluble phosphate of lime, at 32*l.*		16	6	5
0·20 „ potash, at 31*l.*		6	4	—
4·14 „ organic matter, at 1*l.*		4	2	10
Value of 100 tons	£.	123	9	9
Value per ton	£.	1	4	8

Each adult voids on an average 40 oz. per day, this would give for 1,000 men, 40,000 oz., 22·32 cwt., or 1·116 tons; so that the money value of the urine of 1,000 people (adults), at the rate of 1*l.* 4*s.* 8*d.* per ton, is 1*l.* 5*s.* per diem (24 hours), or for the year, 456*l.* 5*s.* per annum.

II. Solid Excrement—Fæces.

Analysis of Dried Human Fæces.—Way.

	Composition of Ash.	Composition of dried Excrement.
Organic matter	—	88·52
Insoluble silica	12·79	1·48
Sesquioxide of iron	4·66	0·54
Lime	14·98	1·72
Magnesia	13·48	1·55
Phosphoric acid	37·17	4·27
Sulphuric acid	2·10	0·24
Potash	10·40	1·19
Soda	2·83	0·31
Chloride of sodium	1·59	0·18
	100·00	100·00

	Water.	Dry Matter.	Nitrogen in Wet.	Nitrogen in Dry.
I.	74·27	25·73	1·44	5·59
II.	73·24	26·76	1·16	4·34
III.	79·60	20·40	1·45	7·13

Determinations by Liebeg.

The solid human excrement was found by Liebig* to contain in the fresh state—

Water		75·00
Organic matter	21·72	25·00
Ash	3·28	
		100·00

Determinations by Wesarg.

Wesarg† has also published a determination of the quantity of water and volatile bodies (expelled at 248° F. (120° C.) from human fæces, and he obtained numbers which closely correspond with the above, viz.:—

Water (and volatile bodies expelled at 248° F. (120° C.)	73·3
Organic matter and ash	26·7
	100·0

From

* Animal Chemistry, 2d edition, p. 288.
† Mikroskopische und Chemische Untersuchung der Fæces bei gesunden Erwachsenen, 1853.

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From these data we calculate that 100 grains of dry human fæces contain *—

Nitrogen	5·6
Phosphoric acid	4·27
Potash	1·19
Non-nitrogenous organic matter	82·98
Total valuable constituents in 100 grains	91·98

Valuable Constituent in 100 *Grains of Moist Fæces:*

Nitrogen	1·40, corresponding to 1·7 of Ammonia.
Phosphoric acid	1·06, corresponding to 2·30 of Phosphate of Lime.
Potash	0·29
Organic matter	21·00
TOTAL Valuable Constituents	23·75 in 100 parts.

Value of Moist Solid Excrement (Fæces):

100 tons correspond to—			£.	s.	d.
1·70 tons of Ammonia	at 56*l.* per ton		95	4	–
2·30 „ Insoluble Phosphate of lime	at 7*l.* „		16	2	–
0·29 „ Potash	at 31*l.* „		8	19	10
21·00 „ Organic matter	at 1*l.* „		21	–	–
Value of 100 tons			£.141	5	10
Value per ton			£.	1	8	3

Each man of the body guard of the Grand Duke of Hesse Darmstadt voided, on an average,† 5½ oz. of moist solid excrement, per day of 24 hours; but allowing 6 oz. for "John Bull," this would give, for 1,000 men, 6,000 oz. = 3·348 cwt. or ·1674 tons; its value, at 1*l.* 8*s.* 3*d.* per ton, being 4*s.* 8*d.* for the value of the solid excrement of 1,000 people per day, or, per annum, 85*l.* 10*s.*

Value of the Excrement of 1,000 People.

	Liquid (Urine.)	Solid (Fæces).	TOTAL.
	£. s. d.	£. s. d.	£. s. d.
Per day	1 5 –	– 4 8	1 19 8
Per year	486 5 –	85 10 –	541 15 –

Value of the Excrement of the Total Population of London (reckoned at 2,600,000†).

	Liquid Urine.	Solid Fæces.	TOTAL.
	£. s. d.	£. s. d.	£. s. d.
Per day	3,350 – –	606 13 –	3,956 13 –
Per year	1,222,750 – –	221,427 – –	1,444,177 – –

* Way "On the Use of Town Sewage as a Manure."—Agricultural Society's Journal, XV.
† Liebig, Animal Chemistry, p. 285.

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TABLE B.—Details of Analysis of Sewage.

TITLE OF SAMPLE.	1. First Mean Sewage (Savoy-street).	2. Second Mean Sewage (Savoy-street).	3. Mean of two previous Analyses.	4. Savoy-street after Heavy Storm.	5. Falcon Brook. I.	6. Earl Sewer. R.	7. Fleet Sewer. N.	8. Fleet before Ruin. C.	9. Fleet after Ruin. D.	10. King's Scholar's Pond. G.	11. King's Scholar's Pond before Ruin. G.	12. King's Scholar's Pond after Ruin. H.	13. North-umberland-street Sewer, May 16.	14. Northumber-land-street Sewer, May 28.	15. Northumber-land-street Sewer, June 13.
SUSPENDED MATTER: (*Grains per Gallon*)															
Mineral	10·58	10·23	14·00	–	1·04	1·46	10·90	0·18	110·54	14·59	25·01	110·48	10·00	21·48	14·44
Organic	8·35	13·55	10·05	–	1·00	1·42	10·96	0·20	35·46	12·04	15·10	30·85	30·40	35·42	25·04
TOTAL	18·93	23·78	25·85	–	3·54	2·88	30·10	15·38	140·00	26·63	41·10	141·33	52·40	50·00	39·48
DISSOLVED MATTER:															
Mineral:															
In 1,000 grains, I.	·7827	·8408	–	–	·5490	·02008	·4407	·7271	·8301	·4452	·6101	·4025	·780	·8018	1·0132
II.	·8002	·8413	–	–	·5420	·0215	·4078	–	–	·4018	–	–	·799	·8457	·0072
Mean	·7944	·8410	–	–	·5458	·02079	·4572	·7271	·8301	·4535	·6101	·4025	·799	·8238	·0002
Mean, Grains per Gallon	55·01	58·80	57·20	–	38·21	44·05	32·00	50·00	58·14	32·04	43·33	34·57	55·24	57·62	07·20
Organic:															
In 1,000 grains, I.	0·2010	·2852	–	–	·0310	·03122	·0733	·1172	·0010	·0045	·1010	·0740	·703	·4010	·5374
II.	0·2852	·2071	–	–	·0300	·0347	·0771	–	–	–	–	–	·704	·4580	·0411
Mean	0·2881	·2701	–	–	·0341	·03290	·0761	·1172	·0010	·0045	·1010	·0740	·748	·4290	·5802
Mean, Grains per Gallon	20·17	18·93	10·75	–	2·30	1·92	5·20	8·20	4·90	3·71	7·07	5·13	52·30	30·00	41·10
TOTAL Dissolved Matter:															
In 1,000 grains, I.	1·0797	1·120	–	–	·5800	·0573	·5107	·8443	·8302	·5307	·7201	·5071	1·483	1·2097	1·5506
II.	1·0914	1·1084	–	–	·5702	·0502	·5440	–	–	·5503	–	–	1·503	1·3097	1·5483
Mean	1·0825	1·1174	–	–	·5700	·0507	·5329	·8443	·802	·5480	·7201	·5071	1·508	1·2597	1·5404
Mean, Grains per Gallon	75·77	78·22	77·04	–	40·00	45·07	37·29	59·10	58·50	38·35	50·40	30·70	107·00	87·71	108·45
TOTAL Solid Constituents:															
Mineral	00·10	78·12	72·10	188·49	40·15	40·11	51·30	00·08	108·08	47·23	00·24	146·05	71·33	70·10	81·70
Organic	28·62	32·88	30·70	108·48	3·00	2·74	10·12	14·40	30·42	17·75	22·20	36·98	88·70	05·61	00·23
TOTAL, Grains per Gallon	04·70	111·00	102·80	200·07	44·14	48·85	07·42	74·48	208·50	04·98	01·50	181·03	100·00	144·01	147·03

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No. 16.—*Mr. Versmann's Analysis of London Sewage.**

		Grains per Gallon.		
		Total Solid Constituents.	Nitrogen.	Phosphoric Acid.
The London Bridge sewer	I.	155·82	7·63	0·63
	II.	116·90	6·06	—
St. Paul's sewer	I.	138·11	10·23	1·54
	II.	108·22	7·62	—

No. 17.—*Mr. Way's Analyses of Sewage Water.*†

	From Dorset Square. Grains per Gallon.			From Barret's Court. Grains per Gallon.		
	soluble.	*insoluble.*	*both.*	*soluble.*	*insoluble.*	*both.*
Organic matter and salts of ammonia	57·32	23·00	80·32	121·50	180·32	301·82
Sand, &c.	0·78	44·50	45·28	1·39	19·30	20·69
Soluble silica	1·16	12·09	13·25	1·57	10·94	12·51
Phosphoric acid	2·53	1·64	4·17	7·71	2·73	10·44
Sulphuric acid	0·28	3·63	3·91	10·71	4·02	14·73
Carbonic acid	10·58	1·99	12·57	11·62	3·97	15·59
Lime	7·40	8·37	15·77	7·50	17·03	24·53
Magnesia	0·07	trace	0·07	2·87	trace	2·87
Oxide of iron and alumina	trace	2·66	2·66	trace	6·20	6·20
Potash	2·60	0·72	3.32	46·91	1·22	14·13
Soda	—	—	—	—	1·51	1·51
Chloride of potassium	—	—	—	—	—	—
Chloride of sodium	27·27	2·10	9·37	31·52	1·72	33·24
	109·00	100·70	209·70	243·30	248·96	492·26

No. 18.—*Mr. Versmann's Analysis of the Sewage of the Town of Leicester.**

Grains per Gallon.

Direct Results of Experiments.		Arrangement of Results.	
Lime	25·20 grs. in the gallon.	Carbonate of lime (with trace of sulphide of calcium)	19·67 grains.
Magnesia	2·59 „	Sulphate of lime	34·51 „
Potash	2·31 „	Carbonate of magnesia	5·46 „
Soda	2·24 „	Chloride of potassium	3·64 „
Iron	5·74 „	Chloride of sodium	2·52 „
Sulphuric acid	21·49 „	Sulphate of soda	2·10 „
Chlorine	3·29 „	Iron, alumina, and phosphates	5·74 „
Carbonic acid	11·55 „	Silica and sand	12·18 „
Silica and sand	12·18 „	Organic matter	20·79 „
Organic matter	20·79 „		106·61 grs.
Nitrogen, 2·15 = Ammonia, 2·60		Nitrogen, 2·15 = Ammonia, 2·60	

* Report, addressed to Fothergill Cooke, Esq.
† See Way "On the Use of Town Sewage as a Manure."—Agricultural Society's Journal, XV., Part 1.

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No. 19.—*Dr. Anderson's Analysis of the Morningside Sewage.**

Organic matter	51·77	grains in the gallon.
Alumina	4·93	
Protoxide of Iron	10·34	
Lime	11·99	
Magnesia	2·85	
Chloride of Sodium	4·49	
Soda	3·00	
Potash	2·66	
Carbonic Acid	11·22	
Sulphuric Acid	3·12	
Phosphoric Acid	1·32	
Silica	25·02	
	132·71	
Ammonia	3·18	

III.—Utilisation of Sewage for Agricultural Purposes.

(A.)—Treatment of Sewage with Lime.

No. 20.—*Mr. Higgs's Analysis of "Tottenham Sewage Guano."*

Moisture	5·25
Organic matter (rich in nitrogen)	31·60
Phosphates	8·64
Sulphates, with alkaline bases	3·87
Carbonic acid	16·20
Soluble silica	5·20
Lime	20·48
Magnesia	2·53
Alumina (with a little sesquioxide of iron)	2·44
Insoluble remainder and loss	3·79
	100·00

No. 21.—*Dr. Voelcker's Analysis of the "Leicester Bricks."*

Water	10·52
Organic matter	12·46
Insoluble siliceous matter	13·50
Sulphate of lime	1·76
Oxides of iron and alumina	2·89
Carbonate of lime	52·99
Carbonate of magnesia	3·67
Chloride of sodium	0·45
Potash	0·26
Phosphate of lime (3 CaO, PO_5)	2·27
	100·77

Nitrogen 0·60 per cent. = Ammonia 0·72 ditto.

No. 22.

* Journal of the Agricultural Society of Scotland, No. 44, New Series, March 1854, p. 270.

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No. 22.—*Mr. Versmann's Analysis of "Leicester Bricks."*

Brick of the Season 1856.

In its original state:		Otherwise stated:	
Water	4·06 per cent.	Water	4·06 per cent.
Organic matter	26·32 „	Organic matter	26·32 „
Lime	28·32 „	Carbonate of lime	46·10 „
Magnesia	1·07 „	Sulphate of lime	2·35 „
Potash	0·46 „	Phosphate of lime	2·32 „
Soda	0·74 „	Sulphide of calcium	0·38 „
Iron and alumina	3·83 „	Carbonate of magnesia	2·25 „
Sulphuric acid	1·38 „	Chloride of potassium	0·61 „
Chlorine	0·29 „	Carbonate of potash	0·10 „
Phosphoric acid	1·07 „	Carbonate of soda	1·26 „
Carbonic acid	22·02 „	Iron and alumina	3·83 „
Sulphur	0·17 „	Silica and insoluble residue	10·42 „
Silica and insoluble residue	10·42 „		100·00

Nitrogen	0·560 per cent.
Ammonia	0·680 „

A more recent analysis of the deposit, fresh from the press, showed the presence of a slightly larger quantity of nitrogen, viz., 0·738 per cent., corresponding to 0·896 of ammonia; but it is remarkable, that even this is a smaller quantity than we obtained in our experiment on the London sewage.

No. 23.—*Dr. Hofmann's Analysis of the Lime Deposit from the Sewage of the Clifton Union.*

Phosphate of lime (3 CaO, PO_5)	3·08	per cent.
Ammonia	0·75	„
Organic matter	20·12	„
Lime and ash	76·01	„
	99·96	

Value per ton 16 *s.* 9 *d.*

No. 24.—*Mr. Versmann's Results as to the Effect of the Treatment of the Leicester Sewage with Lime.*

Mr. Versmann gives the following table (in addition to others containing complete analyses of the Leicester sewage before referred to, No. 16), showing the composition of the Leicester sewage before and after treatment with lime, stated in grains in the imperial gallon.

	Total Residue.	Salts Soluble in Acid.	Organic Matter.	Silica Insoluble in Acid and Sand.
	Grains.	*Grains.*	*Grains.*	*Grains.*
Original sewage	106·47	73·50	20·79	12·18
Supernatant fluid, after treatment with lime	64·33	47·11	12·88	4·34

Mr. Versmann shows that the total quantity of soluble salts removed amounted to 36 per cent. in his experiments on the Leicester sewage; the reduction of organic matter was about 38 per cent., whilst the per-centage of matters removed (including both dissolved and suspended) rose to 37 per cent., whilst, curiously enough, in our trial experiment on the London sewage, we succeeded in separating 40 per cent.

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No. 25.—*Details of Analyses of Lime Deposit from London Sewage.*

Determinations of Nitrogen.

Experiment I.—6·54 grs. of substance gave 1·70 of platinum salt (NH_4Cl, $PtCl_2$) = 0·1066 grs. of nitrogen, or 1·63 per cent.

II.—6·79 grs. of substance gave 1·60 of platinum salt (NH_4Cl, $PtCl_2$) = 0·1003 grs. of nitrogen, or 1·48 per cent.

I. II. *mean.*
1·63 - - 1·48 - - 1·55 = 1·88 per cent of ammonia.

Determinations of Phosphoric Acid in the Ash.

(Stated in Percentage of the Ash.)

Experiment.	Quantity of Substance Used in Grammes.	Pyrophosphate of Magnesia found.	Percentage of Phosphoric Acid (PO_5.)
I.	2·6355	·2040	4·95 } Mean, 5·24.
II.	4·3305	·3745	5·53 }

But since the deposit contains 56·05 per cent. of ash, this would correspond to 2·93 pe cent. in the entire substance.

(B.)—Treatment with a Mixture of Lime, Sulphate of Alumina, and Charcoal.

No. 26.—*Details of Analysis of Deposit obtained from London Sewage by this Process.*

1. *Determinations of Nitrogen.*

Experiment I.—21·35 grs. of deposit, dried at 212° F. (100° C.), gave 4·13 of ammonio-chloride of platinum (NH_4Cl, $PtCl_2$) = ·2590 grains, or 1·2 per cent. of nitrogen.

II.—16·60 grs. of deposit, dried at 212° F. (100° C.), gave 3·13 grs. of ammonio-chloride of platinum (NH_4Cl, $PtCl_2$) = ·1963 grs., or 1·18 per cent. of nitrogen.

I. II. *mean.*
1·21 - - 1·18 - - 1·19 per cent. of nitrogen = 1·44 per cent. of ammonia.

2. *Determinations of Phosphoric Acid.*

(Stated in Percentage in the Ash.)

Experiment.	Quantity of Ash Used.	Pyrophosphate of Magnesia found.	Percentage of Phosphoric Acid (PO_5) in Ash.
I.	3·661	·3630	6·33 } Mean, 6·13.
II.	2·577	·2455	6·09 }
III.	3·1305	·2935	5·99 }

Since the deposit contained 64·03 per cent. of ash, this would correspond to 3·97 per cent. of phosphoric acid in the deposit itself.

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No. 27.—*Dr. Penny's Analysis* of the Deposit obtained by treating the Sewage of Edinburgh with a Mixture of Animal Charcoal, Alum, &c.*

	I.	II.	Mean.
Ammonia	1·50	2·95	2·22
Phosphate of lime	2·05	—	2·05
Organic matter	37·45	50·00	43·72

(C.)—Treatment of Sewage with Charcoal.

1. Filtration of Sewage through Charcoal.

No. 28.—*Analysis of Peat Charcoal after Use as a Filtering Medium.*

(A.) *Determination of Nitrogen.*

I. 4·9 grains of substance gave 1·15 of platinum salt ($NH_4Cl,PtCl_2$) = ·08316 of nitrogen, or 1·690 per cent.

II. 4·22 grains of substance gave 1:32 of platinum salt ($NH_4Cl,PtCl_2$) = 0·984 of nitrogen, or 2·374 per cent.

I.	II.	mean.	mean.
1.690	2 374	2·032 per cent. of nitrogen	= 2·467 of ammonia.

(B.) *Determination of Phosphoric Acid.*

1·137 parts of the *ash* gave 0·037 of pyrophosphate of magnesia ($2MgO,PO_5$) = ·02378 of phosphoric acid (PO^5.), or 2·09 per cent. of the ash; but since the charcoal only contains 5·931 per cent. of ash; this gives 0·12 per cent. of phosphoric acid in the total substance.

2. Agitation of Sewage with Charcoal.

No. 29.—*Analysis of Deposit obtained by shaking Sewage with Charcoal.*

(A.) *Determination of Nitrogen:*

I. 5·74 grains of substance gave 2·60 of platinum salt=·193 of Nitrogen, or 3·36 per cent.

II. 5·83 „ „ gave 3·96 „ =·228 „ or 3·91 „

I.	II.	mean.
3·36	3.91	3·63 per cent. of nitrogen=4·40 per cent. ammonia.

(B.) *Determination of Phosphoric Acid:*

3·478 parts of the ash yielded ·202 of pyrophosphate of magnesia ($2MgO,PO_5$)=·1298 of phosphoric acid (PO_5), or 3·729 per cent.

But since the deposit only contained 29·57 per cent. of ash, the per-centage of phosphoric acid in the total substance was 1·103, or 2·389 of phosphate of lime.

(D.) Treatment of Sewage with Magnesian Salts.

(Sir James Murray's Process.)

No. 30.—*Solubility of the Ammonio-Phosphate of Magnesia.*

One part of this salt requires for solution 45,000 parts of water, mixed with one-eighth of a solution containing 16 per cent. of ammonia gas (Fresenius), that is, 45,000 parts of an ammonia solution of 2 per cent.

One

* *See* Mr. Dugald Campbell's Lecture, read to the Chemical Society, "On the Application of Sewage to Agriculture," and published in the "Engineer."

Appendix

Appendix to Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

One ton = 2,240 lbs. of water, require 44·8 lbs. of ammonia in order to become a solution of this strength, and 141 lbs. of sal ammoniac are necessary to disengage this quantity, having a value of 1 *l.* 12*s.* (at the rate of 26 *l.* per ton).

The sewage water contains on an average about 2 grains of phosphoric acid per gallon, or 0·64 lbs. per ton, which correspond to 2·2 lbs. of the ammonio-magnesian phosphate.

One ton of a 2 per cent. ammonia solution dissolves 0·4 lb. of the ammonio-phosphate, so that of the 1·2 lbs. only one-eighth is actually precipitated; or, in other words, in order to precipitate 0·8 lbs. of the ammonio-magnesian phosphate, having a value of about 4*d.*, from one ton of sewage, 141 lbs. of sal ammoniac are required, of the value of 1 *l.* 12*s.*

No. 30.—*Details of Estimate of the Cost of Metropolitan Works for the Treatment of the London Sewage by the Lime Process.*

Mr. Wicksteed estimates the cost of works, inclusive of purchase of land, with law, and engineering expenses, at 320,000 *l.* The quantity of manure precipitated weekly would be 15,868 tons, or 825,136 tons per annum, which, by the process of consolidation, would be reduced to 366,028 tons, and after drying would yield only 181,584 tons of the manure ready for sale.

The expenses of the manufacture of these 181,584 tons Mr. Wicksteed states as follows:

	£.	s.	d.	
Pumping	15,500, or	1	8½	per ton.
Deodorising	23,500 „	2	7	„
Consolidating	23,000 „	2	6½	„
Drying and stacking	13,000 „	1	5½	„
Together	£. 75,000 „	8	3½	„

To these expenses has to be added the interest at 5 per cent. on the capital invested in the works, which, including land, law, and engineering expenses, may be raised from Mr. Wicksteed's estimate of 320,000 *l.* to 400,000 *l.*; and lastly, rates, taxes, licenses for use of patents, commercial and office expenses, which will amount to a sum at least equal to the interest of the capital, so that the total annual expenditure would be:

	£.	s.	d.	
Manufacturing expenses	75,000, or	8	3½	per ton.
Interest on capital	20,000 „	2	2½	„
Rates, taxes, repairs and contingencies	20,000 „	2	2½	„
	£. 115,000 „	12	8½	„

No. 31.—*Approximative Calculation of the Cost of the Charcoal Deposit.*

	£.	s.	d.
Cost of manufacturing 100 tons of lime-deposit	63	10	10
Cost of 23 tons of lime (the quantity of lime present in 100 tons of lime-deposit)	11	10	–
	52	–	10
Cost of 26 tons of charcoal (the quantity present in 100 tons of charcoal deposit	78	–	–
	£. 130	–	10
Cost of manufacture per ton	£. 1	6	–

Appendix I.

Appendix to Report of Chemical Investigations by Dr. Hofmann and Mr. Witt.

No. 34.—*Cost of Irrigation.*

ESTIMATE of the Cost which it would be necessary to incur for the Daily Distribution of the Ordinary Daily Flow of the Metropolitan Sewage.

	£.
Prime cost of engines, mains, and reservoirs for conveying the sewage an average distance of 15 miles - - - - - - - - -	4,642,500
The formation of 100,000 acres of land into water meadow, at a cost, including distributing mains and watercourses - - - - - -	1,200,000
Capitalisation of annual working expenses of foregoing, horse power alone, say 78,200 *l.*, at 20 years' purchase - - - - - -	1,564,000
	£. 7,406,500

Total cost, 7,406,500 *l.*, or 74 *l.* per acre on 100,000 acres, distributed in 23 separate lots.

In this estimate no provision is made for the daily management required by a system of irrigation so extensive.

No. 35.—*The Craigentinny Meadows.*

"The quantity of water discharged over the low-lying lands in the course of the year must be enormous. I had no opportunity myself of testing the ordinary flow of the Foul Burn, as there was incessant rain during the whole period of my visit, but it has been estimated at 220 cubic feet per minute. The superintendent informed me that it is never allowed to run to waste, except in times of excessive floods. There are not many days in the year in which a greater amount of rain would fall than during my visit, and the irrigation was then proceeding as usual. If it be only assumed, however, that the quantity which comes down in dry weather is applied, during nine months of the year, deducting the Sundays as well, there will, on the above calculation, *be passed over the meadows annually a depth of water between six and seven feet*, and yet the superintendent states that the fertility is invariably in proportion to the quantity of sewage employed.

"The acre = 43,560 square feet.

"Assuming a layer of sewage of a height of seven feet upon the acre, the volume of sewage would be 304,920 cubic feet, = 8,490 tons.

"100 tons of sewage are worth 17 *s.* 7 *d.*

"8,490 tons, the quantity supplied to the meadows annually, have therefore a value of 74 *l.* 12 *s.*"—*Austin's Report*, p. 45.

No. 36.—*Reasons of the Failure of the Metropolitan Sewage Manure Company.*

"Considerable works, of the most expensive kind, were constructed for distributing liquid, very nearly worthless as manure, over a district obtaining the valuable stable manure of the metropolis, at the most economical rate, by means of the return carts which convey to London the produce of the market gardens, and which would otherwise return empty. In fact, practically, this was little more than a company for supplying the market gardens of Fulham with water during periods of drought; and although, no doubt, a beneficial service, it will readily be imagined that the saving of labour of hand-watering over a limited district of garden ground would produce no adequate return for so costly an establishment."—*Austin's Report*, p. 74.

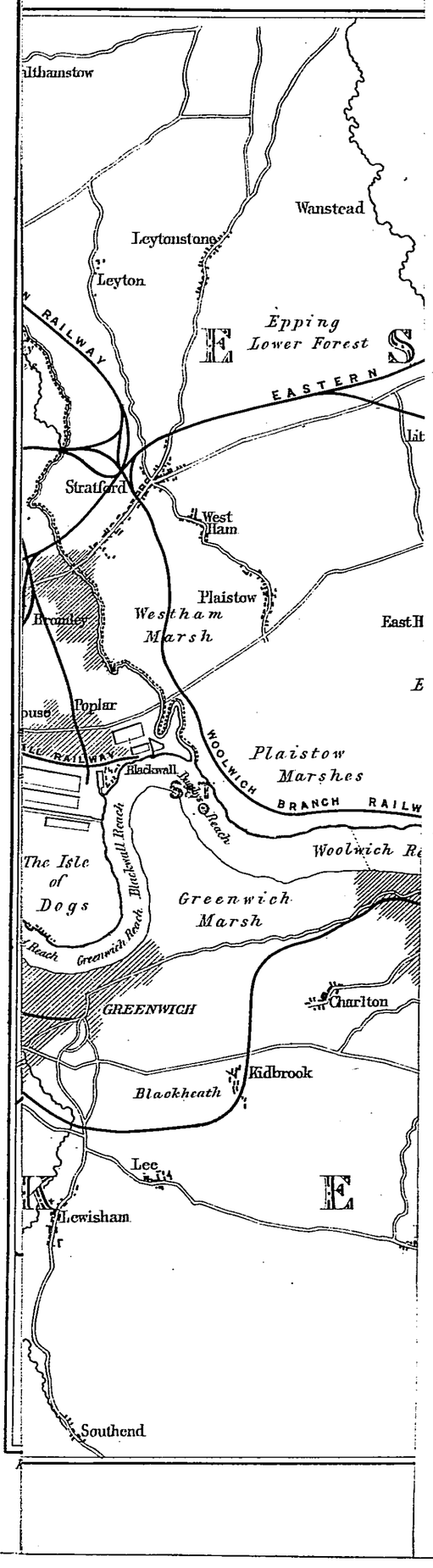
No. 37.—*Comparison of the Value of Sewage with an equal Volume of Coal Gas.*

One ton of sewage has a volume of 36 cubic feet; 100 tons therefore = 3,600 cubic feet, and are worth, as has been shown in the text, 17 *s.* 7 *d.* Hence,

The value of 1,000 cubic feet of sewage is 5 *s.* And
„ 1,000 „ coal gas is 4 *s.* 6 *d.*

No. 38.—*Value of the aggregate Amount of Gas produced Annually in London.*

According to an estimate of George Lowe, Esq., C. E., engineer to the Chartered Gas Company, London, the annual consumption of coal for the purpose of gas-making, in London, is about 840,000 tons, which would yield 7,728,000,000 cubic feet of gas. The value of this volume of gas would be (at 4 *s.* 6 *d.* per 1,000 cubic feet), 1,738,800 *l.*



Hendon
Hornsey
Tottenham High Cross
Walthamstow
Harrow on the Hill
Highgate
Stamford Hill
Leytonstone
Leyton
Stoke Newington
Hampstead
Wilsdon
Hackney Marshes
Homerton
Hackney
Islington
Kingsland
St Hackney
Stratford
West Ham
Pancras
Twyford
R. Brent
Bow
Plaistow
Paddington
Bromley
Westham Marsh
Stepney
Hanwell
Limehouse
Poplar
Ealing
Acton
Blackwall
Kensington
Hammersmith
Rotherhithe
Bermondsey
The Isle of Dogs
Chiswick
Kew
Chelsea
Battersea Park
Battersea
Deptford
GREENWICH
Barnes
Isleworth
Mortlake
Fulham
Camberwell
Peckham
Blackheath
E. Sheen
Richmond
Putney
Clapham
Wandsworth
Roehampton
Brixton
E. Dulwich
Lee
Clapham Common
Herne Hill
Lewisham
Dulwich
Twickenham
Richmond Park
Petersham
Ham
Wimbledon Common
Upper Tooting
Streatham
Sydenham
Teddington
Southend

MIDDLESEX

SURREY

NORTH WESTERN RAILWAY
GREAT NORTHERN RAILWAY
NORTHERN & EASTERN RAILWAY
GREAT WESTERN RAILWAY
LONDON & SOUTH WESTERN JUNCTION RAILWAY
THAMES JUNCTION RAILWAY
LONDON & SOUTH WESTERN RAILWAY
LOOP LINE
BRENTFORD
BLACKWALL RAILWAY
WOOLWICH
GREENWICH RAILWAY
BRICKLAYERS ARMS BR.
CROYDON RAILWAY
R. Lea
R. Thames
Regents Park
Hyde Park
Kensington Gardens
Green Park
St James's Park
Buckingham Palace
Lower Pool
Upper Pool
Limehouse Reach
Blackwall Reach
Deptford Reach
Greenwich Reach
Millbank
Westminster
Somerset House
Lambeth
Clapham Common
Wandsworth Common

A B C D E F G H I K L M N O P Q R S T

Kell Bros Lith.rs Castle St Holborn

APPENDIX, I. (Plate 1.)

Report of Dr. Hofmann & Mr. Witt.

Hornsey
Tottenham High Cross
Walthamstow
Highgate
Stamford Hill
Stoke Newington
Tea R.
Leytonstone
Leyton
Wanstead
Epping Forest
Hackney Marshes
Homerton
Hackney
Kingsland
St. Pancras
Islington
Stratford
West Ham
Bow
Bromley
Stepney
Limehouse
Poplar
Westham Marsh
Plaistow
Lit. Ilford
G.t Ilford
EASTERN COUNTIES RAILWAY
NORTHERN & EASTERN RAILWAY
GREAT NORTHERN RAILWAY
BARKING
R. Roding
East Ham
East Ham Level
LONDON TILBURY & SOUTHEND RAILWAY
Dagenham
Dagenham Marsh
PART OF KENT
Fripcock or Barking Reach
Halfway Reach
Gallions Reach
Plumsted Marshes
Erith Marshes
Erith Reach
WOOLWICH
NORTH KENT RAILWAY
Plumsted
Erith
Charlton
GREENWICH
Deptford
Kidbrook
Blackheath
E. Wickham
Lee
Lewisham
Eltham
Crayford
Bexley
Dartford Heath
Lambabby
Southend
Sydenham
Streatham
Dulwich
Herne Hill
Brixton
Clapham
Camberwell
Peckham
E. Dulwich
CROYDON RAILWAY
BRICKLAYERS ARMS BR.
GREENWICH RAILWAY
Rotherhithe
Bermondsey
The Isle of Dogs
Greenwich Marsh
Woolwich Reach
Blackwall Reach
Deptford Reach
Greenwich Reach
Lower Pool
Upper Pool
Limehouse Basin
Blackwall
Blackwall Basin
Dry Dock
WOOLWICH BRANCH RAILWAY
BLACKWALL RAILWAY
Plaistow Marshes
Millbank
Buckingham Palace
St. James's Park
Green Park
Hyde Park
Kensington Palace
Kensington Gardens
Knightsbridge
Mill Pond
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Nº 233 Ordered, by The House of Commons, to be Printed, 3rd August, 1857.
Henry Hansard, Printer.

APPENDIX II.

Appendix II.

Report on Thames Mud and Water, by Mr. R. Etheridge.

REPORT of *R. Etheridge*, Esq., F.G.S., F.R.S.E., on THAMES MUD and THAMES WATER.

Gentlemen, Philosophical Institution, Bristol, 22 June 1857.

I BEG to transmit you herewith the results of the microscopical examination of the Thames mud and Thames water, which I undertook at your request.

The samples are marked and numbered as in the following list.

No. 1 to 18 inclusive, constituting the samples of mud and deposit; and letters (A.) and (B.), the two samples of water; one of which I designate thick water (A.), collected from a pool, the other clear (B.)—comparatively clear water from the tideway at low water, at Hungerford Pier. The mud, consisting of the very thin surface deposit, was collected from the last or newest deposit of the Thames at about low water, early in the morning before the great steamboat traffic on the river had commenced, which has been found to prevent the copious subsidence of solid matter which takes place during the night.

I have adopted your suggestion of a classification, which although not following any special or generally recognised system, shows most clearly the natural habitat of the living organisms, and their relation to the present subject.

The term *stercorine* includes those forms whose natural habitat is peculiarly in sewage or other water holding matter in a state of decomposition.

In respect to the numerical expression, indicating the proportion of the organic and inorganic matters submitted to my notice, it will be readily seen that to have given critically exact terms would have involved a much larger scope, both of time and appliances, than was available; but my judgment, after reviewing the whole question, and having regard to all the specimens, leads me to consider that 12 to 15 per cent. of the the whole consisted of organic matter, living and in a state of decomposition, including forms called into existence under the peculiarly favourable influences and circumstances for their development, and the remainder consists of inorganic matter, for the most *part alluvial*, but containing at least 20 per cent of abraded road material, granite, porphyry, and other crystalline rocks, and about 30 per cent. of what was evidently crushed flint, gravel, and earthy deposit of the basin of the Thames.

I have, &c.

(signed) *Robert Etheridge*, F.G.S., F.R.S.E.,
Curator to the Museum of Natural History,
Bristol Literary and Philosophical Institution;
Lecturer on Vegetable Physiology and Botany,
Bristol Medical School;
President of the Bristol Microscopical Society.

The Referees on the Main Drainage of the Metropolis.

SAMPLE 1.

(Fifty yards below Southwark Bridge.)

I.—ORGANIC MATTER.—LIVING ORGANISMS:

Animals:

- *a.* Fluviatile forms
  - Class—Infusoria
    - Euplotes charon.
    - Uvella virescens.
    - Kolpoda cucullus.
  - Class—Diatomaceæ
    - Navicula amphisbœna.
    - Gallionella.
- *b.* Marine forms
  - Class—Foraminifera — Rotalia.
  - Class—Zoophyta — Gorgonia (spiculæ of).
- *c.* Stercorine forms
  - Class—Annelida
    - Lurco.
    - Vibrio anguillula glutinis.
    - Red worm.
  - Class—Infusoria
    - Oxytricha gibba.
    - Paramecium aurelia.

Plantæ:

Filaments of fresh water algæ.

Appendix II.

Report on Thames Mud and Water, by Mr. R. Etheridge.

II.—Organic Matter in a state of Decomposition:

- *a.* Animal matter, or tissues — Muscular fibre. Ochreous substance.
- *b.* Vegetable matter, or tissues — Spiral vessels (probably rhubarb) abundant. Scalariform and dotted ducts. Cellular tissue (water plants). „ „ sedge. „ „ rhubarb (probably). Siliceous epidermal coverings, (wheat). „ „ „ (barley). Pigment cells of wheat (caryopsis). Cellular tissue, potato. Hairs of plants, (labiatæ). „ „ (compositæ).
- *c.* Fæcal matter — Black-looking (carbonaceous matter) substance in large quantities. This carbonaceous substance seems to be a natural carbon; masses often striated and of indeterminate character, and filthy in the extreme, constitute a great portion of this deposit. I doubt not it is human fæces disintegrated, and contains the remains of digested and chemically altered food; muscular fibre can be detected in many of the masses.

III.—Inorganic Matter:

a. Extremely fine particles of argillaceous matter (alluvion), finely divided, and having no definite form, being the chief muddy deposit of the river, argillaceous.

b. *Water-worn, and angular siliceous* or quartz grains (ground flint), in great quantity.

c. Felspar (small portions), mica, &c., appears to be the disintegration of granite and other crystalline rocks, and general washings of the streets of the city.

This sample was most offensive and filthy, evidently sewage deposit or accumulation, the great mass of organic matter being decomposing vegetable and animal organisms, having its origin in human food, and other city sources, and the living forms, such as would be found in sewage and other similar conditions only.

SAMPLE 2.

(Fifty yards below Southwark Bridge.)

I.—Organic Matter.—Living Organisms:

			Animals:
a. Fluviatile forms	Class—Diatomaceæ	Navicula amphisbœna.	
		Gallionella.	
	Class—Infusoria	Kolpoda cucullus.	
b. Marine forms	Class—Foraminefera	Rotalia.	
	Class—Zoophyta	Gorgonia (spiculæ of)	
c. Stercorine forms	Class—Annelida	Lurco	Abundant.
		Red worm	
	Class—Infusoria	Oxytricha gibba	
			Plantæ:
			Several filaments of conferva.

II.—Organic Matter in a state of Decomposition:

- *a.* Animal matter — Muscular fibre (masses). Brown ochreous substance.
- *b.* Vegetable matter — Cellular tissue of plants (several kinds). „ „ lettuce and stomata. „ „ onion. „ „ potato. Starch grains of (probably) potatoe. Spiral vessels (of rhubarb probably), large quantity, in masses. Hairs of plants (compositæ and labiatæ). Epidermal coverings (siliceous), wheat straw. Pigment cells (wheat caryopsis). Fig seeds (2). Palaæ of grass. Small fragments of deal, well developed.
- *c.* Fæcal

Appendix II.

Report on Thames Mud and Water, by Mr. R. Etheridge.

II.—Organic Matter in a state of Decomposition—continued.

- *c.* Fæcal matter — Black-looking and ochreous-coloured masses, blotched and striated, mucous; appears evidently to be altered human food. This constitutes a large proportion of the mass under examination.

III.—Inorganic Matter:

a. Fine particles of argillaceous matter (alluvion), having no definite form; the chief muddy accumulations from the banks of the river.

b. Water-worn, angular, and large siliceous or quartz grains, of all forms, in large quantity.

c. Little felspar and mica, as in Deposit 1, all evidently from the disintegration of the city and the washings into the sewers.

SAMPLE 3.

(Fifty yards below Southwark Bridge.)

I.—Organic Matter.—Living Organisms:

			Animals:
a. Fluviatile forms	Class—Infusoria	Paramecium aurelia.	
		Kolpoda cucullus.	
	Class—Diatomaceæ	Gallionella.	
b. Marine forms	Class—Foraminefera	Rotalia.	
c. Stercorine forms	Class—Annelida	Lurco.	
		Vibrio anguillula glutinis.	
		Red worm.	
	Class—Infusoria	Oxytricha gibba.	

II.—Organic Matter in a state of Decomposition:

- *a.* Animal matter — Ochreous substance. Muscular fibre and animal matter in abundance.
- *b.* Vegetable matter — Spiral vessels abundant and in large masses (rhubarb probably.) Cubical parenchyma (water plant). Prismatic. Pigment cells (caryopsis of wheat). Siliceous cuticle of wheat straw. Cellular tissue of potatoe.
- *c.* Fæcal matter — Fæcal matter most abundant.

III.—Inorganic Matter:

The inorganic bodies in this deposit exactly resemble those before described, both as regards quantity and general condition.

Free sulphuretted hydrogen escaped in considerable quantities from this sample; indeed the mass exhibited a large quantity of decomposing vegetable and animal matter, in masses, with partial and almost complete decomposition.

SAMPLE 4.

(Fifty yards below Southwark Bridge.)

I.—Organic Matter.—Living Organisms:

			Animals.
c. Stercorine forms	Class—Annelida	Lurco.	
		Vibrio anguillula glutinis.	
	Class—Infusoria	Oxytrica gibba.	
		Paramecium aurelia.	

No fluviatile or marine forms detected in this sample.

II.—Organic Matter in a state of Decomposition:

- *a.* Animal matter — Ochreous and carbonized matter, striated and blotched; decomposing.

Appendix II.

Report on Thames Mud and Water, by Mr. R. Etheridge.

II.—Organic Matter in a state of Decomposition—continued.

b. Vegetable matter
- Spiral vessels — abundant.
- Cellular tissue of various kinds — abundant.
- Hairs of plants (compositæ).
- Hairs of wheat from caryopsis.
- Siliceous epidermis of wheat straw.
- Starch grains (coloured by iodine).

c. Fæcal matter
- The same black and brown carbonaceous-looking matter, with patches of muscular fibre (altered), some of indeterminate character. The whole of this, I have no doubt, is fæcal, and from the slaughterhouses, &c. &c. in large quantities.

III.—Inorganic Matter:

This so closely resembles those before described that description is unnecessary.

This deposit is filthy in the extreme; chiefly of sewage origin, and yielded sulphuretted hydrogen freely.

SAMPLE 5.

(Fifty yards below Southwark Bridge.)

This sample or mass is more impure, and contains more decomposing organic tissues than the previous, No. 4.

I.—Organic Matter.—Living Organisms:

c. Stercorine forms
- Class—Annelida — Animals: Lurco. Red worm; very numerous. Ova of ditto.
- Class—Infusoria — Oxytricha gibba.

No fluviatile or marine forms detected in this matter.

II.—Organic Matter in a state of Decomposition:

a. Animal matter
- Much animal matter; masses of carbonized matter of fleshy consistency, striated; evidently muscular fibre.

b. Vegetable matter
- Cellular tissue, large masses — abundant.
- Spiral vessels, large masses — abundant.
- Dotted ducts.
- Epidermal siliceous cuticle of wheat straw and caryopsis.
- Starch grains of potato.
- Hairs of plants.
- Pigment cells of some plant.

III.—Inorganic Matter:

Precisely of the same mineral and lithological characters as those previously examined; the quartz grains seem more finely divided and rounded than that of No. 2 and 3.

SAMPLE 6.

(Similar in general condition to No. 5).

I.—Organic Matter.—Living Organisms: Animals:

c. Stercorine forms
- Class—Annelida — Lurco, abundant. Vibrio anguillula glutinis.
- Class—Infusoria — Kolpoda cucullus, Paramecium aurelia, Oxytricha gibba — few.

No fluviatile or marine organisms detected.

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Report on Thames Mud and Water, by Mr. R. Etheridge.

II.—Organic Matter in a state of Decomposition:

Plantæ:

b. Vegetable matter
- Cellular tissue, potato.
- Spiral vessels (sparingly).
- Loose cellular tissue (abundant).
- Hairs of plants.
- Siliceous covering to wheat straw.
- Parenchymatous tissue (like cabbage).

a. Animal matter
- Hairs of mammalia, ox or cow, man, — In several little masses.
- The same ochreous substance.
- Brown or black carbonized matter, &c.

II.—Inorganic Matter:

a. A much larger proportion of grains of silica in this than in either of the other deposits, and less alluvial or clayey matter.

b. Felspar and mica also more abundant.

No sulphuretted hydrogen obtained from this sample.

The samples taken from this locality, when carefully examined, seem to much resemble those from Southwark Bridge; but, on the whole, the amount of dead organic matter is even greater than those previously examined, and the inorganic debris considerably more so.

SAMPLE 7.

(Hungerford Pier.)

I.—Organic Matter: Animals:

a. Fluviatile forms
- Class—Diatomaceæ — Synedra ulna. Gyrosigma hippocampa. Nitzschia elongata. Navicula amphisbœna.
- Class—Infusoria — Kolpoda cucullus.

b. No marine organisms detected.

c. Stercorine forms
- Class—Annelida — Red worm. Lurco. Vibrio anguillula glutinis.
- Class—Infusoria — Paramecium aurelia. Oxytricha gibba.

Plantæ:

Filaments of fresh water algæ.

II.—Organic Matter in a state of Decomposition:

a. Animal matter
- Much decomposing animal matter, ochreous-looking, and partly carbonized.
- Hairs of mammalia.

b. Vegetable tissues
- Spiral vessels (abundant).
- Cellular tissue (cabbage).
- „ „ (potato).
- Siliceous covering (epidermal), wheat straw.
- Dotted ducts.
- Hairs of plants.

c. Fæcal matter — The same black carbonized-looking masses, with pigment tissue and mucous masses.

III.—Organic Matter:

a. Very finely divided quartz grains, forming fine dust-like deposit, but all siliceous. Some of the worn fragments large, and rounded.

b. Felspar, little or none.

SAMPLE 8.

(Hungerford Pier.)

This deposit much resembles No. 7.

I.—Organic Matter.—Living Organisms:

			Animals:
a. Stercorine Forms	Class—Annelida	-	Red worm. Vibrio anguillula glutinis.
	„ Infusoria	-	Kolpoda. Euplotes charon. Paramecium chrysalis.
	„ Diatomaceæ	-	Synedra ulna. Navicula (several species).

II.—Organic Matter in a state of Decomposition:

		Plantæ:
b. Vegetable matter	- -	Cellular tissue (loose), *abundant.* Spiral vessels (probably rhubarb). Hairs of plants. Siliceous epidermal tissue (gramineæ). Dotted vessels.
a. Animal matter, &c., fæcal	-	Much matter (animal) in a state of putrefaction; appears to be muscular fibre and animal food acted upon by digestion. The ochreous substance (brown) mentioned in all the previous deposits.

III.—Inorganic Matter:

a. The mineral and lithological character of this closely resembles that of No. 7, the amount of disintegrated silica being very large.

b. Felspar and mica, sparingly.

SAMPLE 9.

(Hungerford Pier.)

I.—Organic Matter.—Living Organisms:

			Animals:
a. Stercorine Forms	Class—Annelida	-	Vibrio anguillula glutinis. Lurco. Red worm.
	Class—Infusoria	-	Kolpoda cucullus. Paramecium chrysalis.

II.—Organic Matter in a state of Decomposition:

		Plantæ:
b. Vegetable matter, &c.	-	Cellular tissue (loose and abundant). Spiral vessels (rhubarb probably). Siliceous coverings to the gramineæ. Hairs of plants.
a. Animal matter, &c., fæcal	-	The decomposing animal matter is much the same here as in No. 8, chiefly fæcal, and very offensive.

III.—Inorganic Matter:

a. Nearly all the sedimentary mass of this sample consisted entirely of quartz grains, much rounded and worn, the particles of argillaceous deposit or matter being less in proportion than those examined from Southwark Bridge.

d. Felspar and schorly-like-looking crystals broken up; also much carbonaceous matter, pieces of coal, and ashes.

This sample yielded sulphuretted hydrogen copiously.

SAMPLE 10.

(Hungerford Pier.)

This sample so closely resembles Nos. 8 and 9 in every respect, that it needs no enumeration as regards the organic or inorganic contents.

It yielded *sulphuretted hydrogen*, was *most offensive*, and contained much fæcal matter.

The siliceous accumulations, gritty particles, and debris of the crystalline rocks extremely large, as noticed in No. 9. The same coaly matter.

SAMPLE 11 and 12.

(Hungerford Pier.)

I cannot add or detect for addition anything in these two samples different from those mentioned as coming from the same locality; the organic and inorganic conditions are precisely the same, being equally offensive, which undoubtedly arises from sewage deposit.

I cannot help remarking upon the excess of ground siliceous particles and debris of granitic and crystalline rocks in these samples from Hungerford Pier, especially the finely pulverized silica of all colours, red, brown, white, &c.; they are also larger in size than those examined from Southwark Bridge; much of this looks like the finely powdered or disintegrated gravel of the Reading district, mixed with granite debris.

SAMPLE 13.

(Temple Pier.)

As far as the organic and fæcal matter can be diagnosed in the samples brought from this locality, it much resembles those previously examined; there is a greater excess in quantity of the *respective organisms*, both living and that *undergoing decomposition*, especially the latter, which may be justly termed filthy in the extreme.

II.—Organic Matter.—Living Organisms:

			Animals:
a. Stercorine forms	Class—Annelida*	-	Lurco. Red worm. Vibrio anguillula glutinis.
	* These are here much decomposed.		
	Class—Infusoria	-	Swarms with monads, which live amongst the masses of annelida (which are much decomposed). Paramecium aurelia.
b. Marine forms	- Class—Foraminefera	-	Rotalia.
c. Vegetable forms	- Class—Plantæ	-	Filaments of fresh-water algæ.

II.—Organic Matter in a state of Decomposition:

		Plantæ:
a. Vegetable tissues	-	Spiral vessels (probably rhubarb). Dotted ducts. Cellular tissue (loose). Ditto - - (potato). Siliceous coverings of the gramineæ. Hairs of plants.
b, c. Animal matter, fæcal	- -	Much decomposing and slimy matter, of the same nature as that previously described, the ochreous and carbonized-looking masses being abundant. This is undoubtedly animal and fæcal matter.

III.—Inorganic Matter:

The siliceous and crystalline particles here are much worn and broken down, although a considerable portion are fresh and angular, or bear a more crystalline character than that constituting the mass of the deposit at Southwark Bridge.

There is also much coaly matter in this mass, true coal: its origin might be from the coal-yards.

Appendix II.

Report on Thames Mud and Water, by Mr. R. Etheridge.

SAMPLE 14.

(Temple Pier).

I.—Organic Matter.—Living Organisms:

			Animals:
a. Stercorine forms	Class—Annelida	Lurco.	
		Red worm.	
		Vibrio anguillula glutinis.	
	Class—Infusoria	Paramecium.	
		Monads (swarming).	
b. Marine forms	Foraminifera	Rotalia.	
c. Vegetable forms	Class—Algæ	Filaments of conferva.	

II.—Organic Matter in a state of Decomposition:

		Plantæ:
a. Vegetable tissue	Spiral vessels (abundant).	
	Cellular tissue.	
	Ditto - - with stomata (fresh).	
	Hairs of plants.	
	Potato cells and starch grains.	
b. Animal tissue	Muscular fibre and fleshy-looking masses in considerable quantity.	
c. Fæcal matter	A large quantity of decomposing ochreous brown and black looking masses, straited, and partly cellular.	

III.—Inorganic Matter:

a. The usual condition of rounded and angular siliceous grains, finely pulverised.

b. Much argillaceous matter, and fine sediment.

c. Felspar, mica, sparingly.

This sample was extremely filthy, and yielded sulphuretted hydrogen freely; the quantity of vegetable and animal matter under decomposition abundant. *Fætid and filthy.*

SAMPLE 15.

(Temple Pier.)

This sample was precisely the same as No. 14, as regards the vegetable and animal matter living and under decomposition; the quartz ore particles were more numerous, and rolled; the chief feature in this, as in the other, being the masses of tissues under decomposition.

There was also much coaly substance, evidently true coal, finely sifted and washed.

SAMPLE 16.

(Temple Pier.)

I.—Organic Matter.—Living Organisms:

			Animals:
a. Stercorine Forms	Class—Annelida	Lurco.	
		Vibrio anguillula glutinis.	
	Class—Infusoria	Kolpoda cucullus.	
		Paramecium chrysalis.	
		Monads (swarming).	
b. Marine Forms	Class—Foraminefera	Rotalia.	
c. Vegetable Forms	Class—Algæ	Empty filaments of algæ.	

II.—Organic Matter in a state of Decomposition:

		Plantæ:
a. Vegetable tissue	Spiral vessels, Cellular tissue	in masses and quantity.
	Hairs of plants.	
	Siliceous epidermis (wheat straw).	

b. Animal

Appendix II.

Report on Thames Mud and Water, by Mr. R. Etheridge.

II.—Organic Matter in a state of Decomposition—continued.

		Plantæ—*continued.*
b. Animal tissue	Masses of yellow matter, straited, which appears to be muscular fibre.	
c. Fæcal matter	Ochreous, dark brown, carbonaceous-looking masses, as before described and noticed.	

III. Inorganic Matter:

The same as in other samples, the difference being little or none.

SAMPLE 17.

(Temple Pier.)

Nothing can be said respecting this sample more than has been done in Nos. 13, 14, 15, and 16; in every respect it is the same, both as regards the organic and inorganic proportions.

SAMPLE 18.

The animal and vegetable matter in this sample very abundant, the whole rapidly decomposing.

I.—Organic Matter:

			Animals:
a. Stercorine forms	Class—Annelida	Lurco.	
		Red worm.	
		Vibrio anguillula glutinis.	
	Class—Infusoria	Paramecium aurelia.	
		Kolpoda cucullus.	
		Oxytricha gibba.	
	Class—Diatomaceæ	Naviculæ.	
		Synedra.	
			Plantæ:
a. Vegetable forms	Class—Algæ	Filaments of conferva.	

II.—Organic Matter in a state of Decomposition:

		Plantæ:
a. Vegetable tissue	Spiral vessels, Cellular tissue	in large masses.
	Hairs of plants.	
	Starch grains (potato).	
	Epidermal covering (gramineæ).	

The same ochreous and fæcal matter in profusion.

III.—Inorganic Matter:

The condition of the general mass of the sedimentary matter in this sample is the same as in the other deposits from the same locality.

WATER (A.)

(Thick Water). (Hungerford Pier).

Nothing can exceed the filthy condition of this sample of water, which contained, with the exception of the annelid forms (in quantity), almost all the conditions registered in the sedimentary samples.

The contents I arrange and list in the same manner as the samples of mud.

I.—Organic Matter.—Living Organisms:

			Animals:
a. Stercorine forms	Class—Annelida	Lurco (few).	
	Class—Infusoria	Kolpoda cucullus.	
		Paramecium aurelia.	
		Oxytricha gibba.	

b. Fluviatile

Appendix II.

Report on Thames Mud and Water, by Mr. R. Etheridge.

I.—Organic Matter—continued.

Animals—*continued.*

b. Fluviatile forms - - - - - { Ova of mollusca (lymnæa). Portions of carapaces of several entomostraca.

b. Fluviatile forms - Class—Diatomaceæ - { Navicula amphisbœna. Synedra ulna. Gomphonema, 2 sp.

II.—Organic Matter in a state of Decomposition:

Plantæ:

Vegetable matter - { Spiral vessels (of rhubarb probably). Hairs of plants (several kinds). Colpenchymatous tissue and stomata. Cellular tissue (floating masses). Wheat straw tissues (siliceous). Fungus-like looking masses, flock-like, in suspension. (Torulæ?)

The fæcal and brown striated fibrous substance observed in all and every sample before mentioned was equally abundant here, and rapidly settled into regular layers, according to their respective densities. The quartzose grains and argillaceous sediment was most copious, and formed one quarter of the whole; another quarter was entirely organic matter; the remainder, water, was turbid, and never became clear.

WATER (B.)

(Clear Water.) (Hungerford Pier.)

The condition of this water differs remarkably from the former (A.) in every respect, and appears to be the general running water of the Thames. After careful filtering, the washed or retained matter was abundant in organic beings and organic matter, all of which partook more or less of those forms expected to be found in water such as would constitute the great mass of the Thames at this locality.

Most of the contents of this water were disseminated through the whole, there being little or no sediment, what little did occur being non-organic, and consisted of finely divided quartz grains and argillaceous matter; but even in this sample the same ochreous body (straited) occurred, which is undoubtedly striated muscular fibre.

I.—Organic Matter.—Living Organisms: Animals:

Fluviatile Forms - Class Infusoria - - { Vorticella nebulifera (abundant). Vorticella campanula. Euplotes charon. Monas crepusculum. Bodo.

Fluviatile Forms - { Class Diatomaceæ - { Gallionella distans. Gomphonema.
Class Zoophyta - Spiculæ of fresh water Sponge. Human hair (little).
Class Crustacea - Ova of Daphnæ.

II.—Organic Matter in a state of Decomposition:

Plantæ:

Filaments of torulæ (fungi).
Cellular tissue of plants.
Hairs of plants.
Fragments of wheat husks.
Animal matter - - - Brown straited muscular fibre.

III.—Inorganic Matter:

Little sediment of quartz and argillaceous grains.

MAIN DRAINAGE OF THE METROPOLIS. July 1857.

TABLE, illustrating Mr. *Etheridge's* Report to the Referees.

ORGANIC AND INORGANIC MATTER.

DEPOSIT.

		SOUTHWARK BRIDGE.						HUNGERFORD PIER.						TEMPLE PIER.						WATER.	
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	A.	B.
I.—ORGANIC MATTER.																					
Living Organisms:	Animals.																				
a. Stercorine forms	Class—Annelida: Lurco	+	+																		
	Class—Annelida: Vibrio anguillula glutinis	+																			
	Class—Annelida: Red worm	+																			
	Class—Infusoria: Oxytricha gibba	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Infusoria: Paramecium aurelia	+	+	+	+		+	+	+	+	+	+	+	+	+	+		+	+	+	+
	Class—Infusoria: Paramecium chrysalis	+																			
	Class—Infusoria: Kolpoda cucullus	+																			
	Class—Infusoria: Monadina	+																			
	Class—Infusoria: Euplotes charon	+																			
b. Fluviatile forms	Class—Infusoria: Vorticella nebulifera	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Infusoria: Vorticella campanula	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Infusoria: Bodo	+																			
	Class—Infusoria: Uvella virescens	+																			
	Class—Diatomaceæ: Gallionella	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Diatomaceæ: Gomphonema	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Diatomaceæ: Synedra ulna	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Diatomaceæ: Gyrosigma hippocampa	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Diatomaceæ: Nitzschia elongata	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Diatomaceæ: Navicula amphisbœna	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
c. Marine forms	Class—Foraminifera: Rotalia	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Zoophyta - Gorgonia (spiculæ of)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Class—Zoophyta - Spongia (fresh water)	+																			

(continued)

TABLE, illustrating Mr. *Etheridge*'s Report to the Referees—*continued*.

DEPOSIT.

ORGANIC AND INORGANIC MATTER.		SOUTHWARK BRIDGE.				HUNGERFORD PIER.							TEMPLE PIER.						WATER.	
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	A.	B.
II.—ORGANIC MATTER.																					
IN A STATE OF DECOMPOSITION:																					
a. Vegetable matter or tissues	Plantæ.																				
	Spiral vessels																				
	Scalariform ducts																				
	Dotted ducts																				
	Siliceous epidermal coverings (wheat)																				
	Ditto - - ditto (barley)																				
	Pigment cells (wheat)	+	+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+
	Hairs of plants	+	+	+																	
	Starch grains	+	+	+																	
	Fig seeds	+	+	+																	
	Fungi (torulæ)	+	+	+																	
	Cellular tissue	+	+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+
	Algæ (fresh water)		+																		
b. Animal matter or tissues	Muscular fibre																				
	Colloid substance	+	+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+
c. Fæcal matter	Black carbonaceous matter	+	+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+
d. Various animal and vegetable bodies	Deal fragments																				
	Hairs of ox or cow																				
	Hairs of man																				
	Ova of mollusca (lymnæa)																				
	Entomostraca (portions of)																				
	Sulphuretted hydrogen																				
III.—INORGANIC MATTER	Granitic debris	+	+	+	+	+	+	+			+		+	+	+	+	+	+	+	+	+
	Coal and carbonaceous matter																				
	Angular and water-worn quartz																				

1 July 1857

R. Etheridge.
(signed)

APPENDIX III.

Appendix III.

Sewage, Rainfall and Population.

Report on Sewer Gaugings.

EXPERIMENTS made and Information collected by the Referees to determine Quantity of SEWAGE and RAINFALL for which Provision should be made.

1.—REPORT by Mr. *Taylor* on the Sewer Gaugings conducted by the Referees.

29, Great George-street, Westminster,
July 10, 1857.

Gentlemen,

HAVING, under your instructions, conducted a series of gaugings of the principal Metropolitan Sewers, I beg to lay before you a general report on the operations, with remarks on the means employed subsequently for reducing the experiments, and arriving at the results set forth in the Tables of Quantities.

The methods adopted for measuring the sewage are those usually employed in such cases, viz. by weirs, with rectangular openings, fixed across the sewers, and so constructed that the whole of the fluid must fall over the weir. The depths of the volumes thus flowing were recorded every quarter of an hour, and were ascertained from a scale or gauge fixed from three to four feet behind the weir, with its zero point set exactly on a level with the lip or edge thereof. The method usually pursued for getting the depths is to measure it each time on the lip of the gauge, a certain allowance being made for the curvature of the surface of the water; but by the means above described, the proper depth was obtained at once by inspection, and little was left to the judgment of the observers, the extent of their duties being only to read off with precision and regularity the figures cut by the surface of the sewage at each observation. (*See* Diagram, Plate I.)

I may mention that, as the gaugings were of necessity to be taken at intervals during night and day, varying with the tides of the river, it was requisite to obtain the utmost steadiness of conduct and attention on the part of the observers, and to ensure this, as well as the correctness of the observations, as far as possible, superintendents were engaged to visit the different gauges, both by night and day, to see that the duties were being properly performed. In the course of these inspections, a few irregularities on the part of the observers were detected; but any observations rendered at all doubtful from such causes have been rejected.

The gaugings may be divided into two classes, the first comprising the sewers whose outfalls are left open to the river, and the second the sewers which are shut up by means of sluices during the rising of the tide; the quantity of sewage thus accumulating in them being discharged when the river level is low enough to allow it to flow out. The former class of gaugings afford the most reliable results, as every observation gives the true or normal flow of sewage at the time, while in the latter class (unless the whole accumulated quantity can be measured as it flows off) the observations are valueless down to the point at which the accumulation has run off, so as to leave only the normal flow of the time being. This reduces very largely the number of observations from which, in such cases, any results can be obtained.

The following Tables show the Sewers gauged, the Periods over which the Observations extended, the Widths of the Weirs, and the Class to which each belongs, as above defined:—

On the North side of the River.

Name of Sewer.	Period of Gaugings. From.	Period of Gaugings. To.	No. of Days.	Width of Weir.	Remarks as to Class, &c.
				Feet.	
Counter's Creek	25 March	29 April	36	6	Class No. 1.
Ditto, including the Kensington Branch	29 April 16 May	9 May 21 June	47	6	- ditto.
Ranelagh	13 February	11 April	58	6	- ditto.
King's Scholars' Pond	13 February	11 April	58	10	- ditto.*
Northumberland-street	17 March	20 June	96	3	- ditto.
Norfolk-street	13 June	20 June	7	2	- ditto.
Savoy-street	20 April 6 June	23 May 20 June	49	2	- ditto.
Essex-street	24 April	20 June	58	2	- ditto.
Fleet	19 February	11 April	52	8	- ditto.
London Bridge	27 February	11 April	44	4	- ditto.
Ratcliff Cross	31 March	9 May	40	2	- ditto.
Lime Kiln Dock	27 April	9 May	13	2	- ditto.
Hackney Brook	13 April	23 April	11	6	Class No. 2; accumulated sewage gauged at times.

* The King's Scholars' Pond Sewer, although closed with tidal gates, is practically in Class No. 1, as the accumulation had nearly always run off before any gaugings could be recorded.

On the South side of the River.

Name of Sewer.	Period of Gaugings. From.	Period of Gaugings. To.	No. of Days.	Width of Weir.	Remarks as to Class, &c.
				Feet.	
Falcon Brook - - -	17 February	11 April -	54	6	Practically Class No. 1.
Heath Wall - - -	20 February	31 March -	40	4	Class No. 2; accumulation gauged.
Effra at Loughboro' Road -	3 March -	11 April -	40	6	Class No. 1.
Ditto, near the Oval at Kennington - - -	3 March -	11 April -	40	6	- ditto.
Duffield - - - -	5 March -	11 April -	38	6	Class No. 2; accumulation gauged.
Earl - - - - -	14 March -	25 April -	43	6	- - ditto - ditto.

The sewers in the first Table convey about *three-fourths* of the whole drainage of the North side, and those in the second about *three-fourths* that of the South side of the Thames; so that with reference to the whole drainage of London, about *three-fourths* has been actually measured.

Rain gauges. The determination of the quantity of rain flowing into the sewers from a given depth of fall being an important part of the subject, rain gauges were fixed at the following places, and the falls observed in some cases, hourly, during night and day, and in others during the day only:

RAIN GAUGES

On the North side of the River.

At the Kensington Canal Basin, near the Counter's Creek Gauge Weir.
Westbourne Lodge, Paddington.
The Zoological Gardens, Regent's Park.
The Chelsea Waterworks, Thames Bank, Pimlico.
Northumberland Wharf, near Hungerford Market.
The Charter House.
Near the Gauge Weir of the Hackney Brook.*

On the South side of the River.

At the Lambeth Waterworks Reservoirs, Brixton Hill.
Near the Effra Gauge Weir, Loughborough Road, Brixton.
Bricklayers' Arms, Railway Station.

The record of the rain fall was also obtained from the Chartered Gas Works, Westminster, and from a gauge kept at Highgate.

During the first four weeks of the series of sewer gaugings there was a remarkable absence of rain, and, with the exception of the falls accompanying the storms of June, there has scarcely been a sufficiently decisive rain throughout the whole time to give any very well defined results. An attentive consideration, however, of the rain-fall, with reference to the gaugings, evidently shows that no definite quantity can be pronounced to flow off any given district with a given fall, so much depending on the previous state of the ground, whether dried up or saturated, on the season and amount of evaporation, on the quantity of rain falling in a given time, and on the long or short duration of the fall. In a town district, such as that drained by the Savoy and Northumberland-street sewers, it appears the quantity running off into the sewers within six hours† after the fall of rain varies from 10 to 60 per cent. of the quantity fallen; while in a suburban locality, such as the

* This gauge is not recorded in the Rain Table, as very little rain occurred during the short time it was fixed.

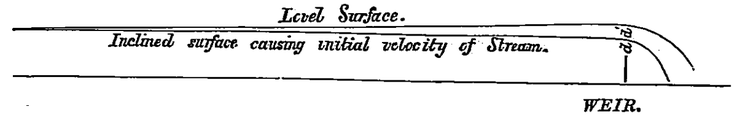
† Of the rain during the storm on 20th June (nearly one inch in 1¼ hour), 65 per cent. ran off this district within 15 hours of the fall; viz.:

46	per cent.	in ¾ths of an hour after the rain ceased.
14	,,	more in the next 6¾ hours.
5	,,	more in the next 7½ hours.
65		

the Counter's Creek Sewer Drains, the quantity reaching the sewers would vary from 0 to 30 or 40 per cent. in 24 hours after the rain, according to the previous conditions of the surfaces as above described; the remainder being carried off by evaporation, absorption, and other causes.

Velocities of flow of sewage. Many of the sewers having large inclinations at the parts where the weirs were fixed, causing the stream to flow towards them with considerable momentum, it became necessary to ascertain the surface velocities in each case at a variety of depths, in order to make the proper additions to the quantities due to such momentum. These velocities were measured over distances of from 10 to 20 feet behind the weirs, as circumstances would allow; and a special table of *mean* velocities, calculated from the experiments for all the different depths of the gaugings at each sewer, for application in the formula for working out the quantities.

Formula used. A formula much in use for calculating the quantity of water flowing over weirs is $5\sqrt{d^3}$, the depth being in inches, and the quantity in cubic feet per minute forevery foot in width of the weir; but I have ascertained from experiments on a large scale that $5{\cdot}5\sqrt{d^3}$ gives a more accurate result; and this formula has been adopted as the basis for working out the quantities in the Tables. It is, however, only suited to cases where the surface of the head of water is still or constant, without any flow towards the weir excepting that produced by the overfall, and requires the additional element of the initial velocity of the stream approaching the weir to be introduced to give true results for such cases. Now the velocity of water flowing over a weir in feet per *second*, deduced from the above formula, expressed in terms of the depth in *inches*, is $v = \sqrt{\frac{d}{\cdot 8}}$ Therefore the velocity of the stream approaching the weir (apart from that due solely to the overfall), having been ascertained by experiment,† its value (while passing the weir), in terms of the depth, is as above stated, $v = \sqrt{\frac{d}{\cdot 8}}$; the depth corresponding therewith, being $d = \cdot 8v^2$. Lastly, the velocity of the flow over the weir being increased beyond what is due to that of the overfall only, by the initial velocity of the stream, the depth, as measured on the weir, must be increased by the corresponding value of this initial velocity; in other words, supposing the weir to be raised sufficiently high to bay back the fluid and form a large still or level head, then the additional depth d' (*see* diagram), would be in excess of the original depth d by a quantity which would produce an increased velocity over the weir equal to the initial velocity ascertained by experiment; such velocity being the equivalent of the depth d', or $\cdot 8\,v^2$;



therefore the two depths being added together, viz., $d + 8{\cdot}v^2$, and substituted for the original depth in the formula, it becomes $Q = 5{\cdot}5\,d\sqrt{d + \cdot 8v^2}$, or $5{\cdot}5\sqrt{d^3 + \cdot 8d^2v^2}$.

Where Q = the quantity in cubic feet per minute,
d = the depth in inches flowing over the weir,
v = the mean velocity of the stream in feet per second, as ascertained from the experiments above alluded to.

The

* $Q = 5{\cdot}5d\sqrt{d}$ where d = depth in *inches*,
Q = cubic feet per *minute*.
Let v = the velocity in feet per second.

Then $Q = \frac{d}{12} \times 60v$, $\frac{d}{12}$ being the area of the stream flowing through the weir, in square feet, and $60v$ the velocity in feet per *minute*.

Therefore substituting the new value of Q in the first equation—

$\frac{60dv}{12} = 5{\cdot}5d\sqrt{d}$
or $5v = 5{\cdot}5\sqrt{d}$
$v = 1{\cdot}1\sqrt{d} = \sqrt{\frac{d}{\cdot 8}}$
and $d = \cdot 8\,v^2$

If d be taken in *feet* the value of v is $\sqrt{\frac{12d}{\cdot 8}} = 3{\cdot}9\sqrt{d}$

† This velocity is of course the combined result of the *fall* in the stream, and the *hydraulic mean depth* thereof.

Appendix III.

Sewage, Rainfall and Population.

Report on Sewer Gaugings.

The following quantities for a flow 10 inches deep and 1 foot wide are given to show the increase due to velocity, as calculated from the above formula:—

Still or Constant Head.	Mean Velocity of Stream approaching Weir, in Feet per Second.					
	·5	1·0	1·5	2·0	2·5	3·0
	Cubic Feet per Minute.					
173·9	175·7	180·8	188·9	199·8	213	228

To facilitate the reduction of the observations, a general Table of quantities was calculated from the formula for depths, increasing from 1 to 30 inches, showing first the quantities due to the still or constant head only, and secondly, those including velocities of the stream, varying, by intervals of 6 inches, from 6 inches to 3 feet per second. The special Tables for the sewers were then made with comparative ease, by abstracting the quantities due to the experimental depths and velocities from the general Table, and multiplying them by the width of the weir in each case.

Before any of the Tables could be added up to arrive at the true average quantity at each period of observation, it was necessary to make a very careful examination of them with a view of excluding the following gaugings:—

1st. Gaugings containing rain, which are distinguished in the Tables by a star, thus (155*, 970*, &c.).

2d. Gaugings which include any accumulation of sewage pent up by the tide.

3d. Gaugings when the overfalls at the weirs were influenced by the rising tide.

4th. Gaugings exhibiting any accidental and sudden increase from the water used during fires, or from the operations of flushing, or from any other causes occasioning extraordinary flows.

5th. The Sunday gaugings; these being invariably lower than the rest, and the flow being evidently influenced by a variety of circumstances incidental to these gaugings only.

The gaugings under the 2d, 3d, and 4th heads are struck through with a black line, and those of the Sundays are distinguished by type, thus (15, 22, &c.).

The above corrections being performed, the Tables were added, and the results exhibit the normal flow of sewage for every quarter of an hour throughout the entire day in each case.

With regard to the exclusion of the gaugings under the 4th head, although the extraordinary flows would under any circumstances occur and the sewers would have to convey them off, yet it would obviously be incorrect to include them with the ordinary gaugings, and thus produce a constant increase of the normal quantities from an accidental and inconstant cause.

I am, &c.
(signed) *John Taylor.*

Appendix III.—*continued.*

2.—TABLE showing the Total Daily Flow in Cubic Feet of all the Sewers in the Metropolitan Area, deduced partly from the Gaugings of the Referees, and partly from the Gaugings made in 1853 by Mr. *Bazalgette* and Mr. *Haywood*.

NORTH. NAME OF SEWER.	Discharge per Day.	Total Discharge per Day.
Gauged by Referees:	*Cubic feet.*	*Cubic feet.*
Counter's Creek, Kensington Sewer	353,880·	
Ranelagh	924,894·	
King's Scholars' Pond	1,203,830·	
Northumberland-street	460,365·	
Savoy-street	190,140·	
Norfolk-street	30,142·	
Essex-street	102,675·	
Ratcliff Cross	905,910·	
Limekiln Dock	131,300·	
Hackney Brook	716,295·	
Fleet	1,741,775·	
London Bridge	1,318,830·	
		8,080,036·
Gauged by Mr. *Bazalgette:*		
Hammersmith Creek, Queen-street, Hammersmith, Eel Brook, Stamford Bridge, Old Counter's Creek, Millman's-row, Church-street, Chelsea, Queen-street, Chelsea, Smith-street, Chelsea, Commercial-road, Ranelagh, Grosvenor Ditch, Horseferry Road, Wood-street, Victoria street, Whitehall-place, Nightingale lane, Smithfield, Union Stairs, Wapping Dock, New Crane Stairs, Wapping Wall or King James, Shadwell Dock Streets, Shadwell Dock Stairs, Nightingale-lane, Limehouse, Great Sluice, Blackwall Sluice	1,128,610·	
Add 55 per cent.* on the above	620,735·	
		1,749,345·
City Sewers, gauged by Mr. *Haywood:*		
Whitefriars Dock	61,266·	
Paul's Wharf	121,793·	
Hambro' Wharf	7,500·	
Dowgate Dock	64,722·	
Custom House	38,796·	
Ditto - - East	11,332·	
Wool Quay	7,746·	
Tower Dock	4,595·	
Irongate	132,536·	
		450,286·
		10,279,667·
Add, for sewers and small drains not gauged, 12 per cent.		1,233,560·
TOTAL		11,513,227·

SOUTH. NAME OF SEWER.	Discharge per Day.	Total Discharge per Day.
Gauged by Referees:	*Cubic feet.*	*Cubic feet.*
Falcon Brook	130,500	
Heathwall	390,240	
Effra, Lower	218,235	
Earl	885,600	
Duffield	1,002,816	
		2,627,391
Ganged by Mr. *Bazalgette:*		
Arnold	169,753	
Dover	21,186	
Pudding Mill	27,920	
Bear	22,373	
Welsh Trooper	263	
Boar's Head	38,968	
Black Lion	736	
Green Bank	11,664	
Bridge Yard	2,477	
Battle Bridge	136,550	
St. John's, Great	52,165	
Globe	28,404	
Limekiln	33,007	
Rotherhithe Pier	30,807	
	576,273	
Add 23 per cent.* on the above	132,542	
		708,815
		3,336,206
Add, for sewers and small drains, 12 per cent.		400,344
TOTAL		3,736,550

* This percentage was obtained by comparing the results of the sewer gaugings of the Referees with Mr. Bazalgette's gaugings of the same sewers.

Appendix III.—*continued.*

3.—TABLE showing the Total Average Discharge in Cubic Feet of the Principal

HOUR.	NORTH.						
	Counter's Creek.	Ranelagh.	King's Scholars' Pond.	Northumberland Street.	Savoy Street.	Essex Street.	Norfolk Street.
A.M. 1 -	9,360	16,885	27,240	8,160	3,405	2,145	499·
— 2 -	8,520	16,350	23,550	7,845	3,270	2,040	486·
— 3 -	8,280	15,240	21,765	7,455	3,210	2,025	471·
— 4 -	8,205	14,624	20,250	7,335	3,180	1,905	450·
— 5 -	8,040	12,705	20,550	7,695	3,120	1,845	400·5
— 6 -	7,920	14,205	20,310	8,130	3,135	1,890	373·5
— 7 -	10,875	19,800	23,190	14,040	3,705	2,055	556·5
— 8 -	17,100	28,755	38,400	28,275	8,565	4,215	2,416·5
— 9 -	20,835	35,790	65,775	38,100	10,230	8,265	3,882·
— 10 -	22,500	55,200	79,905	39,315	12,870	7,695	4,122·
— 11 -	25,635	53,290	87,435	34,185	11,895	6,540	2,277·
— 12 -	20,295	61,485	91,110	28,545	12,810	7,620	1,215·
P.M. 1 -	18,075	63,900	82,195	27,165	14,250	7,470	1,899·
— 2 -	15,825	58,875	79,005	25,800	11,190	6,300	1,890·
— 3 -	16,230	60,480	74,760	23,460	7,890	4,005	1,110·
— 4 -	14,805	58,035	70,440	24,360	10,725	4,500	1,056·
— 5 -	17,040	55,275	69,510	27,015	11,850	5,880	1,200·
— 6 -	17,925	51,510	61,545	25,395	13,500	7,470	1,185·
— 7 -	17,010	47,385	50,955	19,080	11,385	5,385	1,372·5
— 8 -	17,475	46,185	48,810	15,930	10,245	3,480	871·5
— 9 -	16,260	41,850	43,980	13,230	6,375	2,925	660·
— 10 -	13,635	36,420	38,040	10,770	5,370	2,550	652·5
— 11 -	11,445	31,800	32,805	9,945	4,275	2,295	585·
— 12 -	10,590	26,850	32,305	9,135	3,690	2,175	513·
TOTAL - -	353,880	924,894	1,203,830	460,365	190,140	102,675	30,142·5

Appendix III.—*continued.*

Sewers in the Metropolis for every Hour during Twenty-four Hours without Rain.

NORTH.					SOUTH.		TOTAL Flow for each Hour.
Fleet.	London Bridge.	Ratcliffe Cross.	Limekiln Dock.	Hackney Brook.	Falcon Brook.	Upper Effra.	
36,075	25,965	19,395	3,440	28,020	5,190	6,270	194,048·
33,645	25,155	18,990	3,322	26,940	4,965	6,030	181,108·
32,835	24,420	18,975	3,203	26,385	4,800	5,625	174,689·
30,540	24,435	19,290	3,180	25,650	4,695	5,220	168,959·
30,870	24,495	19,290	2,955	25,155	4,620	5,235	166,975·5
35,550	24,690	20,835	2,543	24,570	4,545	5,385	174,081·5
51,585	37,380	23,460	2,962	25,965	4,515	5,880	225,968·5
86,805	69,000	35,190	5,198	26,250	4,725	7,005	361,899·5
103,800	81,945	49,995	4,717	28,170	4,635	7,965	464,104·
104,295	82,980	61,365	5,520	29,220	4,650	9,240	518,877·
124,455	89,430	63,750	7,275	30,240	4,965	10,875	552,247·
124,635	88,380	65,715	9,045	30,990	5,475	11,670	558,990·
123,570	82,155	62,835	9,135	31,170	5,850	11,775	541,444·
102,465	75,420	62,250	8,415	32,040	6,015	13,050	498,540·
97,065	71,325	56,115	8,100	32,265	6,495	11,205	470,505·
106,305	79,875	57,165	9,090	32,310	6,540	12,780	487,986·
108,570	82,890	53,385	9,878	32,670	6,225	13,020	494,408·
89,055	73,140	43,995	8,482	32,745	6,030	11,460	443,437·
72,945	63,885	36,870	5,993	35,055	5,940	10,680	383,940·5
63,090	52,905	28,875	4,050	35,070	6,210	9,555	342,751·5
53,750	43,695	24,735	3,870	34,245	6,090	8,565	300,230·
47,295	35,670	22,410	3,427	31,860	6,015	7,980	262,094·5
42,780	31,515	20,910	3,615	30,240	5,865	7,140	235,215·
39,795	28,080	20,115	3,885	29,070	5,445	6,420	218,068·
1,741,775	1,318,830	905,910	131,300	716,295	130,500	210,030	8,420,566·5

	Actual Flow.	Proportion Per Cent.
Eight hours of Maximum Flow; viz. between 9 a.m. and 5 p.m. - -	4,122,997·	49
Eight hours of Mean Flow; viz. between 7 a.m. and 9 a.m., and between 5 p.m. and 11 p.m. - - - - - - - - - -	2,793,672·	33
Eight hours of Minimum Flow; viz. between 11 p.m. and 7 a.m. -	1,503,897·5	18
TOTAL - -	8,420,566·5	100

Appendix III.—*cotninued.*

4.—TABLE showing for some of the Principal SEWERS the Flow of Sewage in Cubic Feet per Day, and also the estimated Flow per Day per Acre drained, and per Head of the Inhabitants of the Area drained.

NAMES of SEWERS.	Acres Drained.	Number per Acre.	Assumed Population in District.	Flow of Sewage.	Flow per Acre.	Flow per Head of Assumed Population.
				Cubic feet.	*Cubic feet.*	*Cubic feet.*
NORTH SIDE:						
Counter's Creek, Kensington Branch.	1,807	23	41,300	353,880	196	8·6
Ranelagh - - - - -	4,150	32	132,100	924,894	223	7·0
King's Scholars' Pond - -	1,820	92	167,700	1,203,830	661	7·0
Northumberland-street - -	633	253	160,000	783,322·5	1,206	4·8
Savoy-street - - - - -						
Essex-street - - - - -						
Norfolk-street - - - - -						
Fleet - - - - - -	4,220	57	239,000	1,741,775	413	7·2
London Bridge - - - - -	2,250	86	194,750	1,318,830	586	6·4
Ratcliffe Cross - - - - -	1,098	135	148,230	905,910	825	6·1
The average for the other sewers has not been obtained.						
SOUTH SIDE:						
Effra (Upper) - - - - -	3,650	7·3	26,850	210,030	57	7·8
Total North Side of Metropolis - - - - -	31,556	62·	1,963,000*	11,513,227	365·	5·9
Total South Side of Metropolis - - - - -	43,695	16·	693,000*	3,736,550	86·	5·4
TOTAL combined† - -	75,251	35·	2,656,000	15,208,083	202·	5·8

* An increase since 1851 of 12½ per cent. has been assumed.

† In this case the average excess of the gaugings of the Referees over Mr. Bazalgette's gauging has been assumed from the sum of all the sewers gauged by the Referees.

Appendix III.—*continued.*

5.—DETAILED TABLES of DISCHARGE of Principal Sewers.

(1.) TABLE of AVERAGE DISCHARGE for every Quarter of an Hour.

See DIAGRAMS, Plates 2 and 3.

Appendix III.—*continued.*

5.—TABLE showing the Average Discharge in Cubic Feet per Minute of the Principal Sewers in the Metropolis, at each Quarter of an Hour during Twenty-four Hours without Rain.

TIME of OBSERVATION.	NORTH.								SOUTH.					
	Counter's Creek, inclusive of Kensington Swage.	Ranelagh.	King's Scholars' Pond.	Northumberland Street.	Savoy Street.	Norfolk Street.	Essex Street.	Fleet.	London Bridge.	Ratcliffe Cross.	Limekiln Dock.	Hackney Brook.	Falcon Brook.	Heath Wall.
12 0 Midnight	162	354	472	140	59	9·0	36	627	455	326	64½	476	87	222
12 15 A.M.	159	330	438	139	58	8·0	36	614	445	324	63	476	88	198
12 30	154	294	470	135	57	8·4	36	588	431	324	57	473	87	184
12 45	148	281	436	135	56	8·4	36	576	428	323	55	464	86	180
1 0	145	274	426	135	56	8·4	35	568	427	322	54½	455	85	191
1 15	140	278	391	133	55	8·4	34	563	422	320	54½	452	84	208
1 30	138	272	376	132	55	8·0	34	566	420	321	58	449	83	201
1 45	136	266	377	130	54	8·0	34	546	418	313	55	449	82	214
2 0	135	260	368	128	54	8·0	34	543	417	312	54	446	82	209
2 15	133	255	366	127	54	8·0	33	516	411	313	56	443	82	209
2 30	134	242	360	124	54	7·8	34	522	408	306	54	443	80	218
2 45	132	259	357	123	53	7·8	34	508	406	326	52	438	79	218
3 0	133	258	359	123	53	7·8	34	529	403	320	51½	435	79	229
3 15	132	252	333	121	53	7·8	33	508	401	327	54	432	78	225
3 30	129	237	333	122	53	7·8	32	503	409	320	53	429	78	234
3 45	127	228	325	122	53	7·2	31	496	409	320	54	426	79	224
4 0	127	210	337	124	53	7·2	31	515	410	319	51	423	78	217
4 15	125	216	344	124	52	7·2	31	537	409	316	50	423	77	193
4 30	124	213	347	127	52	7·2	31	548	406	316	51	420	77	189
4 45	123	208	342	130	52	6·8	31	558	406	324	48	423	77	177
5 0	123	232	334	132	52	5·5	30	553	412	330	48	411	77	214
5 15	122	247	328	131	52	5·5	30	582	407	336	48	408	77	231
5 30	130	238	345	133	52	6·3	30	609	407	340	40½	408	76	223
5 45	130	230	347	136	52	6·3	33	626	410	363	40½	405	75	232
6 0	147	225	351	142	53	6·8	33	691	422	350	40½	417	75	266
6 15	164	257	348	153	54	7·2	32	767	489	355	40½	426	74	256
6 30	186	378	398	175	57	6·3	34	923	583	370	42	435	74	242
6 45	210	460	449	253	62	8·6	34	1,058	679	404	48	435	76	239
7 0	242	544	441	355	74	15·0	37	1,142	741	435	67	435	77	251
7 15	270	539	551	402	93	26·6	41	1,317	935	495	83	436	77	272
7 30	300	448	744	420	121	33·0	46	1,621	1,155	556	93	436	80	272
7 45	316	386	824	495	168	45·5	71	1,707	1,205	620	90	438	80	316
8 0	340	430	962	568	189	56·0	183	1,804	1,305	675	80½	440	78	316
8 15	345	564	1,022	604	181	61·3	153	1,758	1,339	725	81	459	78	326
8 30	341	650	1,143	607	157	67·0	141	1,732	1,318	794	82½	463	77	311
8 45	345	742	1,258	669	167	61·5	129	1,696	1,391	870	77	471	77	309
9 0	350	848	1,247	660	177	69·0	128	1,626	1,415	943	74	485	77	297
9 15	360	958	1,284	656	202	62·0	131	1,689	1,359	974	78	490	76	291
9 30	381	966	1,386	672	219	74·5	128	1,779	1,366	995	88	488	77	277
9 45	418	908	1,410	660	221	71·3	130	1,859	1,400	1,037	98	484	78	280
10 0	444	851	1,429	663	216	67·0	124	1,934	1,407	1,085	104	486	79	273
10 15	445	852	1,424	605	210	56·6	115	2,107	1,452	1,066	112	486	81	284
10 30	418	904	1,455	606	194	42·3	110	2,141	1,494	1,069	123	496	82	292
10 45	388	959	1,521	557	195	28·6	107	2,115	1,487	1,059	125	516	83	293
11 0	362	1,006	1,527	511	194	24·3	104	2,059	1,529	1,056	125	518	85	302
11 15	342	1,036	1,503	498	190	23·0	98	2,010	1,529	1,097	135	520	88	312
11 30	332	1,046	1,517	484	206	20·3	120	2,098	1,508	1,104	153	515	88	316
11 45	326	1,011	1,527	469	222	17·0	144	2,142	1,417	1,100	158	520	96	306

(*continued*)

Appendix III.—*continued.*

SOUTH.					
Upper Effra.	Lower Effra.	Duffield.	Earl.
107	106	520	530
108	105	607	524
106	106	577	521
103	106	575	486
101	105	587	500
100	111	577	537
103	106	524	548
102	105	573	538
97	102	560	495
97	101	565	457
94	98	502	427
93	93	460	410
91	91	425	427
87	91	504	541
86	92	559	522
87	89	558	508
88	88	485	515
88	87	426	510
88	84	386	466
85	83	368	439
88	84	446	445
89	85	415	448
88	86	377	454
89	87	476	421
93	90	470	398
97	93	469	425
96	90	551	423
97	91	610	431
102	91	631	444
107	97	612	454
122	99	592	456
116	100	575	466
122	101	554	469
126	108	536	478
130	116	535	506
132	121	582	508
143	131	690	529
153	138	690	556
154	141	736	583
154	157	809	621
155	168	857	638
163	167	891	653
171	171	880	655
194	184	911	729
197	192	1,003	765
197	197	966	797
195	211	947	794
195	225	838	799

Appendix III.—*continued.*

5.—TABLE showing the Average Discharge in Cubic Feet per Minute of the Principal Sewers in the Metropolis, at each Quarter of an Hour during Twenty-four Hours without Rain—*continued.*

TIME of OBSERVATION.	NORTH.								SOUTH.					
	Counter's Creek, inclusive of Kensington Sewage.	Ranelagh.	King's Scholars' Pond.	Northumberland Street.	Savoy Street.	Norfolk Street.	Essex Street.	Fleet.	London Bridge.	Ratcliff Cross.	Limekiln Dock.	Hackney Brook.	Falcon Brook.	Heath Wall.
12 0 Noon	322	1,022	1,457	452	236	20·7	146	2,123	1,438	1,080	157	511	93	306
12 15 P.M.	322	1,097	1,342	426	238	20·5	126	2,151	1,426	1,055	161	511	95	303
12 30	295	1,108	1,337	439	237	26·2	109	2,034	1,354	1,049	155	516	96	323
12 45	275	1,033	1,349	471	235	38·2	127	1,930	1,342	1,037	148	523	99	319
1 0	258	970	1,336	475	240	41·7	136	1,800	1,355	1,048	145	528	100	323
1 15	261	950	1,318	455	227	44·2	138	1,770	1,332	1,060	138	530	100	313
1 30	263	975	1,329	441	204	28·6	120	1,631	1,261	1,054	143	530	100	309
1 45	266	1,030	1,284	417	170	26·8	92	1,630	1,229	1,034	138	539	100	302
2 0	268	1,006	1,275	407	145	26·4	69	1,644	1,206	1,002	142	537	101	297
2 15	262	983	1,233	384	138	19·2	62	1,607	1,214	971	137	535	104	302
2 30	250	1,015	1,229	388	130	18·0	63	1,609	1,169	939	143	536	108	294
2 45	245	1,028	1,247	396	127	18·4	69	1,611	1,155	908	138	537	111	289
3 0	239	1,005	1,240	396	131	18·4	73	1,687	1,217	923	122	543	110	294
3 15	238	977	1,214	391	159	18·4	75	1,742	1,311	945	126	534	108	297
3 30	240	944	1,152	385	193	17·8	72	1,763	1,347	963	147	538	110	290
3 45	253	943	1,090	404	192	17·4	73	1,845	1,318	961	168½	540	110	290
4 0	255	947	1,152	444	171	16·8	80	1,924	1,349	942	164½	542	108	279
4 15	277	915	1,151	450	157	16·0	85	1,852	1,399	925	174½	543	105	266
4 30	277	900	1,168	441	170	19·2	94	1,758	1,433	907	165	543	103	266
4 45	288	923	1,163	453	211	22·8	102	1,704	1,356	882	158	550	104	266
5 0	290	894	1,076	457	252	22·0	111	1,659	1,338	845	161	542	103	266
5 15	288	893	1,047	414	238	20·5	122	1,519	1,302	800	154	551	102	255
5 30	285	811	987	434	230	20·2	125	1,438	1,251	724	146½	527	100	320
5 45	283	836	993	441	225	19·3	125	1,321	1,182	716	141	544	101	341
6 0	276	809	905	404	207	19·0	126	1,331	1,141	693	124	561	99	330
6 15	275	730	894	388	174	24·3	117	1,213	1,101	658	111	586	97	330
6 30	279	806	758	318	162	25·6	93	1,172	1,076	633	101	589	96	330
6 45	287	814	840	292	197	22·0	82	1,147	1,058	599	94½	582	102	345
7 0	295	776	832	274	226	19·6	67	1,118	1,024	568	93	580	101	352
7 15	295	768	825	299	215	15·6	64	1,068	952	525	72	583	102	344
7 30	291	775	803	266	187	15·0	58	1,022	922	499	66½	583	103	341
7 45	282	760	794	255	151	14·0	55	998	848	460	62½	586	104	334
8 0	280	713	799	242	130	13·5	55	971	805	441	69	586	105	334
8 15	272	731	737	223	117	11·0	53	929	776	427	71	583	104	325
8 30	277	683	719	229	109	11·0	49	868	748	416	64	576	101	309
8 45	260	643	677	223	104	11·0	47	822	713	408	62	567	100	280
9 0	251	630	653	207	95	11·0	46	805	676	398	61	557	101	271
9 15	237	627	649	188	95	11·0	43	810	632	388	56	547	101	273
9 30	219	594	635	196	95	11·0	43	769	607	379	56½	535	100	263
9 45	209	577	599	157	86	11·0	42	769	580	366	60	526	100	277
10 0	203	563	583	177	82	10·5	42	746	559	361	56	516	100	261
10 15	195	534	549	171	76	10·5	39	724	543	356	64	510	99	257
10 30	187	522	528	164	73	10·0	38	699	532	349	59	504	99	246
10 45	187	501	527	164	69	9·0	38	683	519	346	57	501	97	231
11 0	183	486	521	164	67	9·5	38	672	507	343	61	501	96	224
11 15	178	445	544	162	64	8·0	36	659	456	340	61½	491	93	228
11 30	174	436	537	158	62	8·6	37	664	487	339	66	483	92	235
11 45	173	413	551	149	61	8·6	36	658	474	336	67	488	91	235
Mean of the 24 Hours	242	642	836	320	122	21·	71	1,211	916	629	91	497	91	271

Appendix III.—*continued.*

in the Metropolis, at each Quarter of an Hour during Twenty-four Hours without Rain—*continued.*

NORTH.				SOUTH.					
London Bridge.	Ratcliff Cross.	Limekiln Dock.	Hackney Brook.	Falcon Brook.	Heath Wall.	Upper Effra.	Lower Effra.	Duffield.	Earl.
1,438	1,080	157	511	93	306	191	224	852	744
1,426	1,055	161	511	95	303	185	224	759	720
1,354	1,049	155	516	96	323	187	212	814	741
1,342	1,037	148	523	99	319	198	210	900	754
1,355	1,048	145	528	100	323	215	204	958	754
1,332	1,060	138	530	100	313	227	202	955	749
1,261	1,054	143	530	100	309	227	214	878	766
1,229	1,034	138	539	100	302	216	228	856	735
1,206	1,002	142	537	101	297	200	242	967	768
1,214	971	137	535	104	302	189	247	970	795
1,169	939	143	536	108	294	183	237	922	769
1,155	908	138	537	111	289	187	217	930	755
1,217	923	122	543	110	294	188	214	- -	732
1,311	945	126	534	108	297	200	206	- -	718
1,347	963	147	538	110	290	212	201	- -	720
1,318	961	168½	540	110	290	218	201	- -	699
1,349	942	164½	542	108	279	222	209	856	692
1,399	925	174½	543	105	266	223	215	- -	672
1,433	907	165	543	103	266	220	222	- -	786
1,356	882	158	550	104	266	215	226	- -	790
1,338	845	161	542	103	266	210	230	- -	863
1,302	800	154	551	102	255	202	235	- -	791
1,251	724	146½	527	100	320	195	231	- -	799
1,182	716	141	544	101	341	185	223	- -	771
1,141	693	124	561	99	330	182	216	- -	743
1,101	658	111	586	97	330	183	202	- -	717
1,076	633	101	589	96	330	180	199	- -	735
1,058	599	94½	582	102	345	175	189	1,023	740
1,024	568	93	580	101	352	174	176	984	771
952	525	72	583	102	344	170	173	941	714
922	499	66½	583	103	341	157	167	897	718
848	460	62½	586	104	334	156	163	838	674
805	441	69	586	105	334	154	160	767	645
776	427	71	583	104	325	144	153	773	606
748	416	64	576	101	309	144	151	711	621
713	408	62	567	100	280	142	150	793	622
676	398	61	557	101	271	141	150	772	646
632	388	56	547	101	273	136	147	801	618
607	379	56½	535	100	263	134	147	765	608
580	366	60	526	100	277	132	143	779	597
559	361	56	516	100	261	130	139	694	596
543	356	64	510	99	257	123	135	737	648
532	349	59	504	99	246	119	133	726	628
519	346	57	501	97	231	118	129	758	571
507	343	61	501	96	224	116	124	760	540
456	340	61½	491	93	228	112	122	661	668
487	339	66	483	92	235	110	119	696	679
474	336	67	488	91	235	99	118	580	629
916	629	91	497	91	271	146	152	696	615

Appendix III.—*continued.*

5.—Detailed Tables of Discharge of Principal Sewers.

(2.) Table of Actual Discharge as gauged every Quarter of an Hour.

7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.	
E.																					
–	352	288	288	288	288	288	288	288	260	250	250	250	240	240	240	240	188	177	177	25	MARCH
–	–	288	288	288	288	374	240	240	203	177	177	102	154	154	154	154	154	146	138	26	
–	–	–	–	–	288	260	250	177	177	177	102	102	102	154	146	146	146	138	138	27	
–	–	–	–	–	–	310	288	288	260	212	194	177	177	177	177	162	162	162	154	28	
46	138	–	–	–	–	–	177	177	177	162	162	138	130	130	130	122	122	162	162	29	
79*	–	–	–	–	–	–	–	–	–	–	–	203	203	177	177	177	177	162	162	30	
38	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	203*	203*	231*	177	31	
50	260*	260*	310*	–	–	–	–	–	–	–	–	–	–	–	–	–	177	162	130	1	APRIL
50	240	240	231	250	341	341	–	–	–	–	–	–	–	–	–	–	–	–	–	2	
50	250	250	250	250	240	231	222	212	194	177	162	177	–	–	–	–	–	–	–	3	
34*	609*	565*	541*	541*	541*	541*	491*	455*	442*	430*	430*	397*	385*	397*	420*	442*	–	–	–	4	
85*	374*	374*	374*	363*	352*	352*	352*	341*	341*	330*	330*	330*	320*	310*	310*	310*	310*	310*	310*	5	
33*	310*	298*	310*	310*	310*	298*	288*	250*	231*	231*	231*	231*	231*	231*	222*	231*	231*	231*	231*	6	
42*	408*	374*	352*	352*	352*	374*	374*	397*	397*	385*	374*	374*	385*	374*	397*	374*	363*	341*	298*	7	
74*	352*	352*	341*	330*	352*	374*	363*	341*	310*	298*	288*	260*	250*	240*	240*	231*	222	222	222	8	
91	420	397*	352*	352*	330*	310*	310*	288*	288*	260*	250*	250*	250*	240*	231*	231*	231*	231*	231*	9	
–	–	–	298	250	240	231	203	212	203	203	194	188	188	177	177	177	177	177	177	10	
–	–	–	–	397*	352*	330*	310*	288*	250*	240*	222	212	212	212	212	212	194	194	194	11	
–	–	–	–	–	250*	212*	194*	194*	194*	194*	194*	177	177	177	177	162	162	154	154	12	
–	–	–	–	–	–	330*	298*	250*	250*	310*	420*	467*	491*	491*	455*	420*	374*	341*	320*	13	
–	–	–	–	–	–	–	–	–	310*	250*	231*	231*	212	194	194	194	188	177	177	14	
–	–	–	–	–	–	–	–	–	–	–	288*	240*	222	212	203	194	194	194	188	15	
–	–	–	–	–	–	–	–	–	–	–	–	310	288	250	231	231	231	212	212	16	
30	–	–	–	–	–	–	–	–	–	–	–	–	–	231	212	203	188	177	177	17	
10	320	320	310	298	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	
38	138	138	138	138	138	138	138	138	138	138	138	138	–	–	–	–	–	–	–	19	
60	374	374	374	374	374	374	363	352	341	330	310	298	288	250	240	222	222	222	222	20	
88	298	310	310	310	330	341	341	330	320	310	310	310	288	288	288	288	260	250	222	21	
33*	397*	352*	341*	310*	288*	288*	250*	250*	231*	222*	203	203	194	188	188	177	177	177	177	22	
88	288	260	260	260	260	240	212	203	188	188	177	177	177	177	177	177	177	177	177	23	
10	250	231	231	231	240	240	240	212	188	194	194	177	177	177	177	177	154	154	146	24	
–	–	–	–	240	240	231	212	194	194	203	194	194	188	188	177	154	138	138	138	25	
–	–	–	–	–	–	203	114	146	138	130	122	122	122	122	122	122	114	114	114	26	
–	–	–	–	–	–	–	–	260	240	222	194	177	162	146	138	138	138	138	138	27	
–	–	–	–	–	–	–	–	–	–	–	188	177	154	145	138	138	138	138	138	28	
72	279	268	265	263	250	254	240	223	207	198	188	180	184	181	179	180	174	172	163		

Appendix III.—*continued.*

5.—Detailed Tables of Discharge of Principal Sewers.

(2.) Table of Actual Discharge as gauged every Quarter of an Hour.

M (

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	3
	C U B I C F																						
MARCH 25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
26	177	162	162	162	154	154	146	146	154	154	154	154	154	154	154	154	–	–	–	–	–	–	
27	138	130	130	122	122	114	114	122	130	130	130	138	130	130	130	130	130	130	–	–	–	–	
28	130	130	130	122	122	122	122	122	122	114	122	122	122	122	122	130	130	130	130	138	–	–	
29	154	146	146	130	122	122	122	130	130	138	130	122	122	122	122	122	122	122	122	122	114	114	114
30	154	138	114	114	114	114	114	114	107	107	107	122	122	122	122	130	130	130	130	130	130	130	138
31	162	154	146	146	138	138	138	130	130	130	130	130	122	122									
APRIL 1	177	162	154	154	154	154	154	138	130	130	130	146	146	138	138	138	–	130	130	130	130	130	1
2	138	130	130	130	138	130	122	122	122	122	122	122	122	122	122	122	122	122	122	122	114	114	122
3	194	177	177	177	162	162	162	162	154	138	130	130	130	130	130	130	130	130	122	122	122	122	122
4	–	–	203	177	177	146	130	130	130	122	122	122	122	122	122	122	122	122	122	114	114	114	1
5	–	–	–	–	–	–	–	–	565*	579*	516*	710*	782*	796*	1,053*	1,053*	1,022*	1,006*	1,040*	975*	960*	914*	8
6	320*	330*	330*	408*	–	–	–	–	–	–	–	–	–	–	–	–	341*	330*	341*	330*	320*	320*	3
7	231*	212*	212*	203*	194	194	194	194	194	–	–	–	–	–	–	–	–	–	–	–	194	188	
8	288*	250*	250*	240*	231*	222*	222*	222*	231*	288*	–	–	–	–	–	–	–	–	–	–	–	–	–
9	203	203	194	194	188	188	188	188	188	188	177	177	177	212	–	–	–	–	–	–	–	–	–
10	222*	212*	212*	212*	212*	203	203	194	194	194	194	194	194	194	212	–	–	–	–	–	–	–	–
11	177	162	162	162	162	162	162	154	154	154	154	154	154	154	154	154	154	154	162	–	–	–	–
12	194	194	188	188	177	177	162	154	154	154	154	154	154	154	162	162	154	154	162	177	–	–	–
13	154	154	146	146	138	138	138	138	138	138	146	154	162	177	177	177	177	177	177	177	154	177	
14	288*	260*	250*	250*	260*	310*	330*	341*	341*	330*	320*	310*	310*	288*	288*	250*	250*	250*	231*	231*	231*	231*	231*
15	177	177	177	177	177	162	162	162	162	162	154	154	154	154	154	154	154	154	154	146	146	154	146
16	177	177	162	162	154	154	146	146	138	138	130	130	138	138	138	138	138	138	138	138	138	138	138
17	212	203	194	194	194	194	194	194	194	194	188	177	177	177	177	177	177	177	177	177	177	177	177
18	162	162	162	154	154	154	146	146	146	146	146	138	138	138	138	138	138	138	138	138	138	138	138
19	177	162	154	154	138	138	138	138	138	138	138	138	138	138	138	138	138	130	130	130	130	130	130
20	–	–	–	–	–	–	–	–	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122
21	–	–	–	–	–	–	–	–	–	–	–	–	–	222	194	162	162	146	138	122	122	122	122
22	203	212	231	240	250	–	–	–	–	–	–	–	–	–	–	–	–	231	231	231	231	231	231
23	177	162	162	146	138	138	154	177	177	–	–	–	–	–	–	–	–	–	–	–	–	260	222
24	177	146	138	138	138	138	138	138	138	138	138	138	138	–	–	–	–	–	–	–	–	–	–
25	146	138	138	138	138	138	138	130	130	122	122	122	114	114	114	122	122	–	–	–	–	–	–
26	114	107	114	146	130	107	107	107	107	107	107	107	107	107	107	107	107	107	107	107	114	–	
27	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
28	138	130	130	122	122	122	122	122	122	122	122	122	114	114	114	114	114	114	114	114	114	114	114
	163	156	151	150	150	149	148	146	144	140	138	139	139	133	135	137	136	135	135	132	134	138	

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

COUNTER'S CREEK SEWER (Exclusive of the Kensington Drainage).

MORNING.

30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45
CUBIC FEET PER MINUTE.																																													
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	288	298	320	385	408	408	385	385	408	492	479	504	479	408	298	298	260	260	298	288	260	240	203	212	188	188	177	177	177	162	177	177	177	194	212	212	2
–	–	–	–	–	–	–	–	–	–	–	–	–	260	288	260	260	250	260	260	310	352	363	374	374	341	320	310	320	310	288	260	231	212	194	194	188	177	177	177	102	102	102	102	194	222	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	341	330	352	352	363	320	288	260	298	310	330	310	288	260	240	212	212	194	194	194	194	194	177	203	203	212	240	2
130	138	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	154	162	162	194*	212*	212*	222*	222*	212*	203*	188	177	177	177	162	154	162	154	146	146	146	146	138	138	138	138	138	138	138	1
122	114	114	114	114	114	114	122	122	122	–	–	–	–	–	–	–	–	–	–	–	–	288	310	310	288	288	288	288	240	260	231	222	222	212	194	188	177	177	177	177	177	177	194	194	194	1
114	114	114	122	122	114	114	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	310	310	260	250	240	260	288	260	250	222	212	203	203	194	188	177	177	177	194	203	194	203	2
130	130	130	138	138	146	146	177	212	240	260	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288	260	260	250	250	240	231	212	203	194	194	188	194	194	194	194	194	203	212	212	2
130	130	130	130	130	130	145	177	222	231	231	203	194	222	288	–	–	–	–	–	–	–	–	–	–	–	–	–	455*	455*	432*	374*	310*	288*	250*	222*	222*	212	203	194	194	194	203	203	212	222	2
122	114	114	122	122	114	138	162	177	222	231	212	203	240	288	310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	320*	231*	222*	203	194	194	188	188	194	194	194	203	5
122	122	122	122	122	145	177	177	194	222	240	203	212	240	250	288	288	310*	491*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	796*	754*	467*	397*	352*	330*	310*	310*	3
122	114	114	114	114	130	138	162	177	212	122	114	146	162	288	288	310	288	288	288	320	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
1,040*	975*	960*	914*	885*	930*	796*	811*	782*	826*	1,022*	1,264*	1,298*	1,281*	1,248*	1,231*	1,215*	1,198*	1,132*	1,132*	1,132*	1,117*	1,101*	1,101*	1,040*	1,022*	975*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6*
341*	330*	320*	320*	288*	288*	320*	341*	363*	385*	385*	374*	352*	374*	374*	374*	397*	420*	397*	385*	385*	397*	397*	420*	420*	397*	385*	385*	385*	374*	374*	341*	330*	310*	320*	–	–	–	–	–	–	–	–	–	–	0*
–	–	194	188	188	188	212	231	260	288	288	288	288	320	341	341	341	352	341	330	341	341	374	363	352	352	352	374	352	320	288	288	288	288	260	250	240	231	212	212	203	212	–	–	–	–	
–	–	–	–	–	320*	310*	310*	310*	320*	330*	330*	320*	341*	363*	352*	352*	363*	374*	363*	352*	352	352	352	352	352	330	320	288	288	288	288	260	250	240	240	288*	420*	579*	618*	631*	726*	726*	–	–	–	–	
–	–	–	–	–	–	–	352*	352*	341*	341*	320*	298*	341*	330*	341*	352*	374*	397*	684*	710*	960*	1,117*	1,083*	975*	870*	754*	684*	570*	541*	504*	455*	432*	397*	397*	385*	374*	374*	374*	374*	397*	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	479*	516*	455*	397*	408*	432*	442*	432*	408*	363*	341	320	288	260	250	250	260	288	288	288	298	298	298	310*	298*	298*	260*	250*	250*	240*	240*	231*	250*	250*	260*	298*	298*	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	455*	420*	385*	374*	374*	374*	374*	374*	363*	341	341	320	298	288	288	310*	330*	330*	330*	341*	374*	397*	397*	420*	420*	374*	341*	320*	298*	298*	298*	310*	
162	–	–	–	–	–	–	–	–	–	–	–	–	–	–	374*	341*	288*	288*	250*	231*	203*	177	177	177	177	177	177	177	188	177	188	188	177	177	177	177	177	177	177	177	177	177	177	177	177	
162	177	–	–	–	–	–	–	–	–	–	–	–	–	–	–	341	330	320	320	310	310	298	260	288	288	288	288	288	288	288	288	260	240	231	212	194	188	188	188	177	177	188	194	212	203	203	
177	177	154	177	–	–	–	–	–	–	–	–	–	–	–	–	–	–	492*	408*	397*	397*	397*	408*	420*	397*	385*	374*	374*	374*	352*	341*	320*	310	288*	288*	260*	250*	250*	240*	240*	231*	250*	250*	260*	298*	298*	
231*	231*	231*	231*	250*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	352	352	341	363	363	341	330	310	298	288	288	288	288	288	240	231	222	222	212	212	212	212	212	212	212	231	281	
146	146	154	146	146	146	154	194	–	–	–	–	–	–	–	–	–	–	–	–	420	397	374	374	374	341	330	320	310	310	310	288	260	250	240	231	231	231	212	212	212	212	222*	231*	491*	768*	
138	138	138	138	138	138	154	194	203	212	–	–	–	–	–	–	–	–	–	–	–	–	516	491	455	397	341	341	341	341	341	288	288	288	250	231	231	222	222	222	222	222	231	231	231	240	
177	177	177	177	177	177	194	222	231	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	330	320	298	298	298	298	288	250	231	212	212	212	222	231	222	231	231	231	
138	138	138	138	138	146	162	231	250	260	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	250	231	194	177	162	162	154	154	154	154	154	
130	130	130	130	130	130	130	122	122	122	122	122	122	122	122	122	130	146	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	240	231	231	212	203	
122	122	122	122	122	122	122	122	154	177	188	203	203	188	177	212	240	250	231	240	231	231	288	298	298	288	298	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
138	122	122	122	122	122	138	162	177	203	231	231	212	212	260	330	341	352	330	330	352	341	330	330	320	310	288	260	298	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
231	231	231	231	212	188	162	188	194	222	231	231	231	250	288	288	288	310	288	288	260	288	330	352	330	288	260	250	288	288	288	260	231	212	177	194	–	–	–	–	–	–	–	–	–	
–	–	260	222	177	154	154	177	194	212	222	203	203	250	310	310	310	330	341	310	310	330	330	352	341	310	288	298	288	288	288	260	250	222	212	203	203	194	194	194	–	–	–	–	–	
–	–	–	–	–	–	288	250	231	231	231	222	212	212	231	288	298	298	310	330	330	310	310	310	310	352	320	310	288	288	288	288	288	288	288	240	231	231	231	231	231	231	231	212	194	194	203	
–	–	–	–	–	–	–	–	–	–	–	288	231	250	288	–	–	–	–	138	138	130	122	122	122	122	122	122	122	138	138	146	154	154	146	138	138	138	138	138	138	138	138	130	130	122	122	
107	107	114	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	320	310	288	260	260	250	250	310	320	288	288	288	288	260	250	231	212	194	177	177	177	162	146	146	146	146	146	146	146	
114	114	114	114	114	114	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288	288	288	320	330	288	288	250	250	288	288	240	212	194	194	177	177	177	162	154	154	154	154	154	154	177	
114	114	114	114	114	114	122	138	–	–	–	–	–	–	–	–	–	–	–	–	–	288	288	288	320	330	288	288	250	250	288	288	240	212	194	194	177	177	177	162	154	154	154	154	154	154	
135	132	134	138	136	143	155	190	207	216	209	225	205	248	287	307	309	314	305	301	303	315	317	334	324	315	293	290	247	290	287	264	247	230	214	205	202	196	193	190	186	185	190	194	202	200

Mean of the 24 Hours - - - - - 215 Cubic Feet per Minute.

Note.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (~~759~~), also the Sunday Gaugings printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix II

S.

E V E N I N G.

2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
CUBIC FEET PER MINUTE.																																									
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	352	288	288	288	288	288	288	260	250	250	250	240	240	240	240	188	177	177	25	MARCH
77	162	177	177	177	194	212	212	222	288	–	–	–	–	–	–	–	–	–	–	–	288	288	288	288	374	240	240	203	177	177	102	154	154	154	154	154	146	138	26	
77	177	102	102	102	102	194	222	231	250	260	288	–	–	–	–	–	–	–	–	–	–	–	–	288	260	250	177	177	177	102	102	102	154	146	146	146	138	138	27	
04	194	194	177	203	203	212	240	250	260	260	260	260	260	250	250	260	–	–	–	–	–	–	–	–	310	288	288	260	212	194	177	177	177	177	162	162	162	154	28	
46	146	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	107	138	146	138	–	–	–	–	–	–	177	177	177	162	162	138	130	130	130	122	122	162	162	29
77	177	177	177	177	194	194	194	194	212	222	231	250	250	250	330*	374*	397*	420*	442*	479*	–	–	–	–	–	–	–	–	–	–	–	–	203	203	177	177	177	177	162	162	30
38	177	177	177	194	203	194	203	212	203	212	222	231	231	250	240	231	240	260	250	238	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	203*	203*	231*	177	162	31
																																								1
94	194	194	194	194	203	212	212	212	212	255	231	240	250	250	250	250	250	250	250	250	260*	260*	310*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
03	194	194	194	203	203	212	222	231	231	240	250	260	260	260	260	250	240	250	260	250	240	240	231	250	341	341	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
04	194	188	188	194	194	194	203	212	231	231	240	250	250	240	231	231	231	240	240	250	250	250	250	250	240	231	222	212	194	177	162	177	–	–	–	–	–	–	–	–	4
06*	754*	467*	397*	352*	330*	310*	310*	310*	310*	352*	385*	397*	408*	420*	467*	541*	631*	684*	710*	684*	609*	565*	541*	541*	541*	491*	455*	442*	430*	430*	397*	385*	397*	420*	442*	–	–	–	–	5
–	–	–	–	–	–	–	–	–	579*	541*	491*	467*	442*	442*	432*	408*	397*	397*	397*	385*	385*	374*	374*	374*	363*	352*	352*	352*	341*	341*	330*	330*	330*	320*	310*	310*	310*	310*	310*	310*	6
–	–	–	–	–	–	–	–	–	–	–	–	–	516	455	374*	352*	352*	352*	352*	363*	363*	310*	298*	310*	310*	310*	298*	288*	250*	231*	231*	231*	231*	231*	231*	222*	231*	231*	231*	231*	7
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	363*	352*	408*	455*	455*	442*	408*	374*	352*	352*	352*	374*	374*	397*	397*	385*	374*	374*	385*	374*	397*	374*	363*	341*	298*	8
18*	631*	726*	726*	–	–	–	–	–	–	–	–	–	–	–	–	–	553*	442*	397*	374*	352*	352*	341*	330*	352*	374*	363*	341*	310*	298*	288*	260*	250*	250*	250*	240*	240*	231*	231*	231*	231*	9
74*	374*	397*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	491	420	397*	352*	352*	330*	310*	310*	286*	288*	260*	250*	250*	250*	240*	231*	231*	231*	231*	231*	231*	10
10*	320*	288*	288*	240*	250*	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	298	250	240	231	203	212	203	203	194	188	188	177	177	177	177	177	177	11
74*	341*	320*	298*	298*	298*	298*	310*	352*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	307*	352*	330*	310*	288*	250*	240*	222	212	212	212	212	212	194	194	194	12
77	177	177	177	177	177	177	177	177	177	162	162	–	–	–	–	–	–	–	–	–	–	–	–	–	–	250*	212*	194*	194*	194*	194*	177	177	177	177	162	162	154	154	13
38	177	177	188	194	212	203	203	212	212	231	240	250	288	–	–	–	–	–	–	–	–	–	–	–	–	–	330*	298*	250*	250*	310*	420*	467*	491*	491*	455*	420*	374*	341*	320*	14
10*	240*	231*	250*	250*	260*	298*	298*	298*	352*	363*	397*	432*	455*	420*	420*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	310*	250*	231*	231*	212	194	194	194	188	177	177	15
12	212	212	212	212	212	231	291	212	320*	397*	408*	420*	420*	432*	442*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288*	240*	222	212	203	194	194	194	188	16
12	212	212	212	222*	231*	491*	768*	885*	1,053*	1,040*	899*	796*	754*	782*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	310	288	250	231	231	231	212	212	17
22	222	222	222	231	231	231	240	250	260	288	288	310	288	288	288	288	288	288	310	310	330	–	–	–	–	–	–	–	–	–	–	–	–	–	231	212	203	188	177	177	18
12	222	231	222	231	231	231	231	231	231	231	240	250	288	288	288	288	288	320	320	310	310	320	320	310	298	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
32	162	154	154	154	154	154	154	154	154	154	154	154	154	146	146	146	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	–	–	–	–	–	–	–	–	–	20
–	–	–	240	231	231	212	203	194	203	212	231	240	250	288	320	341	341	341	341	363	374	374	374	374	374	374	363	352	341	330	320	310	298	288	288	288	288	260	250	222	21
6	–	–	–	–	–	–	–	–	330	320	298	288	288	288	288	288	288	288	288	260	288	298	310	310	310	330	341	341	330	320	310	310	288	288	288	288	288	288	288	288	22
F	–	–	–	–	–	–	–	–	–	–	–	–	899*	870*	840*	726*	726*	726*	516*	455*	438*	397*	352*	341*	310*	288*	288*	250*	250*	231*	222*	203	203	194	188	188	177	177	177	177	177	23
14	194	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	374	352	320	310	288	288	260	260	260	260	240	240	240	212	188	194	194	177	177	177	177	177	154	154	146	24
17	177	177	177	177	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	310	250	231	231	240	240	231	212	194	194	203	194	194	188	188	177	154	138	138	138	25
11	231	231	231	212	194	194	203	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	203	114	146	138	130	122	122	122	122	122	122	114	114	114	26
38	138	138	138	130	130	122	122	122	177	194	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	260	240	222	194	177	162	146	138	138	138	138	138	138	27
46	146	146	146	146	146	146	146	146	162	162	177	194	212	212	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	188	177	154	145	138	138	138	138	138	28
42	154	154	154	154	154	154	154	177	188	203	203	222	231	231	231	231	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	APRIL
93	190	186	185	190	194	202	200	214	221	237	241	246	257	258	258	261	265	268	262	272	279	268	265	263	250	254	240	223	207	198	188	180	184	181	179	180	174	172	163	

ng at the Mean Results. *See* Explanation in Appendix III, Page 76.

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DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11
APRIL 29	130	130	130	122	122	122	122	122	122	122	122	122	114	114	114	114	114	114	114	107	107	107	107	114	122	154	177	194	–	–	–	–	–	–	–	–	–	–	–	–	565	618	516	491
APRIL 30	177	177	154	154	154	154	154	154	146	146	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	177	231	288	310	–	–	–	–	–	–	–	–	–	–	–	–	–	397
MAY 1	162	154	154	154	146	146	146	146	146	138	138	138	138	138	138	138	138	138	138	138	138	138	138	146	154	154	177	231	250	298	310	363	397	–	–	–	–	–	–	–	–	–	–	–	–
MAY 2	194	177	177	162	154	154	154	154	154	154	154	146	146	146	146	146	146	146	146	146	146	146	154	154	162	194	212	240	260	310	352	374	374	363	363	374	–	–	–	–	–	–	–	–	–
MAY 3	–	203	188	177	177	177	177	177	177	177	177	162	162	162	154	154	154	154	154	154	154	154	154	154	154	146	138	146	154	154	154	154	154	162	162	162	177	188	–	–	–	–	–	–	–
MAY 4	–	–	–	–	–	–	–	–	–	–	146	146	138	138	138	138	138	138	138	138	138	138	138	138	154	162	177	212	240	250	250	260	288	330	341	341	341	341	330	330	363	374	385	385	374	352
MAY 5	162	162	–	–	–	–	–	–	–	–	–	–	–	–	–	–	188	177	177	–	194	177	162	146	146	146	154	194	212	222	298	352	374	385	385	374	374	374	374	397	432	420	516	528	455	374	352
MAY 6	154	154	146	146	138	138	138	–	–	–	–	–	–	–	–	–	–	–	–	–	–	194	–	–	102	177	194	222	250	288	330	330	330	352	374	374	374	397	420	363	385	455	442	363	352
MAY 7	177	162	154	154	146	138	138	138	138	138	–	–	–	–	–	–	–	–	–	–	–	–	194	177	177	162	194	203	240	288	288	298	310	330	330	352	352	374	385	397	397	455	432	420	397	374
MAY 8	162	154	138	138	138	138	138	130	130	130	122	122	–	–	–	–	–	–	–	–	–	–	–	–	212	212	212	212	288	288	310	310	352	341	341	368	374	374	455	455	467	303	385	374	363
MAY 9	154	145	145	145	138	138	130	130	130	130	130	130	130	130	–	–	–	–	–	–	–	–	–	–	–	–	341	352	374	352	352	330	320	320	352	374	397	397	341	352	352	352	363	363	341
MAY 10																																												
MAY 11																																												
MAY 12																																												
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MAY 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MAY 17	177	154	154	146	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	146	146	–	–	–	–	–	–	–	–	–	–	–	–
MAY 18	–	–	138	130	130	130	130	130	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	130	138	154	177	188	203	222	250	288	320	341	352	320	320	310	288	–	–	–	–	–
MAY 19	–	–	–	–	–	177	177	162	154	154	154	154	154	140	138	138	138	138	130	130	130	122	122	122	122	130	154	177	194	203	212	250	260	341	374	374	352	352	352	352	374	397	442	467	467
MAY 20	–	–	–	–	–	–	–	–	–	–	–	177	162	146	138	130	122	122	122	122	114	114	114	114	122	140	162	177	212	250	288	288	330	352	352	341	352	374	397	442	467	467	432	397	385	330
MAY 21	162	162	–	–	–	–	–	–	–	–	–	–	–	–	–	–	222	188	154	138	130	130	122	122	122	130	154	177	194	260	298	310	341	374	352	341	330	330	330	352	408	455	455	442	352
MAY 22	177	162	154	154	154	154	–	–	–	–	–	–	–	–	–	–	–	–	–	222	212	177	154	138	130	138	162	177	240	298	310	320	352	374	374	341	330	330	352	408	455	479	491	442	385	341
MAY 23	203*	194*	188*	177*	177*	162*	154	154	154	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	605*	516*	467*	432*	442*	455*	397*	408*	397*	397*	397*	385*	397*	397*	442*	491*	516*	528*	516*	491*	397*	374*
MAY 24	177	177	177	177	177	162	154	154	146	146	146	146	146	146	146	–	–	–	–	–	–	–	–	–	–	–	–	–	231	212	188	177	154	154	154	146	146	146	146	154	154	154	162	162	177	177
MAY 25	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	–	–	–	–	–	–	–	–	–	–	–	–	352	330	330	330	330	320	310	260	250	330	397	420	397	374	330
MAY 26	231*	222*	203*	188*	177*	162*	154	154	146	138	138	138	138	138	138	138	138	130	130	130	130	138	138	138	–	–	–	–	–	–	–	–	432	397	374	374	374	397	442	479	516	491	442	374	341
MAY 27	177	162	154	154	154	154	154	154	154	154	154	146	138	130	130	130	122	122	122	122	122	122	122	122	130	138	138	146	–	–	–	–	–	–	–	363	365	442	467	491	491	442	374	341
MAY 28	177	177	177	177	177	162	154	138	138	138	138	138	138	130	130	130	122	122	122	122	122	122	122	122	130	138	146	154	177	194	222	240	–	–	–	–	–	–	479	491	491	467	408	374
MAY 29	177	177	162	154	154	154	154	138	138	138	138	138	130	130	130	122	122	122	122	122	122	122	122	122	138	154	162	177	194	203	212	260	320	341	–	–	–	–	–	–	–	432	397	352
MAY 30	–	177	177	162	154	154	154	154	154	154	154	162	250	240	212	203	198	198	188	162	154	146	138	138	154	188	194	194	222	260	320	341	363	374	352	352	352	341	–	–	–	–	–	–	–
MAY 31	–	–	–	–	154	154	154	154	154	154	146	138	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	146	154	154	162	177	177	162	–	–	–	–
JUNE 1	–	–	–	–	114	114	114	114	114	114	114	114	107	107	107	107	107	107	107	107	107	107	107	122	138	146	154	203	231	260	260	260	288	310	310	310	310	310	341	363	397	–	–	–	–
JUNE 2	–	–	–	–	–	–	–	–	–	130	130	130	130	130	130	138	138	130	122	122	122	122	122	130	138	177	177	194	194	194	212	222	260	374	352	330	330	330	330	432	467	467	467	467	467
JUNE 3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	122	122	122	114	107	107	107	107	107	130	145	154	162	222	288	288	288	288	310	310	330	341	352	352	408	467	432	385	374	374
JUNE 4	177	177	177	177	177	–	–	–	–	–	–	–	–	–	–	–	122	122	122	122	122	122	122	138	154	177	194	231	240	288	320	352	374	352	352	352	352	330	330	374	442	432	397	363	341
JUNE 5	177	177	177	177	177	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	138	138	138	138	138	154	188	212	231	250	298	320	330	320	310	320	330	330	352	374	408	455	467	397	363	341
JUNE 6	145	138	138	138	138	138	130	130	130	–	–	–	–	–	–	–	–	–	–	–	–	–	–	222	231	231	231	250	260	288	288	310	310	320	320	330	330	330	352	374	408	455	467	397	363	341
JUNE 7	231*	222*	212*	194*	194*	194*	194*	194*	203*	194*	188*	188*	194*	194*	203*	250*	341*	541*	–	–	–	–	–	–	–	–	–	–	250*	250*	231*	222*	203*	203*	203*	203*	212*	212*	212*	212*	240*	288*	330*	352*	363*	491*
JUNE 8	122	130	130	122	122	122	122	122	122	122	122	122	122	122	122	122	122	–	–	–	–	–	–	–	–	–	–	–	231	250	288	288	288	228	208	310	310	310	310	352	397	397	374	363	352	341	341
JUNE 9	177	177	177	162	154	154	154	145	145	138	138	138	138	130	122	122	122	122	122	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	442	420	492	442	420	397	442	479	455	432	408	397
JUNE 10	260*	250*	240*	222*	212*	212*	203*	194*	177*	177*	162	154	154	154	154	145	145	138	138	138	138	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	467	491	516	516	516	479	467	442	408	363
JUNE 11	177	162	162	138	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	432	397	397	397	374	352
JUNE 12	154	154	154	145	138	122	122	122	122	122	122	114	107	107	107	107	107	107	107	107	107	107	107	107	130	138	138	154	–	–	–	–	–	–	–	–	–	–	–	455	455	467	479	491
JUNE 13	154	154	154	145	138	138	130	122	122	122	122	122	122	114	114	114	107	107	107	107	107	107	107	107	107	114	130	154	177	188	250	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUNE 14	162	154	138	138	130	130	130	130	130	130	130	130	130	130	130	130	122	122	114	107	107	107	107	114	114	114	107	114	114	122	122	122	122	–	–	–	–	–	–	–	–	154	154	154	–
JUNE 15	122	122	122	114	114	107	107	107	107	107	107	107	107	107	107	107	100	100	100	100	93	93	100	107	114	122	138	154	162	177	222	250	260	288	298	298	–	–	–	–	–	–	–	–	–
JUNE 16	194	188	177	154	145	145	138	138	130	130	122	122	122	122	122	122	122	114	114	107	107	107	107	122	138	154	162	177	222	260	288	310	341	352	330	341	352	–	–	–	–	–	–	–	–
JUNE 17	–	–	–	–	194	177	154	145	130	122	122	114	107	107	107	93	93	9	93	93	93	93	100	122	138	154	162	177	222	260	288	341	397	397	374	330	330	350	397	420	–	–	–	–	–
JUNE 18	–	–	–	–	–	–	–	–	154	138	130	130	122	122	114	114	114	107	107	107	107	107	107	107	130	154	154	177	212	250	288	330	341	341	330	310	298	363	374	420	432	420	397	352	330
JUNE 19	–	–	–	–	–	–	–	–	–	–	–	–	138	138	138	130	130	122	114	114	107	107	107	107	138	154	162	177	188	212	288	310	374	374	320	310	298	310	363	408	442	442	420	374	330
JUNE 20	162	154	154	–	–	–	–	–	–	–	–	–	–	–	–	–	899*	739*	710*	455*	397*	374*	352*	330*	352*	363*	374*	420*	516*	516*	516*	579*	618*	579*	516*	504*	479*	467*	516*	516*	528*	579*	516*	432	374
JUNE 21	154	154	154	154	154	154	154	154	154	154	145	–	–	–	–	–	–	–	–	–	310*	260*	341*	565*	1,117*	1,401*	1,614*	1,614*	1,435*	1,231*	1,006*	840*	768*	684*	541*	504*	455*	420*	374*	363*	330*	298*	288*	288*	288*
JUNE 22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	341	–	–	–	–	–	–	–
	162	159	154	148	145	140	138	136	135	133	134	132	133	132	129	127	127	125	124	123	123	122	130	130	147	164	180	210	242	270	300	316	340	345	341	345	350	360	381	418	444	445	418	388	362

MEAN OF TH

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunda

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

COUNTER'S CREEK SEWER (Inclusive of the Kensington Branch).

EVENING.

DATE.	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	45
	CUBIC FEET PER MINUTE.																																															
FEBRUARY 13	–	–	–	–	–	–	–	–	–	565	618	516	491	468	574	574	330	310	288	260	250	250	260	288	288	298	288	250	250	250	250	231	250	250	288	298	310	310	298	288	288	288	298	330	320	310	310	366
14	–	–	–	–	–	–	–	–	–	–	–	–	397	374	352	352	330	310	298	260	250	250	260	310	341	341	310	288	240	231	231	231	250	260	288	310	320	320	320	310	310	310	330	330	320	298	–	–	612
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	225
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	504
17	397	–	–	–	–	–	–	–	–	–	–	–	–	–	352	341	320	288	250	231	231	231	231	250	250	250	250	240	231	231	240	250	288	288	298	310	310	310	310	288	288	288	288	288	288	288	288	288	372
18	374	363	363	374	–	–	–	–	–	–	–	–	–	–	–	–	–	–	330	260	260	250	260	288	288	288	288	288	260	298	310	310	310	320	330	341	341	330	341	341	341	341	341	363	341	310	384	
19	154	162	162	102	177	188	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	222	203	194	194	194	194	194	194	194	194	194	194	194	194	194	194	177	177	162	154	177	188	2(	–
20	330	341	341	341	341	330	330	363	374	385	385	374	352	310	288	350	330	330	330	310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2(	489
21	385	385	374	374	374	374	374	374	510	528	455	374	352	330	350	330	330	330	288	260	250	250	250	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2(	384
22	330	352	374	374	374	397	420	363	385	455	442	363	352	330	330	330	397	455	298	288	288	288	288	260	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	330
23	330	330	352	352	374	385	397	397	455	432	420	397	374	341	341	363	397	298	288	288	288	288	288	288	310	260	260	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	306
24	352	341	341	352	374	374	374	455	407	363	385	374	363	341	330	288	288	260	260	250	250	288	288	288	288	260	250	250	250	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	318
25	320	320	341	368	374	374	374	455	407	363	385	374	363	341	341	330	288	260	250	288	288	288	288	288	288	260	260	250	250	250	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	408
26																																															
27																																															
28																																															
MARCH 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(
2	146	146	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(
3	320	341	352	320	320	310	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(
4	374	374	352	352	352	352	374	397	442	467	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(
5	352	352	341	352	374	397	442	467	467	492	397	385	330	330	320	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(
6	374	352	341	330	330	330	374	397	420	455	455	442	352	330	310	310	310	310	310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(
7	374	374	341	330	330	352	408	455	470	491	442	385	341	330	352	385*	307*	420*	455*	401*	541*	605*	618*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(
8	397*	397*	385*	397*	397*	442*	491*	516*	528*	516*	491*	397*	374*	341	330	341	341	330	298	250	240	208	310	330	330	310	298	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(
9	154	146	146	146	146	154	154	154	154	162	162	177	177	177	177	177	188	177	188	188	188	188	177	177	177	177	177	162	162	162	162	162	162	162	162	162	154	154	154	154	154	154	154	146	146	14	–
10	330	330	330	320	310	260	250	330	397	420	397	374	330	310	330	298	341	310	288	250	231	231	240	250	260	250	240	231	231	231	222	222	222	231	250	288	298	298	260	260	240	231	231	231	260	26	330
11	–	432	397	374	374	397	442	479	516	491	442	374	341	330	330	330	320	310	310	260	250	250	260	250	250	240	250	240	240	250	288	288	288	310	310	310	310	310	288	288	250	250	250	260	330	31	306
12	–	–	–	–	–	–	–	–	491	442	442	374	341	310	310	310	320	310	288	250	250	260	260	250	250	250	250	240	250	240	240	250	288	298	310	310	310	310	298	–	–	–	–	–	–	31	318
13	–	–	–	–	–	–	–	479	491	491	467	408	374	330	320	320	310	310	288	250	240	260	260	250	250	240	250	240	240	250	288	288	298	310	330	330	320	310	288	288	250	250	250	250	288	38	408
14	–	–	–	–	–	–	–	–	–	432	397	352	330	310	310	320	310	310	288	250	240	250	260	250	250	240	250	231	240	250	288	288	298	298	310	330	330	320	310	288	288	250	250	250	250	298	3(	279
15	320	341	–	–	–	–	–	–	–	–	–	–	–	–	–	–	341	310	288	250	240	250	260	250	250	240	250	240	240	250	288	288	298	310	330	330	330	310	288	288	260	260	260	260	260	260	3(	408
16	303	374	374	352	352	352	352	352	352	352	352	352	352	352	352	352	330	298	288	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	3(	408
17	288	310	310	330	341	352	352	408	467	432	385	374	374	352	330	320	310	288	288	250	250	240	231	231	231	222	222	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2(	240
18	374	352	352	352	352	330	330	374	442	432	397	363	341	320	310	310	310	288	250	250	250	250	250	240	231	231	222	222	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	408
19	330	320	310	320	330	374	397	467	491	455	385	363	341	341	330	330	298	288	250	250	250	250	250	231	222	222	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	516
20	320	320	330	330	330	352	374	408	455	467	397	363	341	320	310	310	310	288	250	250	250	250	250	250	231	222	222	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	
21	203*	203*	203*	212*	212*	212*	212*	240*	288*	330*	352*	363*	491*	516*	528*	491*	479*	408*	374*	341*	341*	330*	288*	250*	240*	222*	212*	212*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	
22	228	208	310	310	310	352	397	397	374	363	352	341	341	310	310	310	374	352	341	330	330	330	330	310	298	288	288	288	288	250	231	231	231	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	
23	–	442	420	492	442	420	397	442	479	455	432	408	397	374	374	374	352	330	320	298	288	288	288	260	260	260	260	260	250	240	231	212	212	203	203	–	–	–	–	–	–	–	–	–	–	–	3(	
24	–	–	–	467	491	516	516	516	479	467	442	408	363	363	352	352	352	330	298	288	288	288	260	250	250	231	222	212	212	212	212	231	240	250	250	250	250	250	250	250	250	250	250	250	250	250	3(	
25	–	–	–	–	–	–	–	432	397	397	397	397	374	352	352	320	298	298	288	250	240	240	250	250	231	222	212	212	212	212	212	231	240	250	250	250	250	250	250	250	250	250	250	250	250	250	3(	
26	–	–	–	–	–	–	–	–	455	455	407	479	491	479	442	408	307	288	260	250	250	250	250	250	250	222	212	212	212	212	222	240	250	260	260	260	260	260	260	260	260	260	260	260	260	260	3(	
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288	260	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	260	260	260	260	260	260	260	260	260	260	260	260	260	3(	
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288	260	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	260	260	260	260	260	260	260	260	260	260	260	260	260	3(	
APRIL 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288	260	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	260	260	260	260	260	260	260	260	260	260	260	260	260	3(	
2	122	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288	260	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	260	260	260	260	260	260	260	260	260	260	260	260	260	3(	
3	286	298	–	–	–	–	–	–	–	–	–	–	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	3(	
4	341	352	330	341	352	–	–	–	–	–	–	–	–	363	330	320	288	250	231	222	212	231	231	231	222	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	3(	
5	397	397	374	330	330	330	350	397	420	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3(	
6	341	341	330	310	298	363	374	420	432	420	397	352	330	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2(	
7	374	374	320	310	298	310	363	408	442	442	420	374	330	298	288	250	240	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2(	
8	618*	579*	516*	504*	470*	467*	516*	516*	528*	579*	516*	432	374	330	320	341	352	352	330	310	298	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2(	
9	768*	684*	541*	504*	455*	420*	374*	363*	330*	298*	288*	288*	288*	288*	288*	288*	266*	250*	240*	231*	231*	231*	222*	222*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2(	516
10	–	–	–	–	341	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2(	338
11																																															
12																																															
13																																															
	340	345	341	345	350	360	381	418	444	445	418	388	362	342	332	326	322	322	295	275	258	261	263	266	268	262	250	245	230	238	240	253	255	277	277	288	290	288	285	283	276	275	279	287	295	295	2(	413

MEAN OF THE 24 HOURS - - - - 242 CUBIC FEET PER MINUTE.

Gaugings marked with a *Star*, and those struck through with a Black Line, thus (759), also the Sunday Gaugings printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III, Page 76.

APPENDIX G.

MINUTE.

DATE.	45	30	15	7	45	30	15	8	45	30	15	9	45	30	15	10	45	30	15	11	45	30	15	45
APRIL 29	320	320	310	310	—	—	—	—	—	—	—	—	—	—	—	—	—	—	203	194	194	194	194	188
APRIL 30	330	330	298	320	260	288	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260
MAY 1	288	288	288	288	260	200	260	288	260	200	260	260	260	200	260	260	260	260	260	260	260	260	260	260
MAY 2	363	341	310	341	288	298	260	288	288	298	260	260	260	260	260	260	260	260	260	260	260	260	260	260
MAY 3	177	162	177	154	177	177	177	177	177	177	177	194	177	177	177	194	177	177	177	162	177	177	177	177
MAY 4	240	250	288	260	260	250	250	250	250	250	250	231	240	250	250	231	240	250	250	177	240	250	250	250
MAY 5	288	288	288	320	310	310	310	240	250	268	250	250	250	268	250	250	250	268	250	177	250	268	250	250
MAY 6	330	320	298	320	310	310	310	310	288	288	260	231	250	288	231	231	231	288	231	177	231	288	231	231
MAY 7	360	352	310	310	288	310	310	288	288	288	260	212	231	288	231	212	231	288	231	177	231	288	231	231
MAY 8	138	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 16	194	194	212	194	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAY 20	162	162	162	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	177	194	194	194	194
MAY 21	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194
MAY 22	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*	212*
MAY 23	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
MAY 24	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192
MAY 25	250*	260*	288*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*
MAY 26	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
MAY 27	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
MAY 28	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
MAY 29	177	188	177	177	177	188	177	177	177	188	177	177	177	188	177	177	177	188	177	177	177	188	177	177
MAY 30	250*	320*	352*	288*	288*	320*	352*	288*	288*	320*	352*	288*	288*	320*	352*	288*	288*	320*	352*	288*	288*	320*	352*	288*
MAY 31	374*	491*	420*	374*	420*	491*	420*	374*	420*	491*	420*	374*	420*	491*	420*	374*	420*	491*	420*	374*	420*	491*	420*	374*
JUNE 1	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212
JUNE 2	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 3	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 4	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 5	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154
JUNE 6	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*	231*
JUNE 7	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 8	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 9	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 10	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 11	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163
JUNE 12	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154
JUNE 13	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154
JUNE 14	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 15	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 16	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 17	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 18	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 19	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 20	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162
JUNE 21	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
JUNE 22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	279	287	295	295	291	282	260	272	277	260	251	237	219	209	203	195	187	187	183	178	174	173		

In a Black.—Sess. 2.

CUBIC FEET.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45
FEBRUARY 18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	477	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	369	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MARCH 1	306	354	330	279	288	279	279	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	462	462	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480
3	354	354	330	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	330	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	270	306	279	279	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
13	306	306	279	279	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
14	330	330	279	279	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
15	552	576*	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
16	480	519*	480*	480*	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
17	480	552	384	300	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
18	300	—	295	295	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
19	—	—	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
20	—	—	—	—	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	384	384	306	306	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
28	306	306	252	204	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
29	240	240	462	462	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
30	462	462	408	408	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
APRIL 1	516	516	480	480	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462
2	330	306	306	306	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279
3	—	—	—	—	306	306	306	306	306	306	306	306	306	306	306	306	306	306	306	306	306	306	306	306
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	516	516	270	270	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	306	306	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
APRIL 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

RANELAGH SEWER.

MORNING.

CUBIC FEET PER MINUTE.

	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30
APRIL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	885	1,134	885	885	1,038	1,038	870	1,593	1,524	1,038	1,116	1,362	1,002	987	1,002	987	1,056	1,056	1,098	1,056	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	516	504	546	540	540	540	540	540	516	516	516	516	504	504	318	318	318	330	330	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	852	885	1,002	1,020	1,038	1,038	870	828	852	870	885	885	852	987	885	987	1,020	1,020	1,020	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,116	1,020	984	1,080	1,038	852	852	885	1,005	1,020	1,005	1,005	1,005	1,005	972	1,098	1,056	1,056	1,056	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	885	990	1,080	1,080	1,098	1,134	1,182	1,134	1,080	1,032	1,134	1,182	1,398	1,116	1,062	1,062	1,062	1,032	99	
	240	240	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	990	1,062	1,098	1,020	1,062	852	990	1,020	1,020	990	1,020	1,020	990	852	852	780	852	852	8	
	204	204	204	204	204	204	204	306	465	489	465	384	252	279	465	552	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,020	1,020	984	984	1,020	984	885	852	852	852	885	852	78	
	–	–	–	–	–	516	612	579	579	552	642	711	612	612	780	579	552	489	489	552	552	552	552	552	552	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,068	1,068	990	990	990	1,020	1,0	
	–	–	–	–	–	–	–	–	–	489	403	489	465	489	552	552	795	885	1,020	1,020	984	984	984	984	1,020	1,062	984	984	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	408	306	384	516	576	711	885	990	852	885	885	852	990	852	1,182	810	1,068	1,020	990	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	354	462	552	750	816	885	885	816	750	750	816	990	612	816	1,062	1,020	990	1,020	1,098	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	580	612	750	780	780	780	780	780	780	852	1,062	990	990	885	990	1,380	1,416	1,020	852	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	780	852	885	852	750	711	750	816	552	684	816	552	852	552	852	552	684	816	816	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	516	489	489	516	552	711	885	1,098	1,398	1,338	1,182	1,980	1,467	1,360	1,203	1,098	1,134	1,134	1,134	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	354	330	354	354	354	384	408	384	384	384	354	354	330	330	306	306	306	279	279	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	750	780	885	990	852	816	885	852	852	852	852	852	852	816	852	852	852	8	
	252	252	225	225	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,134	1,134	1,134	1,062	1,062	1,098	990	990	990	990	990	852	816	816	816	795	795	8	
	204	204	252	279	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,062	1,020	1,020	885	990	1,062	1,020	990	885	885	8			
	162	162	144	144	144	144	306	576	615	576	552	462	354	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,020	1,020	1,020	1,062	1,020	1,020	1,020	1,020	1,002	990	885	852	852	852	8	
	123	384	540	330	279	225	225	330	279	552	552	462	330	384	552	576	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	816	852	852	885	8	
	–	–	–	252	279	279	306	306	306	306	384	330	330	462	489	489	552	552	489	489	552	576	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,020	1,062	1,0	
	–	–	–	–	–	–	–	384	384	552	552	408	252	225	306	408	552	408	408	852	1,020	1,020	885	780	852	885	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	516	552	384	330	408	540	576	615	780	852	816	750	684	684	816	990	1,182	1,134	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	408	552	615	615	750	852	885	816	750	684	750	852	1,020	1,062	990	885	990	1,062	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	780	885	1,020	780	576	816	750	1,020	1,182	1,164	1,020	1,020	1,020	1,062	1,020	852	780	780	885	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	684	684	780	684	615	1,098	1,038	1,020	1,002	1,020	1,062	1,020	990	990	852	816	852	1,338*	1,062*	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,596*	1,506*	1,590*	1,548*	1,506*	1,506*	1,590*	1,506*	1,416*	1,338*	1,134*	1,062*	1,020*	1,020*	1,020*	1,098*	1,338*	1,467*	1,590*	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,064*	2,022*	1,524*	1,338*	1,098*	1,134*	1,020*	1,020*	990*	1,020*	1,134*	1,062*	1,062*	1,020*	1,020*	1,020*	1,134*	1,134*	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	852	990	870	816	1,338	990	852	816	816	885	885	1,590	1,338	990	990	990	852	852	852	–	–	–	–	–
	408*	462*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,062	1,008	1,062	990	852	852	885	966	990	1,020	990	990	1,020	1,062	990	852	885	870	8	
	396*	369*	354*	354*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	990	990	990	852	834	852	852	852	852	816	885	990	885	885	852	8			
	225	225	225	225	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,020	1,020	990	990	1,020	1,020	1,062	1,020	1,020	990	966	966	870	8	
	225	225	225	204	204	204	252	225	279	306	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,020	1,020	990	966	966	885	966	966	885	8	
	–	204	204	204	204	225	306	354	384	384	384	306	306	384	516	564	591	768	990	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	885	885	885	990	990	990	1,038	1,080	1,080	1,020	1,062	1,098	1,134	1,020	9
	225	225	225	225	225	225	225	279	462	552	615	540	369	432	615	615	852	795	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	279	279	279	279	306	306	3
	–	–	–	–	–	–	195	225	384	552	552	306	306	330	516	576	615	816	885	1,062	1,020	885	852	852	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	384	384	462	552	552	750	780	990	1,020	1,020	885	885	990	1,062	1,062	1,020	1,020	990	990	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	615	615	780	885	990	852	852	816	780	852	990	1,002	1,002	1,020	1,020	1,134	1,338	1,098	990	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,020	966	885	885	885	990	990	966	990	1,062	1,080	1,062	966	885	1,020	1,062	1,098	1,062	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	684*	615*	615*	552*	462*	462*	408	384	384	354	354	306	306	279	279	279	252	252	252	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	750	684	780	816	990	1,098	1,098	1,062	990	1,062	990	990	990	852	852	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	885	1,020	1,182	1,062	990	1,020	1,134	1,098	1,020	990	1,020	1,062	1,038	1,098	1,116	1,098	1,098	1,098	1,038	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	885	852	816	852	885	885	990	1,020	1,020	1,020	1,062	1,098	1,062	1,020	–	–	990	8			
	225	225	225	225	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,416*	1,311*	1,134*	1,338*	1,359*	1,380*	1,338*	1,311*	1,293*	1,098	1,098	1,062	990	990	990	990	990	9	
	225	225	225	225	225	225	225	225	225	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,416*	1,359*	1,338*	1,293*	1,098	1,098	1,062	990	990	990	990	990	9	
	3,060*	2,594*	2,350*	2,292*	2,118*	2,594*	3,582*	4,488*	5,262*	–	–	5,454*	5,316*	5,316*	5,124*	5,070*	5,124*	5,316*	5,454*	5,592*	–	5,316*	5,124*	5,124*	5,124*	5,124*	–	–	–	–	–	–	–	–	–	–	–	–	–	2,337*	1,965*	1,686*	1,548*	1,548*	1,506*	1,506*	1,467*	1,4	
	–	780*	780*	780*	780*	816*	816*	885*	990*	1,098*	990*	1,020*	990*	1,062*	1,098*	1,062*	1,134*	1,416*	1,467*	1,467*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,682*	2,658*	2,594*	2,350*	1,965*	1,965*	1,9	
	–	–	–	330	330	330	369	552	615	750	738	615	576	750	780	852	852	1,098	1,338	1,098	990	990	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	552	552	576	576	576	552	552	684	750	780	990	1,098	1,020	885	852	852	885	1,020	1,020	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	516	552	615	615	852	885	1,002	1,467*	1,686*	2,904*	3,342*	3,534*	3,462*	2,904*	2,594*	2,350*	1,965*	1,722*	1,686*	1,590*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,002	1,062	1,359	1,440	1,467	1,380	1,380	1,416	1,416	1,416	1,416	1,380	38 0	1,416	1,359	1,338	1,293	1,293	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	852	852	1,038	1,134	1,197	1,062	1,182	1,416	1,632	1,590	1,506	1,416	1,416	1,467	1,596	1,590	1,590	1,590	1,965*	2,118*	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	208	232	247	238	230	225	257	378	460	544	539	448	386	430	564	650	742	848	958	966	908	851	852	904	959	1,006	1,036	1,046	1,011	1,022	1,097	1,108	1,033	970	950	975	1,030	1,006	983	1,015	1,028	1,005	977	944	943	947	915	9

MEAN OF THE 24 HOURS - - 642 CUBIC FEET PER MINUTE.

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings, printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 76.

EVENING.

CUBIC FEET PER MINUTE.

DATE.	5	7	10	10	65	86	60	10	10	17*	409*	920	1	2	3	4	5	6	7	8	9	10	11	12	13
MARCH																									
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

DATE.	8	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45
APRIL																																						
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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DATE.	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
FEBRUARY																																														
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2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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DATE.	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45
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W. B. Hack, Engineer.

esults. *See* Exhumation in Appendix III., page 76.

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C U B I C F E E T P E R M I N U T E.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45
FEBRUARY 13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,424	1,475	1,
14	565	498	498	498	430	430	430	–	410	430	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,542	1,542	1,
15	565	450	450	410	386	430	430	410	335	335	335	335	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	370	354	354	354	354	354	354	410	335	386	386	386	386	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	739	739	739	679	679	408	430	386	386	386	386	386	386	354	354	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	739	739	720	720	606	565	498	386	370	370	370	370	370	354	335	335	335	335	335	335	320	320	320	320	320	320	320	320	320	410	657	797	860	942	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	386	386	354	–	–	518	354	335	320	320	335	320	320	320	386	386	386	370	335	335	295	295	295	280	295	295	335	335	320	320	320	320	354	354	354	354	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	335	335	295	295	295	295	295	280	295	320	335	335	320	320	320	320	320	624	295	679	700	739	860	860	942	10,17
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,304	1,187	624	679	700	739	860	860	942	1,017	1,255	1,328	1,424	1,475	1,305	1,328
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,187	1,187	1,187	1,187	1,074	1,328	1,328	1,424	1,475	1,370	1,370	1,370	1,370	1,424	1,450	1,
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	965	965	1,187	1,255	1,164	1,187	1,255	1,255	1,304	1,304	1,450	1,
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,370	1,187	1,187	1,255	1,328	1,424	1,370	1,370	1,515	1,
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,187	1,782	1,756	1,756	1,782	1,943	1,782	1,
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,187	1,187	1,328	1,328	1,573	1,
27	700	518	679	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28	498	498	498	498	518	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	700	624	797	1,
MARCH 1	518	386	370	370	370	320	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	295	295	295	295	295	295	295	295	295	295	280	295	295	295	205	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	320	295	295	295	295	295	295	295	354	335	335	337	320	320	280	280	280	280	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	430	386	386	386	386	354	354	354	565	548	587	565	548	548	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	606	606	606	606	565	498	498	498	295	335	335	335	320	320	320	320	335	320	295	205	205	205	320	320	295	335	320	320	354	518	840	900	987	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	450	386	354	354	320	320	295	295	295	386	386	386	386	370	370	430	410	498	518	1,255	1,255	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	498	410	410	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14	386	386	370	370	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15	797*	624*	624*	450*	386	386	386	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	386	386	386	386	386	–	–	–	679	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	386	386	386	386	386	354	354	354	370	370	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	624	587	587	587	548	410	370	370	370	370	370	498*	587*	707*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	386	386	386	386	335	354	386	450*	707*	565*	565*	450*	450*	450*	450*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	1,782*	2,876*	3,129*	2,012*	1,782*	450*	1,017*	1,017*	707*	565*	354	354	354	354	335	354	354	370	370	370	354	386	386	386	386	386	386	587	719	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	660	860	739	624	548	386	354	354	–	–	765	450	320	320	320	335	335	320	320	335	335	320	354	354	295	265	386	518	518	518	565	624	860	860	920	920	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	920	707	765	624	548	386	354	354	386	386	548	548	430	819	860	860	987	987	1,074	1,074	1,187	1,187	1,280	1,395	1,475	–	–	–
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	624	587	548	354	–	–	–	498	354	624	679	679	819	987	987	1,074	1,395	1,395	1,424	1,450	1,475	1,475	1,475	1,475	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	920	860	1,017	1,187	1,255	1,255	1,304	1,370	1,424	1,424	1,475	1,370	1,
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,187	1,304	1,304	1,450	1,280	1,450	1,450	1,280	1,304	1,370	1,370	1,450	1,
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,424	1,424	1,304	1,304	1,424	1,424	1,542	1,542	1,
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	819*	739*	–	–	1,187	1,187	1,
28	386	386	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,475	1,475	1,
29	410	386	386	386	386	386	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30	335	320	335	330	320	320	320	320	320	320	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
31	430	430	430	354	354	354	354	354	320	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
APRIL 1	450	410	410	354	354	354	335	335	354	354	354	354	354	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	518	450	430	370	370	335	335	335	335	335	354	354	354	386	386	386	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	–	–	–	624	518	386	370	370	–	410	335	320	320	320	320	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335
4	–	–	–	–	–	–	–	–	–	–	–	–	–	1,475*	1,395*	2,573*	2,573*	3,097*	2,723*	2,395*	2,290*	2,018*	1,943*	1,601*	1,697*	2,080*	2,940*	3,060*	2,542*	2,470*	2,363*	2,363*	2,363*	2,050*	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	624	450	410	410	410	410	410	430	450	587	840	860	920	860	926	1,187	1,255	1,328	1,424	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	606	498	386	450	518	679	965	1,050	1,187	1,187	1,255	1,328	1,370	1,475	1,515	1,542	1,601	1,475	1,395	1,475	1,601	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	679	679	518	860	942	987	1,074	1,255	1,328	1,395	1,395	1,542	1,601	1,475	1,395	1,475	1,601	2,
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	624	900	1,017*	1,280*	1,328*	1,542*	1,026	1,626*	2,107*	5,017*	5,110*	5,525*	5,197*	4,314*	4,150*	2,
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,475	1,424	1,424	1,424	1,475	1,395	1,328	1,328	1,395	1,475	1,395	1,515	1,573	1,
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,328	1,328	1,304	1,328	1,328	1,280	1,424	1,475	1,475	1,475	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	472	438	470	430	426	391	376	377	368	366	360	357	359	333	333	325	337	344	347	342	334	328	345	347	351	348	398	449	441	551	744	824	962	1,022	1,143	1,258	1,247	1,284	1,386	1,410	1,429	1,424	1,455	1,521	1

MAY 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

JUNE 1 2 3 4 5 6 7 8 9 10 11 12 13

MEAN O

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (75

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

KING'S SCHOLARS' POND SEWER.

EVENING. CUBIC FEET PER MINUTE.

DATE.	8	8:30	8:45	9	9:15	9:30	9:45	10	10:15	10:30	10:45	11	11:15	11:30	11:45	12	12:15	12:30	12:45	1	1:15	1:30	1:45	2	2:15	2:30	2:45	3	3:15	3:30	3:45	4	4:15	4:30	4:45	5	5:15	5:30	5:45	6	6:15	6:30	6:45	7
MARCH	–	–	–	–	–	–	–	–	–	1,424	1,475	1,542	1,475	1,475	1,424	1,328	1,255	1,255	1,304	1,395	1,395	1,370	1,304	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	1,542	1,542	1,914	1,782	1,730	1,730	1,601	1,424	1,370	1,370	1,424	1,475	1,450	1,450	1,450	498	498	518	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	587	587	606	565	587	565	565	548	518	518	518	518	518	498	1,370	1,255	1,187	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	1,542	1,515	1,424	1,395	1,187	1,187	1,255	1,328	1,328	1,328	1,328	1,328	1,424	1,475	1,395	1,328	1,328	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	1,626	1,626	1,542	1,515	1,370	1,370	1,280	1,370	1,515	1,515	1,515	1,515	1,424	1,395	1,304	1,255	1,164	1,164	1,050	1,017	1,328	1,187	1,187	1,187	1,050	1,050	1,050	1,050	860	860	860	840
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,660	1,515	1,370	1,370	1,280	1,370	1,328	1,305	1,328	1,227	1,255	1,304	2,107	1,980	1,227	1,304	1,050	1,050	1,050	965	942	1,074	1,074	1,074	1,050	1,050	819	819	840	840
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,280	–	–	–	–	1,573	1,395	1,304	1,050	1,017	1,017	1,017	1,187	1,187	1,187	1,074	1,017	920	860	518	430	386	370
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	797	860	942	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	295	320	320	354	354	354	354	354	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	679	700	739	860	860	942	10,17	1,017	1,255	1,328	1,370	1,424	1,450	1,424	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1,187	1,074	1,328	1,328	1,424	1,475	1,305	1,328	1,370	1,370	1,370	1,424	1,450	1,450	1,450	1,450	1,475	1,395	1,304	1,601	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	965	–	1,187	1,255	1,164	1,187	1,255	1,255	1,304	1,304	1,450	1,475	1,450	1,450	1,475	1,475	1,475	1,475	1,475	1,475	1,626	1,669	1,475	1,450	1,424	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	1,370	1,187	1,187	1,255	1,328	1,424	1,370	1,370	1,515	1,515	1,475	1,475	1,424	1,424	1,424	1,424	1,424	1,424	1,424	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	1,187	1,782	1,756	1,756	1,782	1,943	1,782	1,855	1,573	1,424	1,475	1,450	1,424	1,450	1,395	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	1,187	1,187	1,328	1,328	1,573	1,475	1,424	1,475	1,475	1,475	1,424	1,450	1,424	1,424	1,475	1,475	1,475	1,475	1,424	1,450	1,280	1,187	1,187	1,475	1,475	1,328	1,328	1,424	1,187	1,017	987	860	860	765	765	840	920
	–	–	–	–	–	–	–	–	–	700	624	797	606	606	587	606	587	548	587	587	624	587	498	430	386	450	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	1,475	1,450	1,450	1,395	1,395	1,187	1,187	1,255	1,255	1,227	1,328	1,450	1,187	1,074	1,017	1,017	1,017	1,074	1,074	1,074	1,074	1,164	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	1,475	1,782	1,888	1,888	1,825	1,328	1,328	1,328	1,280	1,328	1,450	1,280	1,070	1,070	1,074	1,187	1,187	1,304	1,187	1,187	1,164	1,328	1,328	1,187	1,187	1,161	860	860	860	860
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,187	1,187	1,328	1,328	1,280	1,450	1,280	1,626	1,943	1,515	1,395	1,187	1,475	1,475	1,328	1,328	1,424	1,017	1,424	1,450	1,450	1,304	1,074	1,161	860	860	819	840
	518	840	900	987	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	860*	797*	840*	700*	587*	498*
	295	386	386	386	370	370	430	410	498	518	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1,475	1,475	1,304	840	900	900	942	1,164	1,164	1,255	1,255	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	819	797	739	819	819	1,255	1,280	1,328	1,450	1,475	1,542	1,475	1,475	1,626	1,601	1,697	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	920	987	1,187	1,280	1,280	1,328	1,424	1,424	1,424	1,450	1,395	1,542	1,626	1,573	1,573	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	1,475	1,304	1,187	1,370	1,475	1,542	1,475	1,450	1,450	1,475	1,475	1,601	1,626	1,515	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	1,573	1,573	1,542	1,542	1,475	1,573	1,573	1,542	1,475	1,475	1,475	1,601	1,601	1,450	1,328	1,255	1,304	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	1,626	1,626	1,601	1,697	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
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G.

30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
R M I N U T E.																						
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	720	587	587	587	587	13
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	624	624	720	739	14
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	386	370	370	15
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	739	739	16
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	765	17
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
860	840	819	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
765	765	765	700	760	700	679	739	739	–	–	–	–	–	–	–	–	–	–	–	–	–	24
335	386	386	386	498	450	450	386	370	370	354	335	335	335	–	–	–	–	–	–	–	–	25
–	860	860	860	819	840	797	720	765	700	720	730	720	720	624	624	–	–	498	–	–	–	26
–	–	–	–	860	819	819	739	739	700	624	624	679	657	657	587	565	565	624	819	819	965	27
–	–	–	–	–	–	–	720	679	679	765	819	765	765	679	797	587	624	720	739	624	906	28
–	–	–	–	–	–	–	–	–	–	819	739	679	624	624	624	624	679	657	739	624	548	29
–	–	–	–	–	–	–	–	–	–	–	739	624	–	657	587	548	565	548	548	548	410	30
–	–	–	–	–	–	–	–	–	–	–	–	–	–	739	679	679	624	624	548	432	410	31
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	386	354	335	335	335	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	386	386	370	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	498	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
860	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
765	840	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
819	840	920	920	860	860	965	965	860	860	–	–	–	–	–	–	–	–	–	–	–	–	8
700*	587*	498*	335	335	335	386	386	386	386	370	354	370	370	–	–	–	–	–	–	–	–	9
–	–	–	–	–	–	1,187	965	920	920	1,017	–	–	–	–	–	–	–	–	–	–	–	10
–	–	–	–	–	–	–	765	657	657	606	518	518	518	518	518	430	565	565	498	–	–	11
–	–	–	–	–	–	–	–	739	739	700	700	739	720	679	606	498	498	450	498	498	–	12
–	–	–	–	–	–	–	–	–	–	720	657	624	624	624	548	548	565	498	498	498	430	13
–	–	–	–	–	–	–	–	–	–	–	679	624*	657	624	624	450	450	386	386	386	386	14
–	–	–	–	–	–	–	–	–	–	–	797*	860	900*	900*	942*	1,187*	965*	1,164*	1,074*	987*	860*	15
–	–	–	–	–	–	–	–	–	–	–	–	–	430	386	335	335	335	320	335	335	335	16
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	606	518	518	498	493	17
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	660	660	739	739	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	624	450	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,187*	20
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
1,017	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
354	354	335	335	320	320	320	320	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
797	797	720	765	700	739	797	797	720	720	657	624	624	–	–	–	–	–	–	–	–	–	24
920	860	819	765	765	739	679	624	624	548	548	587	548	518	518	–	–	–	–	–	–	–	25
–	–	1,187*	987*	965*	797	739	679	565	565	565	548	518	450	430	430	430	–	–	–	–	–	26
–	–	–	–	–	–	860	797	679	657	624	624	624	518	518	518	498	498	498	518	518	518	27
–	–	–	–	–	–	–	–	920	657	587	587	548	518	498	498	498	430	410	410	410	410	28
–	–	–	–	–	–	–	–	–	–	–	–	840	797	720	587	430	430	410	430	410	410	29
–	–	–	–	–	–	–	–	–	–	–	–	–	–	450	386	354	354	335	335	335	335	30
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	819*	765*	730*	624	624	518	31
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	660	797	765	739	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	624	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
3,610	3,518*	3,129*	2,573*	2,507*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
450	430	430	430	430	430	430	430	430	430	819	739	657	–	–	–	–	–	–	–	–	–	6
920	920	920	942	920	860	900	900	860	900	920*	765	679	624	587	–	–	–	–	–	–	–	7
1,450*	1,626*	1,395*	1,304*	1,304*	1,304*	1,074*	1,074*	987*	965*	860*	765	720	657	624	624	587	–	–	–	–	–	8
–	–	1,370*	1,304*	1,187*	1,017*	965*	920*	965*	860*	765	720	657	565	548	548	498	498	–	–	–	–	9
–	–	–	–	–	–	797	797	797	624	587	587	587	587	587	565	565	565	565	–	–	–	10
–	–	–	–	–	–	–	450	450	430	386	386	386	386	386	370	370	370	354	320	320	320	11
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
4	758	840	832	825	803	794	799	737	719	677	653	649	635	599	583	549	528	527	521	544	537	551

M A

30	45	5	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	187	170	181	165	160	149	17
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	187	187	176	170	165	165	160	160	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	176	176	176	176	165	160	160	20
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
–	–	–	227	239	219	198	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25
49	753	–	245	198	198	192	192	192	192	187	187	–	–	–	–	–	–	–	–	–	–	–	26
27	632	–	258	221	210	204	192	187	176	165	–	–	–	–	–	–	–	–	–	–	–	–	27
36	649	–	233	258	221	210	198	192	187	216	252	198	192	–	–	–	–	–	–	–	–	–	28
15	640	–	289	258	245	221	198	192	187	181	176	181	187	181	176	170	–	–	–	–	–	–	29
72*	520	–	139	139	134	134	134	129	129	129	129	129	129	129	129	129	129	–	–	–	–	–	30
82	558	–	–	398*	356*	322*	315*	282*	245*	221	198	198	192	176	165	165	165	160	155	149	149	149	31
36	736	–	–	–	–	–	–	–	342*	308*	245*	221*	198	192	187	181	176	170	165	160	160	160	1
00	649	–	–	–	–	–	–	–	–	–	–	181	181	181	181	176	176	170	165	160	160	160	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	187	187	187	187	187	192	192	192	192	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	144	144	144	4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
–	–	–	160	160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
–	–	–	335	322	301	252	221	210	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
07	–	–	204	282	258	252	239	221	198	–	–	–	–	–	–	–	–	–	–	–	–	–	8
53	736	–	221	216	210	210	210	204	198	198	–	–	–	–	–	–	–	–	–	–	–	–	9
21*	1,313	–	245	227	216	221	227	210	192	187	181	181	181	181	–	–	–	–	–	–	–	–	10
32	615	–	204	198	187	176	165	165	165	155	149	149	149	149	149	149	–	–	–	–	–	–	11
71	771	–	258	252	245	239	233	227	221	204	187	187	198	198	192	198	210	192	187	187	–	–	12
42	349	–	198	181	165	160	155	198*	204*	204*	187*	170*	165*	160*	149	144	144	–	–	–	–	–	13
24	615*	–	413*	356*	342*	363*	398*	534*	1,260*	1,324*	1,228*	1,006*	718*	487*	405*	342*	252*	216*	192*	181	181	181	14
26	798	–	221	221	216	204	198	198	192	192	187	187	181	181	181	181	181	176	170	165	165	165	15
71	705	–	–	–	–	–	–	–	258*	245*	198*	198*	198*	187	187	187	187	176	176	176	165	165	16
89	804	–	–	–	–	–	–	–	–	–	165	176	170	155	155	155	155	149	149	144	144	144	17
–	–	–	–	–	–	–	–	–	–	–	–	–	176	176	176	176	170	170	170	165	160	160	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	198	192	187	187	176	155	149	149	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
–	–	–	9	342	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
–	–	–	8	328	315	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
–	–	–	3	322	289	216	204	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
–	–	–	7	442	435	377	349	377	405	377	301	160	160	144	144	144	139	139	–	–	–	–	24
32	70	9	221	216	216	198	192	221	198	198	192	176	160	155	155	155	149	144	144	–	–	–	25
36	70	9	227	216	216	216	198	192	181	176	176	192	198	181	155	149	144	144	139	139	–	–	26
58	23	–	–	–	134	134	139	124	119	115	108	108	119	115	119	119	119	115	108	108	–	–	27
95	55	–	–	–	–	–	–	–	176	155	144	144	139	139	134	134	134	134	134	129	–	–	28
15	63	–	–	–	–	–	–	–	–	–	144	139	139	144	139	144	139	134	134	134	–	–	29
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	198	192	144	144	–	30

E.

DATE.	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
FEBRUARY 15	700	700	700	679	739	739	739	—	—	—	—	—	—	—	—	—	—	—	—	FEBRUARY 13
16	386	498	459	459	386	370	370	354	335	335	335	624	624	624	624	624	624	624	624	14
17	860	819	840	707	720	765	707	720	739	739	739	624	624	624	624	624	624	624	624	15
18	—	860	819	819	739	739	700	624	624	624	624	657	657	657	657	657	657	657	657	16
19	—	—	—	—	720	679	679	765	819	765	765	679	679	679	679	657	657	657	657	17
20	—	—	—	—	—	—	—	819	739	694	694	765	765	765	765	679	679	679	679	18
21	—	—	—	—	—	—	—	—	—	—	—	694	694	694	694	765	765	765	765	19
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	694	694	694	694	20
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26
MARCH 1	930	860	860	965	965	860	860	370	370	—	—	—	—	—	—	—	—	—	—	MARCH 27
2	335	335	335	386	386	386	386	1,197	1,197	—	—	—	—	—	—	—	—	—	—	28
3	—	—	—	1,197	965	920	869	606	606	—	—	—	—	—	—	—	—	—	—	29
4	—	—	—	765	657	657	700	700	657	657	657	657	657	657	657	657	657	657	657	30
5	—	—	—	—	739	720	720	720	624	624	624	624	624	624	624	624	624	624	624	31
6	—	—	—	—	—	—	—	—	739	739	739	548	548	548	548	548	548	548	548	APRIL 1
7	—	—	—	—	—	—	—	—	—	—	—	565	565	565	565	565	565	565	565	2
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26
APRIL 1	2,573*	2,507*	430	900	1,074*	987*	900	430	430	430	430	430	430	430	430	430	430	430	430	APRIL 27
2	1,304*	1,304*	1,304*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	28
3	1,304*	1,304*	1,304*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	1,074*	29
4	1,304*	1,187*	1,017*	965*	965*	965*	965*	965*	965*	965*	965*	965*	965*	965*	965*	965*	965*	965*	965*	30
5	987*	965*	797	797	797	797	797	797	797	797	797	797	797	797	797	797	797	797	797	MAY 1
6	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	2
7	765	765	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	3
8	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	4

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15
MARCH 17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	140	149	155	155	155	155	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	160	160	155	140	144	155	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	160	149	144	139	139	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134
22	—	155	155	155	155	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
APRIL 1	155	149	144	144	139	139	139	139	139	139	139	139	139	139	139	139	—	—	—	—	—	—
2	149	144	144	139	139	139	139	139	139	139	139	139	139	139	139	139	—	—	—	—	—	—
3	187	187	181	181	181	181	176	176	176	176	176	176	176	176	176	176	—	—	—	—	—	—
4	144	139	194	134	134	134	129	129	129	129	129	129	129	129	129	129	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	176	108	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	160	140	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	165	160	160	155	155	155	155	155	140	140	—	—	—	—	—	—	—	—	—	—	—	—
17	144	144	139	134	134	134	134	134	134	134	—	—	—	—	—	—	—	—	—	—	—	—
18	160	155	155	155	155	149	149	144	144	144	144	144	144	144	144	144	—	—	—	—	—	—
19	155	155	155	144	144	144	144	144	144	144	144	144	144	144	144	144	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	108	108	108	108	108	108	108	108	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	134	134	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	—	—	—	—	—	—
28	129	124	110	110	119	115	115	115	115	115	115	115	115	115	115	115	—	—	—	—	—	—
29	134	134	134	134	129	129	124	124	119	119	119	119	119	119	119	119	—	—	—	—	—	—
30	124	129	124	124	124	119	115	115	115	115	115	115	115	115	115	115	—	—	—	—	—	—

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

NORTHUMBERLAND-STREET SEWER.

MORNING.

CUBIC FEET PER MINUTE.

DATE	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	1
FEBRUARY 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	542	556	520	511	472	413	391	369	384	391	405	413	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	591	566	558	472	449	599	526	465	487	465	526	511	472	442	427	413	413	413	615	632	542	435	–	–	–	–
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	745	615	582	542	550	550	986	649	520	465	480	487	495	526	435	649	391	369	377	363	413	369	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	753	1,156	736	574	550	511	520	472	457	480	487	480	480	487	465	413	384	369	398	405	391	391	413	480	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	472	472	435	465	465	465	435	435	487	391	391	420	391	356	391	420	398	398
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	308	308	294	239	233	216	204	198	198	192	181
7	29	129	129	129	129	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	449	384	420	457	457	472	442	398
8	16	210	210	170	149	129	134	134	134	181	258	405	398	495	591	566	566	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	420	472	405
9	–	144	144	144	144	144	144	144	144	216	449	495	487	542	550	607	708	807	771	649	649	753	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	144	144	144	144	198	315	413	487	503	615	649	640	542	487	640	762	727	632	640	591	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	457	520	599	534	574	807	771	771	736	649	640	591	566	566	503	435	413	427	442	413	442	465	472	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	558	594	503	632	736	692	708	615	640	640	607	574	511	542	503	449	413	405	384	435	480	480	465	442	–	–	–	–	–	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	149	149	227	322	328	384	442*	472*	520*	566*	550*	542*	495*	413*	301	294	289	289	398	465	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14	–	–	–	–	–	–	–	–	–	–	–	–	–	542	550	487	599	566	487	542	582	558	566	503	566	503	495	558	550	520	526	472	495	465	480	472	–	–	–	–	–	–	–	–	–	–	–	–	–
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	817*	771*	798*	807*	736	736	771	718	649	708	511	487	442	427	413	398	405	405	442	480	442	–	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	700	649	718	736	615	599	503	511	480	413	427	405	405	398	427	413	398	405	413	398	427	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	864*	835*	780*	640*	526	480	465	457	472	472	449	465	472	442	413	398	427	465	457	472	487	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	550*	542*	736*	472	449	435	398	413	457	465	435	435	455	405	427	472	449	435	398	413	449	–	–
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	442*	599*	798*	1,065*	1,105*	958*	938*	798*	708*	649*	727*	534*	558*	520*	465*	465*
20	89*	649*	526*	442*	465*	435*	457*	826*	1,026*	1,105*	1,035*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	187	187	187	187	187	187	187	187	187	187	187
21	29	129	129	155	187	192	204	155	187	315	405	465	413	457	558	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	427	465	465	465	465	465
22	34	134	134	134	134	134	134	134	134	301	465	413	405	405	607	762	762	753	771	817	807	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	413	398	398	398	398	398
23	–	144	144	144	144	144	144	144	144	322	322	487	520	487	511	566	632	718	753	753	753	736	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24	–	–	134	134	134	134	134	134	165	363	465	566*	753*	607*	798*	649*	640*	789*	948*	1,707*	1,421*	1,313*	1,156*	1,105*	1,055*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25	–	–	–	–	–	198	210	233	227	221	413	398	398	558	736	692	574	745	817	835	632	615	607	566	566	624	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	550	566	640	798	798	817	798	771	771	649	599	624	550	487	503	472	449	457	599*	1,055*	1,116*	1,156*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	165	176	176	198	322	335	342	349	363	391	391	391	384	369	342	258	239	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	465	465	542	487	487	607	624	615	607	566	591	599	526	566	542	487	472	457	465	480	526	–	–	–	–	–	–	–	–	–	–	–	–	–	–
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	807*	798*	807*	736	762	826	798	753	649	615	542	649	487	465	465	391	398	405	435	465	435	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	789	817	771	753	771	708	649	599	599	607	550	511	465	449	442	435	457	542	526	511	511	–	–	–	–	–	–	–	–	–	–	–	–	–
31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	789	804	753	632	632	534	442	495	520	472	472	457	465	520	938*	1,580*	1,399*	1,239*	844*	582*	526*	–	–	–	–	–	–	–	–
APRIL 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	599	566	550	550	472	503	487	427	442	427	427	503	487	398	342	328	328	328	356	342	342	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	736	615	550	558	550	534	520	442	465	503	534	534	457	442	427	413	465	465	457	457	503	–	–	–	–
3	2,608	108	108	108	108	108	108	108	108	245	384	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	258	245	342	472	413	322	233	210	210	210	176	176	176	176	170	170	170	170	170
4	429	129	129	129	129	129	129	134	144	342	449	442	398	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	457	457	457	503	465	503	550	566
5	1,329	129	129	129	129	129	129	129	129	210	328	457	398	435	511	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	405	413	427	420	435	442	472
6	1,339	139	139	139	139	139	139	139	149	315	427	495	566	542	534	649	700	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	649*	632*	649*	599*	487*
7	–	–	–	–	245	239	221	210	198	198	216	227	384	435	526	718	745	708	700	632	632	700	607	591	566	550	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	144	308	427	413	405	420	472	607	624	727	736	700	736	708	768	640	632	534	511	526	472	480	487	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	170	192	258	176	252	315	301	239	258	239	216	204	308	349	356	413	465	472	342	294	210	198	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	82	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	398	495	449	487	495	550	526	487	520	480	465	449	449	472	495	472	487	487	449	435	427	413	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	649	640	615	632	632	566	526	495	413	413	413	398	405	405	413	427	427	427	435	413	391	384	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	640	607	558	526	472	427	398	356	349	342	398	449	420	435	420	405	391	322	322	322	356	342	–	–	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	457	449	398	342	349	363	384	427	503	503	480	427	405	398	398	398	391	369	356	349	413	487	487

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings, printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix

L I S.

E V E N I N G.

45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
C U B I C F E E T P E R M I N U T E.																																										
413	391	369	384	391	405	413	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	187	170	181	165	160	149	17	MARCH
413	413	413	615	632	542	435	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	187	187	176	170	165	165	160	160	18	
435	649	391	369	377	363	413	369	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19	
465	413	384	369	398	405	391	391	413	480	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	176	176	176	176	165	160	160	20	
435	487	391	391	420	391	356	391	420	398	398	472	503	480	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21	
308	308	294	239	233	216	204	198	198	192	181	176	176	170	165	165	160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
–	–	–	449	384	420	457	457	472	442	398	398	442	398	342	405	449	435	435	405	335	308	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	
–	–	–	–	–	–	–	–	420	472	405	472	503	487	413	427	487	495	398	340	258	245	221	227	239	219	198	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24	
–	–	–	–	–	–	–	–	–	–	–	–	398	391	377	442	534	472	391	258	245	230	221	245	198	198	192	192	192	187	187	–	–	–	–	–	–	–	–	–	–	–	25	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	511	503	442	413	342	294	245	227	227	258	221	210	204	192	187	176	165	–	–	–	–	–	–	–	–	–	–	–	26	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	465	377	294	245	282	245	233	258	221	210	198	192	187	216	252	198	192	–	–	–	–	–	–	–	–	–	27	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	335	301	294	289	258	245	221	198	192	187	181	176	181	187	181	176	170	–	–	–	–	–	28	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	144	139	139	134	134	134	129	129	129	129	129	129	129	129	129	129	–	–	–	–	29	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	398*	356*	322*	315*	282*	245*	221	198	198	192	176	165	165	165	160	155	149	30	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	342*	308*	245*	221*	198	192	187	181	176	170	165	160	31	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	181	181	181	181	176	176	170	165	160	1	APRIL
405	413	398	427	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	187	187	187	187	187	192	192	2	
398	427	465	457	472	487	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	144	144	3	
435	455	405	427	472	449	435	398	413	449	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	
1,105*	958*	938*	798*	708*	649*	727*	534*	558*	520*	465*	591*	826*	844*	789*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	
–	–	–	–	187	187	187	187	187	187	187	187	181	181	181	176	176	176	176	170	170	165	165	160	160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	
–	–	–	–	–	–	–	–	427	465	465	449	495	465	472	480	449	420	349	335	328	328	328	335	322	301	252	221	210	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	
–	–	–	–	–	–	–	–	–	413	398	427	487	511	457	480	503*	550*	566*	480*	405*	356*	308	294	282	258	252	239	221	198	–	–	–	–	–	–	–	–	–	–	–	–	–	8	
–	–	–	–	–	–	–	–	–	–	–	405	398	398	449	449	420	413	420	420	301	245	233	221	216	210	210	210	204	198	198	–	–	–	–	–	–	–	–	–	–	–	–	9	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	566	542	526	413	369	322	294	289	258	245	227	216	221	227	210	192	187	181	161	181	181	181	–	–	–	–	–	–	–	10	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	301	289	245	245	239	239	221	204	198	187	176	165	165	165	155	149	149	149	149	149	–	–	–	–	–	–	–	11	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	315	294	258	252	245	239	233	227	221	204	187	187	198	198	192	198	210	192	187	187	–	–	12	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	198	192	198	181	165	160	155	198*	204*	204*	187*	170*	165*	160*	149	144	144	–	–	–	–	–	13	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	435*	413*	356*	342*	363*	398*	534*	1,260*	1,324*	1,228*	1,006*	718*	487*	405*	342*	252*	216*	192*	181	14	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	233	221	221	216	204	198	198	192	192	187	187	181	181	181	181	181	176	170	165	15	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	258*	245*	198*	198*	198*	187	187	187	176	176	176	165	16	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	165	176	170	155	155	155	155	149	149	144	17	
1,239*	844*	582*	526*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	176	176	176	176	170	170	170	165	18	
328	328	328	356	342	342	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	198	192	187	187	176	155	19	
442	427	413	465	465	457	457	503	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20	
210	176	176	176	176	170	170	170	170	170	170	165	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21	
–	–	–	457	457	457	503	465	503	550	566	487	534	550	542	472	542	465	427	384	356	356	369	342	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22	
–	–	–	–	405	413	427	420	435	442	472	487	495	480	487	503	534	599	465	413	391	328	323	328	315	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	
–	–	–	–	–	–	649*	632*	649*	599*	487*	632*	1,730*	1,313*	1,016*	798*	632*	449	413	363	369	391	363	322	289	216	204	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24	
–	–	–	–	–	–	–	–	–	–	–	–	457	405	322	342	384	369	308	239	221	210	427	442	435	377	340	377	405	377	301	160	160	144	144	144	139	139	–	–	–	–	25	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	282	258	258	301	258	239	227	216	216	216	198	192	221	198	198	192	176	160	155	155	155	149	144	144	–	26	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	134	134	139	124	119	115	108	108	119	115	119	119	119	115	108	108	27	
–	413	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	176	155	144	144	139	139	134	134	134	134	134	134	28	
413	391	384	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	144	139	139	144	139	144	139	198	192	144	144	29	
405	391	322	322	322	356	342	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
427	405	398	398	398	391	369	356	349	413	487	520	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	

E V E N I N G.

1	15	30	45	DATE.
C U B I C F E E T P E R M I N U T E.				
67	67	67	67	20 APRIL
67	64	64	64	21
71	67	67	67	22
62	59	59	59	23
64	62	62	59	24
67	67	67	67	25
53	53	53	53	26
67	67	67	62	27
67	62	59	59	28
62	62	62	62	29
59	56	56	56	30
62	62	62	62	1 MAY
83	83	80	80	2
62	62	62	62	3
83	74	71	71	4
62	59	59	59	5
62	62	59	59	6
59	56	56	56	7
67	62	59	56	8
74	62	59	59	9
67	67	67	62	10
56	53	53	53	11
59	59	56	56	12
62	62	67	71	13
83	67	64	62	14
125	113	83	74	15
83	83	80	62	16
59	59	59	59	17
67	64	62	59	18
53	53	53	50	19
80	77	74	74	20
67	67	67	64	21
40*	132*	132*	113*	22
–	–	–	–	23
–	–	–	–	24
–	–	–	–	25
–	–	–	–	26
–	–	–	–	27
–	–	–	–	28
–	–	–	–	29
–	–	–	–	30
–	–	–	–	31
–	–	–	–	1 JUNE
–	–	–	–	2
–	–	–	–	3
–	–	–	–	4
–	–	–	–	5
–	–	–	–	6
–	–	–	–	7
67	67	67	64	8
351*	485*	228*	152*	9
62	59	59	59	10
62	62	59	59	11
59	53	53	53	12
74	67	62	62	13
50	50	50	50	14
53	53	53	53	15
56	53	53	53	16
50	50	50	50	17
56	53	53	53	18
71*	64	64	64	19
–	–	–	–	20
67	64	62	61	

ded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 70.

(*continued*)

MORNING.

CUBIC FEET PER MINUTE.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45
FEBRUARY 1	139	139	139	134	129	124	119	119	115	115	115	115	115	115	115	115	115	115	119	119	134	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	129	124	124	119	119	119	119	119	119	115	115	115	115	115	124	134	134	134	165	155	144	139	139	139	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	–	–	124	124	129	129	129	124	119	115	115	115	115	115	108	108	119	119	119	124	124	124	134	181	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	115	115	115	115	115	115	115	108	108	108	108	108	108	108	115	115	115	258	384	435	398	377	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	115	115	119	124	139	170	301	335	384	457	487	558	607	649	615	591	574	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	124	124	124	129	134	144	144	134	155	216	294	342	308	413	736	727	640	718	649	649	591	727	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	170	149	144	144	144	204	322	377	427	465	503	649	700	736	727	753	727	649	640	624	615	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	216	328	435	480	542	599	599	495	591	700	727	649	649	640	700	649	624	582	–	–
9	144	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	328	349	369	413	550	582	582	566	624	649	727	708	736	753	771	700	–	–
10	170	170	170	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	221	227	328	442	435	377	342	420	435	449	413	384	–	–
11	115	115	115	115	115	115	115	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	624	649	700	566	550	582	566	599	503	495	–
12	134	134	134	134	129	120	129	129	129	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	727	574	632	607	591	566	550	526	–	–
13	139	139	139	139	139	134	134	129	129	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	632	649	700	649	591	550	520	–	–
14	144	144	139	139	134	134	134	134	134	134	134	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	745	649	607	558	449	–	–
15	144	144	139	134	134	134	129	129	129	129	129	129	129	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	566	526	599	–	–
16	144	144	139	139	144	144	139	129	129	129	129	124	124	124	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	503	480	–	–
17	149	144	144	139	134	138	138	129	129	129	129	124	124	124	124	119	119	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	115	108	108	108	108	108	105	105	105	105	105	105	105	105	105	105	105	105	105	108	108	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	144	144	139	134	129	129	119	119	115	115	115	115	119	119	119	115	115	115	115	115	115	119	119	115	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	170	149	149	149	144	144	144	144	144	142	289	198	155	144	129	139	139	139	144	139	139	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	221	144	134	124	115	115	115	115	115	115	115	115	115	115	115	115	115	139	134	139	198	245	294	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	908	498	115	115	115	115	119	119	124	139	129	134	129	139	139	144	155	187	301	391	349	511	542	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,156*	1,136*	1,208*	1,800*	1,218*	910*	692*	413*	258*	239*	204*	170	160	245	377	457	566	574	607	632	727	745	649	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	204	210	165	170	227	155	129	149	139	124	139	149	149	227	301	282	204	252	413	369	258	435	369	349	349	356	–
25	119	119	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	221	108	108	105	115	165	308	442	457	349	391	465	465	480	480	440	465	465	457	435	465	491	480	–
26	139	139	139	139	139	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	245	221	245	294	328	495	487	550	624	640	780	762	599	708	745	632	624	566	495	472	–
27	139	139	134	134	129	129	124	119	115	115	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	449	435	384	349	449	649	632	520	599	632	692	700	582	599	550	574	534	–
28	149	149	149	144	144	144	139	139	134	134	134	134	134	134	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	503	599	582	640	736	798	798	762	771	753	753	574	–	–	–
29	170	155	144	139	134	134	129	129	129	129	124	124	124	124	124	124	124	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	855	771	640	615	640	615	632	582	591	495	–	–
30	144	144	144	144	144	144	139	139	139	139	139	139	139	139	139	144	149	149	149	149	149	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	736	649	700	649	718	727	700	–	–
31	160	149	149	144	144	149	149	149	144	144	144	144	144	144	144	144	139	139	134	134	134	144	144	144	144	144	–	–	–	–	–	–	–	–	–	–	–	–	–	–	442	413	369	328	–	–
APRIL 1	335	3																																												
2	765	7																																												
3	765	7																																											
4	987*	9																																											
MAY 1	124	124	124	124	124	124	124	124	124	124	124	124	119	119	119	119	119	119	119	119	119	119	119	119	115	144	155	301	342	322	384	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	129	129	129	129	124	124	119	119	119	119	119	119	–	119	115	115	115	115	115	115	115	115	115	119	124	134	124	134	124	155	192	233	328	624	607	–	–	–	–	–	–	–	–	–	–	–
3	–	119	119	115	108	108	108	115	108	105	105	105	100	100	100	105	139	119	134	134	134	134	134	134	144	160	239	198	342*	503*	442*	398	526	599	599	615	640	649	727	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	134	149	134	134	149	160	139	134	356	487	465	480	632	745	599	649	727	649	708	649	632	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	134	134	134	124	124	115	108	108	108	108	119	119	119	129	129	129	119	119	139	176	245	328	356	420	534	591	615	615	649	708	640	640	692	708	640	632	640
6	–	–	–	–	–	–	–	–	–	–	–	–	–	129	115	108	108	108	108	115	115	115	129	129	129	134	198	282	245	328	363	391	435	632	632	640	649	632	632	624	700	692	640	727	700	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	198*	227*	258*	245*	258*	398*	442*	472*	449*	420*	328*	282*	245*	221*	210*	252*	328*	413*	442*	534*	640*	599*	520*	487*	558*	882*	855*	919*	–
8	115	115	119	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	105	108	108	115	119	129	119	160	245	294	356	398	427	591	480	520	632	512	526.	511	503	591	566	503	520	526	–
9	134	124	124	124	124	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	119	119	134	144	204	258	335	384	405	442	503	503	511	582	574	526	558	574	591	566	534	607	–	–	–
JUNE 10	216*	170*	155*	144*	144*	139*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	160	149	170	187	258	413	413	442	472	566	708	615	624	599	624	762	745	692	607	591	591	–
11	149	149	144	144	144	144	139	139	139	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	210	198	282	369	342	405	520	550	574	624	700	607	591	719	718	599	632	582	526	–	–
12	144	144	139	139	134	134	129	129	129	129	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	384	377	427	550	700	718	692	607	582	582	640	574	558	566	495	526	–
APRIL 13	139	134	129	129	134	134	129	124	124	124	124	124	124	124	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	607	591	591	591	591	582	574	574	574	511	520	534	495	–	–
14	170	165	160	149	144	139	134	129	129	124	124	119	119	119	115	119	124	119	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	328	308	294	363	342	335	328	322	342	495	369	–
15	124	124	124	119	78	119	119	119	119	115	108	108	124	129	129	129	129	129	134	134	129	124	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	520	487	472	472	495	–
16	149	139	134	129	124	119	115	115	134	124	115	115	115	115	115	108	108	108	119	155	134	119	119	124	124	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	599	487	–	–
17	124	119	119	124	124	129	129	119	115	115	115	115	115	115	119	108	108	105	105	105	105	134	105	105	115	115	105	149	176	252	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	124	119	119	119	115	115	115	115	108	108	108	100	100	100	100	100	100	100	100	100	100	108	115	108	108	108	119	119	155	245	322	391	480	640	649	–	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	258	170	155	155	160	160	155	155	139	139	144	134	134	134	144	144	181	210	245	245	239	328	356	322	391	427	442	435	495	566	526	591	718	649	615	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	1,410*	1,177*	771*	582*	566*	427*	363*	342*	301*	294*	301*	245*	239*	289*	245*	413*	700*	771*	798*	1,177*	1,239*	1,260*	–	1,126*	977*	986*	1,006*	986*	1,026*	958*	929*	891*	1,095*	–	–	–
	140	139	135	135	135	133	132	130	128	127	124	123	123	121	122	122	124	124	127	130	132	131	133	136	142	153	175	253	355	402	420	495	568	604	607	669	660	656	672	660	633	605	606	557

MEAN OF

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (~~758~~), also the Su

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

NORTHUMBERLAND-STREET SEWER—*continued.*

EVENING.

CUBIC FEET PER MINUTE.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15
APRIL	405	405	398	413	449 574	487 558	472 520	449 487	413 487	398 503	420 495	391 495	405 487	413 465	384 449	457 480	495 511	487 526	511 520	526 520	511 520	427 520	– 495	– 558	– 511	– 449	–	–	–	–
	–	–	–	–	–	–	–	–	187	198	192	192	192	192	192	187	181	181	176	170	165	165	155	144	144	144	144	139	139	138
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	480	449	442	449	534	472	449	520	457	363	322	282	258	243
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	369	413	420	413	480	472	457	487	449	413	369	289	303	315
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	534	487	487	435	413	308	245	282	258	255
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	449	413	384	384	413	377
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	282	253
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	550	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	335	315	294	282	282	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	520	472	449	420	465	480	480	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	398	420	413	449	457	420	391	369	356	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	398	391	391	384	487	457	405	398	384	377	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	369	398	405	435	449	442	427	391	356	342	356	384	413	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	398	384	391	442	435	495	427	413	391	391	356	342	342	363	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	465	435	449	487	495	480	480	480	420	363	377	349	369	391	349	384	398	–	–	–	–	–	–	–	–	–	–	–	–	–
	420 487	413 442	391 465	356 480	398 511	258 457	221 398	198 342	176 369	165 363	170 308	176 349	176 356	170 377	170 369	170 391	165 420	155 413	–	–	–	–	–	–	–	–	–	–	–	–
	–	369	405	449	487 798	427 542	413 413	405 398	398 356	384 315	369 335	369 356	369 335	349 308	342 282	335 301	377 377	363 413	384 356	398 356	377 449	413 465	420 449	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	520	442	465 1,260*	413 891*	413 526*	472 526*	511 542*	405 566*	420 449*	449 449*	495 487*	457 465*	413 465*	413 427*	377 398*	335 301*	322 258*	294 335*	294 413*	244 384
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	617	624	607	591	566	526	487	465	356	294	289	289	258	209
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	204	149	155	149	149	144	144	144	144	142
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	465*	457*	442*	427*	487*	435*	345
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	289	245	216	239	235
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	294	284
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
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	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
	574	558	503	457	427	420	413	449	480	480	413	405	435	349	335	315	335	377	405	440	472	442	427	363	413	480	413	363	384	405
	–	–	–	–	–	–	–	520	487	480	–	–	–	–	–	–	–	–	427	427	384	472	550	487	480	472	413	349	315	282	245
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	413	472	487	542	398	369	308	301
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	465	435	449	487	413	258	322	301
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

DATE.	5	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45
APRIL 20	238	238	184	140	132	132	132	132	132	117	83	83	74	67	67	67	67	67	67
21	218	223	186	132	113	107	107	107	107	107	83	74	71	71	71	67	64	64	64
22	223	242	184	128	107	96	83	89	218	372	300	96	74	71	71	71	67	67	67
23	251	242	184	128	107	96	83	89	218	372	300	96	74	71	71	62	59	59	59
24	218	184	140	113	96	96	86	83	83	74	71	83	67	67	67	64	59	59	59
25	218	184	144	125	96	96	86	83	83	83	83	83	74	74	74	64	62	62	62
26	218	184	164	132	132	125	117	110	104	96	116	83	83	83	74	67	67	67	67
27	218	67	67	67	67	62	59	56	56	53	53	53	53	53	53	53	53	53	53
28	210	84	148	110	107	100	96	86	83	77	74	74	71	67	67	67	67	67	67
29	210	51	152	135	110	104	83	74	100	86	83	83	83	77	74	67	62	59	59
30	228	218	201	113	100	96	83	83	80	74	71	67	67	67	64	62	62	62	62
MAY 1	218	205	125	110	83	74	67	67	67	67	64	62	62	62	59	59	56	56	56
2	192	228	192	144	125	104	96	96	96	83	83	83	74	71	64	62	62	62	62
3	242	228	192	144	125	104	96	96	96	83	83	83	74	71	64	62	62	62	62
4	305	295	218	184	148	128	96	192	156	132	128	125	113	74	64	62	62	62	62
5	300	295	218	184	148	128	96	201	156	132	128	125	113	74	64	62	62	62	62
6	83	74	74	74	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
7	228	251	140	125	125	107	107	107	107	104	104	104	104	104	104	104	104	104	104
8	184	184	113	96	86	80	74	74	74	74	74	74	74	74	74	74	74	74	74
9	218	218	132	107	96	83	83	74	74	74	71	71	71	71	71	71	71	71	71
10	201	218	184	132	113	96	86	86	86	74	74	64	64	64	64	64	64	64	64
11	192	228	125	107	100	96	86	86	86	86	86	64	64	64	64	64	64	64	64
12	218	196	233	201	164	107	96	96	96	86	86	86	74	74	74	74	74	74	74
13	228	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
14	196	210	168	132	107	96	96	96	96	83	83	74	67	62	62	62	62	62	62
15	205	184	125	117	117	152	156	132	117	104	83	74	67	64	62	62	62	62	62
16	201	218	205	153	148	135	96	86	86	86	83	74	67	64	62	62	62	62	62
17	228	228	152	128	123	128	117	113	121	152	113	156	83	74	67	64	62	62	62
18	228	205	214	148	123	128	125	121	121	128	125	104	83	83	74	67	64	64	64
19	210	71	59	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
20	214	201	184	148	117	136	125	104	121	132	104	125	104	83	74	67	64	64	64
21	184	228	205	164	104	83	80	77	238	290	251	252	96	80	80	80	77	74	74
22	240	228	201	164	132	110	104	96	96	113	96	96	83	80	80	80	80	80	80
23	205	205	184	140	121	113	104	107	100	96	96	96	83	74	67	67	67	67	67
24	205	205	251*	228*	214*	196*	140*	136*	218*	242*	237*	238*	214*	168*	148*	140*	132*	132*	113*
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JUNE 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	64	67	71	74	83	74	67	67	67	67	67	67	67	67	67	67	67	67	67
10	152*	228*	195*	205*	228*	144*	195*	351*	485*	228*	155*	351*	485*	228*	155*	351*	485*	228*	155*
11	50	50	62	67	67	64	62	62	62	59	62	62	62	59	62	62	62	59	62
12	50	50	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
13	62	62	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
14	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
15	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
16	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
17	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
18	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	61	62	64	67	67	64	62	62	62	59	62	62	62	59	62	62	62	59	62

DATE.	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45
MAY 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	139	139	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	144	139	139	245	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	369	280	315	315	—	—	—	227	227	—	—	—	—	—	—	—	—	—	—	—	—	—
6	345	283	258	258	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	384	384	377	377	—	—	—	227	227	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	282	282	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	322	221	322	289	289	221	282	227	210	198	198	187	187	144	144
10	—	—	369	369	—	—	—	315	139	315	134	134	134	134	134	134	134	134	124	124	115	115
11	—	—	—	—	—	—	—	—	—	—	170	160	140	149	155	155	144	144	144	149	139	139
12	—	—	—	—	—	—	—	—	—	—	204*	289*	258*	245*	283*	198	187	199	170	176	155	144
13	—	—	—	—	—	—	—	—	—	—	—	—	187	198	198	204	204	165	165	160	149	140
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	198	165	181	160	155	149	140	140
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	335	335	252	252	192	192
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	252	193	165	165
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	119
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	945	945	945	945	945	945	930	930	930	945	933	933	933	933	933	933	933	933	933	933	933	933
24	413*	384*	413*	384*	369*	350*	356*	328*	328*	328*	328*	328*	328*	328*	328*	328*	328*	328*	328*	328*	328*	328*
JUNE 1	420	420	420	435	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	283	283	245	227	210	210	198	192	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	301	301	258	258	245	258	252	245	233	233	221	227	233	221	233	252	—	—	—	—	—	—
4	301	301	258	282	232	258	233	233	221	245	245	258	221	245	245	262	335	335	221	252	221	252
5	487*	472*	282	245	232	245	233	227	233	237	216	210	198	198	198	210	204	204	198	198	198	198
6	—	—	520*	435*	393*	377*	360*	328*	323*	308*	301*	301*	204*	280*	280*	301*	204*	204	204	204	204	204
7	176	170	144	139	139	139	139	134	134	134	134	134	139	139	139	139	139	139	139	139	139	139
8	442*	413*	430*	420*	413*	305*	280*	280*	285*	338*	301*	301*	187	187	187	187	187	187	187	187	187	187
9	501*	550*	472*	427*	377*	360*	377*	511*	727*	968*	708*	708*	817*	607*	377*	377*	308*	245*	308*	297	245*	245*
10	377	280	258	258	258	258	227	198	216	216	221	356	826	245	167	187	—	—	170	160	170	160
11	427	253	259	233	227	216	210	904	904	198	198	198	929	294	258	258	227	258	227	155	140	140
12	—	—	259	294	210	210	204	216	204	198	192	192	187	176	210	210	204	204	308	181	160	140
13	—	—	—	—	—	—	—	289	204	245	245	245	239	198	192	192	204	204	377	227	210	198
14	—	—	—	—	—	—	—	—	—	—	945	945	939	221	124	124	124	124	124	124	124	124
15	—	—	—	—	—	—	—	—	—	—	129	129	129	124	124	124	124	124	124	124	124	124
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	252	252	160	160	160	155	155	160
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	149	149	129
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	318	308	384	356	377	384	308	308	384	384	384	384	384	384	384	384	384	384	384	384	384	384
24	342	342	369	342	328	328	335	336*	817*	566*	480*	—	—	—	—	—	—	—	—	—	—	—
JUNE 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	315*	315*	274	299	266	255	242	223	229	223	207	188	190	157	177	171	164	164	164	162	158	149
10	149	149	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	144	144	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	144	144	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	170	170	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	124	124	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	140	140	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	129	129	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	149	149	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

MICROSCOPIC FIELDS

| DATE. | 12 | 15 | 30 | 45 | 1 | 15 | 30 | 45 | 2 | 15 | 30 | 45 | 3 | 15 | 30 | 45 | 4 | 15 | 30 | 45 | 5 | 15 | 30 | 45 | 6 | 15 | 30 | 45 | 7 | 15 | 30 | 45 | 8 | 15 | 30 | 45 | 9 | 15 | 30 | 45 | 10 | 15 | 30 | 45 | 11 | 15 | 30 | 45 | 12 | 15 | 30 | 45 | 13 | 15 | 30 | 45 | 14 | 15 | 30 | 45 | 15 | 15 | 30 | 45 | 16 | 15 | 30 | 45 | 17 | 15 | 30 | 45 | 18 | 15 | 30 | 45 | 19 | 15 | 30 | 45 | 20 | 15 | 30 | 45 | 21 | 15 | 30 | 45 | 22 | 15 | 30 | 45 | 23 | 15 | 30 | 45 | 24 | 15 | 30 | 45 | 25 | 15 | 30 | 45 | 26 | 15 | 30 | 45 | 27 | 15 | 30 | 45 | 28 | 15 | 30 | 45 | 29 | 15 | 30 | 45 | 30 | 15 | 30 | 45 | 31 | 15 | 30 | 45 | 1 | 15 | 30 | 45 | 2 | 15 | 30 | 45 | 3 | 15 | 30 | 45 | 4 | 15 | 30 | 45 | 5 | 15 | 30 | 45 | 6 | 15 | 30 | 45 | 7 | 15 | 30 | 45 | 8 | 15 | 30 | 45 | 9 | 15 | 30 | 45 | 10 | 15 | 30 | 45 | 11 | 15 | 30 | 45 | 12 | 15 | 30 | 45 | 13 | 15 | 30 | 45 | 14 | 15 | 30 | 45 | 15 | 15 | 30 | 45 | 16 | 15 | 30 | 45 | 17 | 15 | 30 | 45 | 18 | 15 | 30 | 45 | 19 | 15 | 30 | 45 | 20 | 15 | 30 | 45 | DATE. |
|---|---|---

Appendix III.—*continued.*

MAIN DRAINAGE, METROPOLIS.

SAVOY-STREET SEWER.

CUBIC FEET PER MINUTE.

| DAT | MORNING. | | |

L I S.

EVENING.

45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
CUBIC FEET PER MINUTE.																																									
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	184	164	164	164	218	228	184	140	132	132	132	132	132	117	83	74	74	67	67	67	67	67	67	67	20
160	132	–	–	–	104	125	144	–	144	132	152	184	228	228	228	275	265	205	144	136	156	205	223	223	136	132	113	107	107	107	107	107	83	74	71	71	71	67	64	64	64	21
196	205	210	275*	275*	260*	265*	265*	228*	184*	168*	563*	638*	514*	472*	351*	246	205	148	125	192	237	251	242	184	128	107	96	83	83	218	372	300	96	74	71	71	71	67	67	67	67	22
144	144	140	136	107	132	192	210	218	148	164	228	265	300	242	242	205	132	132	140	201	223	218	184	140	113	96	96	83	83	83	74	71	67	67	67	62	62	59	59	59	23
117	110	110	107	96	107	117	210	228	218	184	152	218	275	214	228	205	156	144	156	152	205	218	184	144	125	96	96	86	83	83	83	83	74	74	67	67	67	64	62	62	59	24
168	152	140	132	228	305	290	237	184	184	196	218	237	275	275	256	275	218	140	218	242	251	201	184	164	152	132	125	117	110	104	96	116	83	83	83	74	67	67	67	67	25
83	83	77	77	74	71	74	77	74	71	71	71	71	67	64	62	62	62	62	62	62	62	67	74	67	64	62	59	56	53	53	53	53	53	53	53	53	53	53	53	53	26
218	192	164	148	132	125	132	205	228	164	148	164	184	251	265	218	218	164	121	113	184	218	184	160	148	110	107	100	96	86	83	77	74	74	71	67	67	67	67	67	62	27
164	132	275	242	156	132	184	196	184	156	192	192	275	275	246	246	237	184	128	152	218	242	251	192	152	125	110	104	83	74	100	86	83	83	83	77	74	67	62	59	59	28
192	132	113	113	107	104	132	184	164	132	125	132	218	290	315	265	265	260	228	152	205	237	218	205	201	113	100	96	83	88	80	74	71	67	67	64	62	62	62	62	62	29
164	132	104	96	96	96	100	125	184	184	132	218	251	275	265	246	237	184	132	152	205	246	218	205	125	110	83	74	67	67	67	67	64	62	62	62	59	59	56	56	56	30
152	113	113	113	96	96	96	184	192	201	160	164	164	228	275	228	265	214	164	128	107	132	228	242	228	192	144	125	104	96	96	96	83	83	83	74	71	64	62	62	62	62	1
201	184	156	132	125	125	132	201	201	164	152	152	228	275	290	265	290	275	242	214	300	275	300	285	218	184	148	228	201	192	156	132	128	125	113	104	96	83	83	80	80	2
104	104	104	96	96	96	96	96	96	96	96	83	83	83	83	83	83	83	83	83	83	83	83	83	74	74	67	67	67	67	67	67	67	67	62	62	62	62	62	62	62	3
201	132	132	136	136	144	144	144	148	132	132	184	256	242	201	164	228	188	148	218	260	275	251	196	140	125	125	107	107	107	107	104	110	113	110	104	96	83	74	71	71	4
132	96	96	107	113	121	148	184	156	148	117	125	210	246	205	237	251	218	184	156	214	218	184	152	113	96	86	80	74	74	74	74	71	71	71	67	62	59	59	59	59	5
132	121	110	110	110	110	160	201	184	140	156	164	228	275	256	228	214	205	132	160	205	228	218	148	132	107	96	83	83	74	74	74	71	67	64	64	64	59	59	59	56	6
132	140	132	113	96	96	117	164	184	192	132	132	132	237	265	237	228	218	164	148	164	205	218	228	184	132	113	96	86	86	86	74	64	64	64	59	59	59	56	56	56	7
156	132	117	104	110	132	156	196	164	132	132	132	196	237	275	251	228	218	168	152	228	237	196	132	125	107	100	96	86	86	113	132	96	83	74	67	67	67	62	59	56	8
251*	218*	164	144	132	132	156	184	201	218	205	184	251	265	275	210	205	205	201	158	237	300	275	228	201	156	104	107	96	86	86	86	86	83	83	74	74	74	62	59	59	9
96	83	83	83	83	83	83	83	83	83	83	83	80	77	77	77	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	64	62	59	53	10
196	184	156	196	132	148	184	164	160	152	113	113	96	228	275	228	218	228	260	218	228	237	210	168	132	125	107	96	96	96	96	83	74	67	64	62	59	59	59	56	53	11
132	96	107	117	117	110	164	192	210	214	210	152	242	275	228	218	246	184	132	113	148	228	184	140	125	117	117	152	156	132	117	104	83	74	67	62	59	59	59	56	56	12
140	125	117	110	104	113	184	228	210	184	132	132	210	265	237	265	218	152	128	128	184	228	218	228	205	152	117	104	96	86	86	86	83	74	67	64	62	62	62	67	71	13
160	140	132	132	140	148	184	210	228	228	156	192	218	275	275	275	295	300	228	148	218	228	265	228	214	148	128	128	125	125	121	113	128	104	96	96	96	86	83	83	80	14
184	184	184	184	132	132	201	228	228	218	201	218	246	265	251	242	237	228	184	156	218	242	251	196	156	136	128	125	125	121	113	128	104	96	96	96	86	83	83	80	62	15
104	77	77	77	77	77	74	74	74	74	67	64	62	59	59	59	59	59	56	53	53	62	71	59	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	16
201	156	164	152	164	184	192	205	184	132	132	184	205	228	205	228	218	218	228	196	164	218	242	228	205	164	121	104	83	80	77	228	200	251	152	59	56	53	53	53	50	17
184	164	132	110	125	132	152	152	148	148	148	144	201	237	228	210	218	228	196	164	218	246	228	201	164	152	132	110	104	96	96	96	113	96	96	83	80	80	77	74	74	18
144	132	117	96	117	144	164	184	196	184	184	132	184	228	232	265	251	265	246	192	205	218	246	228	205	184	152	132	113	104	107	100	96	96	96	83	74	67	67	67	64	19
164	132	140	121	140	132	184	196	184	156	140	205	232	275	256	237	265	214	152	184	218	232	205	184	140	128	121	113	104	140*	136*	218*	242*	237*	228*	214*	168*	148*	140*	132*	113*	20
300*	275*	237*	205*	201*	201*	228*	256*	246*	232*	205*	275*	280*	205*	275*	228	218	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
214	132	132	132	132	132	196	218	201	164	164	192	205	275	228	218	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
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–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
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–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
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–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
140	113	113	117	132	140	737*	826*	526*	456*	911*	840*	703*	576*	378*	305*	305*	237*	228*	223*	315*	367*	305*	285*	205	152	125	121	132	125	113	107	83	83	83	74	71	67	67	67	64	1
184	160	113	107	107	132	117	140	218	210	184	184	256	270	310	275	491*	422*	315*	300*	378*	410*	378*	315*	265*	251*	265*	251*	378*	467*	351*	378*	351*	205*	228*	192*	64	62	62	59	59	2
214	201	184	184	184	164	184	192	218	184	144	228	275*	335*	310*	285*	275*	237	184	164	223	228	218	164	121	110	110	86	77	96	104	83	74	67	64	62	62	62	59	59	59	3
148	125	104	107	113	104	113	184	218	184	152	164	214	251	265	260	218	275	192	164	210	228	205	228	184	164	152	96	96	83	83	80	77	77	71	64	64	59	53	53	53	4
237	184	140	110	104	96	113	184	104	152	148	205	228	116	132	184	218	144	214	228	164	164	205	228	184	164	152	144	128	125	117	104	104	96	83	83	83	80	74	67	62	5
228	164	201	144	242	184	184	237	251	251	218	205	260	305	251	251	265	214	237	228	251	275	251	218	184	152	144	128	125	117	104	104	96	83	83	83	80	74	67	62	62	6
77	77	77	77	77	77	74	74	74	74	71	67	64	62	62	62	62	59	59	56	53	56	56	56	56	53	53	53	53	53	53	53	53	53	53	53	53	53	50	50	50	7
218	223	218	210	196	184	184	218	196	164	148	132	196	251	205	218	251	218	184	184	125	148	184	164	205	218	184	164	164	164	132	113	107	83	83	83	77	64	62	59	59	8
132	148	140	132	86	96	83	152	196	184	132	125	184	218	184	184	184	184	164	125	184	164	201	144	132	125	96	83	80	74	83	83	83	83	83	83	83	83	83	83	83	9
125	125	86	83	83	83	113	184	251*	148	152	140	148	218	205	184	218	196	164	125	164	184	184	140	117	107	132	113	96	83	83	83	83	83	83	83	83	83	83	83	83	10
184	132	107	96	107	110	132	192	205	196	184	152	132	196	205	184	128	164	205	164	184	152	144	132	125	576*	730*	576*	378*	300*	251*	218*	240*	132*	113*	96*	77*	71*	64	–	–	11
152	132	110	113	107	104	132	168	188	140	132	125	164	184	164	148	140	164	164	156	184	152	144	132	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
228*	223*	228*	223*	218*	242*	228*	205*	251*	214*	218*	223*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
170	145	138	130	127	131	159	193	192	171	157	170	211	252	238	230	225	207	174	162	197	226	215	187	151	130	117	109	104	95	95	95	86	82	76	73	69	67	64	62	61	

rriving at the Mean Results. *See* Explanation in Appendix III., page 76.

1	15	30	45	DATE.
43	43	43	40	24
54	54	48	48	25
46	46	46	46	26
43	43	43	43	27
38	38	38	35	28
54	54	54	51	29
46	46	46	46	30
48	48	46	46	1
31	31	31	31	2
–	–	–	28	3
–	–	–	–	4
–	–	–	–	5
–	–	–	–	6
31	31	31	–	7
31	31	31	31	8
35	35	35	35	9
26	26	26	26	10
31	31	31	31	11
31	31	31	31	12
40	35	33	33	13
38	38	38	38	14
38	38	38	–	15
–	–	–	–	16
–	–	–	–	17
–	–	–	–	18
–	–	–	–	19
–	–	–	38	20
–	–	–	–	21
–	–	–	–	22
–	–	–	–	23
–	–	–	–	24
–	–	–	–	25
–	–	–	–	26
–	–	–	–	27
–	–	–	–	28
–	–	–	–	29
–	–	–	–	30
–	–	–	–	31
–	–	–	–	1
–	–	–	–	2
–	–	–	–	3
–	–	–	–	4
–	–	–	–	5
–	–	–	–	6
–	–	–	–	7
–	–	–	–	8
–	–	–	–	9
–	–	–	–	10
–	–	–	–	11
–	–	–	–	12
–	–	–	–	13
–	–	–	–	14
–	–	–	–	15
–	–	–	–	16
–	–	–	–	17
–	–	–	–	18
–	–	–	–	19
–	–	–	–	20
33	33	33	33	1
378*	193*	64*	–	2
33	31	31	31	3
33	33	33	33	4
48	43	46	46	5
31	31	31	31	6
40	40	40	40	7
33	33	33	33	8
33	33	33	31	9
28	28	28	28	10
–	–	–	–	11
–	–	–	–	12
–	–	–	–	13
–	–	–	–	14
–	–	–	–	15
–	–	–	–	16
–	–	–	–	17
–	–	–	–	18
–	–	–	–	19
–	–	–	–	20
38	36	37	36	

APRIL MAY JUNE

W. B. Hach, Engineer.

MAIN DRAINING.

CUBIC FEET PER MINUTE.

MORNING.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45
JUNE 14	9·0	8·0	8·4	8·4	8·4	8·4	8·0	8·0	8·0	8·0	7·8	7·8	7·8	7·8	7·8	7·8	7·2	7·2	7·2	7·2	6·8	5·5	0·3	6·3	6·8	7·2	0·3	8·6	15·0	26·6	33·0	45·5	56·0	61·3	67·0	61·5	69·0	74·5	71·3	67·0	56·6	42·3	36·6	25·0
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JUNE 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

MEAN.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45
JUNE 14	9·0	8·0	8·4	8·4	8·4	8·4	8·0	8·0	8·0	8·0	7·8	7·8	7·8	7·8	7·8	7·8	7·2	7·2	7·2	7·2	6·8	5·5	0·3	6·3	6·8	7·2	0·3	8·6	15·0	26·6	33·0	45·5	56·0	61·3	67·0	61·5	69·0	74·5	71·3	67·0	56·6	42·3	36·6	25·0
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JUNE 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Mean of the Month

EVENING.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45
JUNE 14	9·0	8·0	8·4	8·4	8·4	8·4	8·0	8·0	8·0	8·0	7·8	7·8	7·8	7·8	7·8	7·8	7·2	7·2	7·2	7·2	6·8	5·5	0·3	6·3	6·8	7·2	0·3	8·6	15·0	26·6	33·0	45·5	56·0	61·3	67·0	61·5	69·0	74·5	71·3	67·0	56·6	42·3	36·6	25·0
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JUNE 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

MEAN.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45
JUNE 14	9·0	8·0	8·4	8·4	8·4	8·4	8·0	8·0	8·0	8·0	7·8	7·8	7·8	7·8	7·8	7·8	7·2	7·2	7·2	7·2	6·8	5·5	0·3	6·3	6·8	7·2	0·3	8·6	15·0	26·6	33·0	45·5	56·0	61·3	67·0	61·5	69·0	74·5	71·3	67·0	56·6	42·3	36·6	25·0
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JUNE 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Mean of the Month

Note.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (555), also t

MEA

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

NORFOLK-STREET SEWER.

EVENING.

DATE.	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15
	CUBIC FEET PER MINUT																																															
APRIL 1	26	24	51	31	13	16	18	18	16	16	16	15	11	11	13	11	13	15	13	13	13	15	15	13	13	11	13	13	13	11	11	11	11	11	11	–	–	26	–	–	–	–	–	–	–	–	–
2	–	–	–	–	51	48	51	46	43	41	51	43	16	15	13	13	15	13	13	26	36	38	38	43	48	33	33	33	31	16	15	36	36	33	33	33	29	16	22	26	29	29	24	21	21	21	22	31	21
3	–	–	–	–	–	–	–	72	66	62	46	24	48	43	43	43	43	22	36	15	38	43	43	48	46	22	51	22	21	16	15	13	15	13	13	13	13	15	16	22	26	26	24	21	21	21	22	31	15
4	43	48	54	48	43	–	–	–	–	–	–	–	–	–	–	–	–	46	31	26	46	–	–	–	31	51	13	21	13	–	–	15	16	15	15	15	15	15	16	22	22	26	26	24	21	21	21	22	13	15
5	48	62	68	72	74	78	41	72	82	82	–	–	–	–	–	–	–	18	41	38	46	48	–	–	18	13	13	13	13	–	–	13	13	13	13	13	13	13	13	15	22	26	29	24	21	21	21	13	13	21
6	58*	58	62	82	78	82	94	108	94	82	72	72	–	–	–	–	–	–	–	–	–	–	–	–	–	15	18	13	–	–	–	–	–	–	–	–	–	–	15	22	26	29	29	26	24	21	21	21	15
7	45·5	56·0	61·3	67.0	61·5	69·0	62·0	74·5	71·3	67·0	56·6	42·3	28·6	24·3	23·0	20·3	17·0	20·7	20·5	26·2	38·2	41·7	44·2	28·6	26·8	20·4	19·2	18·0	18·4	18·4	18·4	17·8	17·4	16·8	16·0	19·2	22·8	22·0	20·5	20·2	19·3	19·0	24·3	25·6	22·0	19·6	15·6	19·2

MEAN OF THE WHOLE - - - 21 CUBIC FEET PER MINUTE.

LIMEKILN DOCK SEWER.

DATE.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MAY 1	86	86	100	93	93	93	93	107	107	104	118	118	111	107	122	133	152	152	156	164	172	176	164	164	160	156	156	160	176	–	–	–	–	–	–	–	–	–	–	–	–	–	275	172	–
2	93	83	77	71	65	59	65	74	90	97	97	129	129	129	137	144	152	160	152	144	133	129	125	118	125	114	97	83	77	77	133	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
3	–	206	148	97	86	77	65	71	90	90	90	90	93	114	114	148	152	160	164	164	144	133	129	114	125	137	164	164	164	148	133	129	156	172	172	189	–	–	–	–	–	–	–	–	–	–	–	13
4	–	–	–	–	361	300	224	168	133	144	140	144	144	144	164	197	189	164	148	133	125	125	125	125	125	118	107	140	156	125	125	125	176	185	164	156	152	144	172	–	–	–	–	–	–	–	–	14
5	–	–	–	–	–	–	–	–	–	–	285	242	228	219	185	185	185	164	185	172	164	164	164	164	164	164	164	164	164	164	164	160	160	156	160	148	125	125	125	125	156	118	114	111	111	156	–	15
6	90	90	90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	261	244	145	153	152	152	149	144	133	125	114	100	97	97	93	93	93	97	111	107	107	104	97	93	90	90	90	90	90	90	–	16
7	71	54	54	63	54	54	71	–	–	–	–	–	–	–	–	–	–	–	–	–	–	300	206	156	133	118	114	107	104	100	125	156	164	164	164	164	164	164	164	156	156	133	86	77	74	71	68	620	17
8	68	59	59	59	59	59	65	80	86	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	125	114	107	104	160	129	185	185	185	185	189	160	129	144	144	144	144	133	122	104	902	18
9	77	59	59	59	54	54	54	68	97	114	125	133	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	176	185	160	125	185	185	189	164	144	118	104	90	80	74	68	623	19
10	93	100	104	97	86	83	90	90	80	83	100	111	107	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	160	156	160	125	185	185	189	160	129	144	144	144	133	122	104	744	20
11	122	100	93	100	93	86	93	97	90	93	100	140	172	164	144	144	–	–	–	–	–	–	–	–	–	–	–	–	–	156	164	164	164	164	164	164	164	164	164	164	164	164	164	164	164	164	164	25
12	107	104	104	104	100	100	104	114	114	111	125	122	122	114	114	118	118	118	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
2	90	80½	81	82½	77	74	78	88	98	104	112	123	125	125	135	153	158	157	161	155	148	145	138	143	138	142	137	143	138	122	126	147	168½	164½	174½	165	158	161	154	146½	141	124	111	101	94½	93	728	28
3																																															29
4																																															30
5																																															31

MEAN OF THE 24 HOURS - - - 91 CUBIC FEET PER MINUTE.

HACKNEY BROOK SEWER.

DATE.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUNE 1	604*	604*	604*	804*	804*	804*	818*	804*	780*	775*	775*	775*	760*	760*	760*	732*	732*	585	585	585	585	598	598	598	598	598	598	598	598	598	598	598	598	598	598	598	598	585	598	611*	611*	651*	677*	691*	705*	705*	718*	705*	705
2	611*	598*	573	573	611	611	611	611	598	598	585	775*	585	585	585	573	732*	573	560	560	573	585	573	573	585	585	585	573	573	560	573	573	573	573	804*	–	–	–	–	–	–	–	–	–	–	–	–	1,406	9
3	497	497	497	497	497	497	510	510	523	510	510	691*	691*	523	523	523	510	497	497	497	510	510	523	523	523	510	510	523	523	523	523	523	585	624*	705*	732*	775*	876*	967*	1,091*	1,172*	1,188*	1,172*	1,172*	1,204*	1,288*	1,339*	1,372*	1,372*	1,355	11
4	677*	677*	677*	677*	677*	691*	691*	691*	691*	691*	691*	691*	705*	705*	705*	718*	718*	691*	691*	691*	691*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	691*	691*	691*	691*	691*	691*	691*	691*	705*	718*	718*	732*	746*	746*	746*	746	12
5	485	485	485	497	497	535	547	547	547	573	585	598	624	637	664	651	624	611	611	611	611	611	611	611	611	611	611	611	611	611	611	611	611	611	921	818	760	732	718	705	677	677	664	637	637	637	624	624	637	13
6	426	426	426	426	414	414	414	414	414	402	402	402	437	677	804	921	1,028	1,091	1,107	1,107	1,107	1,107	1,107	1,107	1,107	1,155	1,172	1,168	1,204	1,221	1,188	1,139	1,059	1,028	997	921	818	760	732	718	705	677	677	664	637	637	624	624	624	14
7	391	402	402	402	414	437	449	437	426	426	437	449	461	461	449	449	437	426	427	449	449	449	449	461	473	473	461	461	461	401	461	449	449	461	461	461	461	461	473	473	473	485	535	573	585	585	585	573	573	15
8	414	414	414	426	437	461	473	461	449	449	461	473	461	449	449	437	437	437	426	426	437	449	461	473	485	485	485	485	485	473	485	485	485	473	473	473	473	473	485	485	485	473	473	473	485	497	497	497	497	16
9	380	380	391	402	414	426	426	426	426	437	437	437	449	449	449	449	449	449	461	473	485	485	497	497	497	497	497	510	510	510	510	510	523	535	560*	611*	624*	624*	1,123*	1,238*	1,288*	1,255*	–	–	1,204*	1,204*	1,188*	1,188*	1,188	17
10	473	473	485	485	485	497	497	497	497	497	497	497	510	523	523	510	510	510	510	523	535	535	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
11																																															19
12	438	440	450	463	471	485	490	488	484	486	486	496	516	518	520	515	520	511	511	516	523	528	530	530	539	537	535	536	537	543	534	538	540	542	543	543	550	542	551	527	544	561	586	589	582	580	583	20

MEAN OF THE 24 HOURS - - - 497 CUBIC FEET PER MINUTE.

*.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (753), also the Sunday Gaugings printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., Page 76.

95

M

DATE.

	45	30	15	10	11	15	30	45	9	15	30	45	8	15	30	45	7	15	30	45	5
APRIL																					
24	40	43	43	46	43	43	43	43	46	48	48	48	46	54	54	54	83	83	83	83	—
25	48	48	54	59	54	54	54	54	59	62	59	59	62	54	54	54	93	70	70	67	—
26	46	46	46	43	46	43	43	43	43	38	38	38	40	48	48	48	48	43	43	40	—
27	43	43	43	43	43	43	43	43	43	48	46	46	48	48	48	48	48	48	48	51	—
28	35	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	—
29	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	—
30	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	—
MAY																					
1	46	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	—
2	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	—
3	28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	—
9	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	—
10	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	—
11	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	—
12	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	—
13	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
14	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JUNE																					
1	53	33	33	35	35	35	35	35	33	38	33	33	40	40	40	40	40	40	40	40	—
2	64*	155*	33	200*	64*	38*	49*	107*	118*	114*	80*	51*	100*	100*	90*	70*	90*	70*	51*	51*	—
3	31	33	33	33	33	33	33	35	35	35	35	35	46	51	48	46	46	46	46	46	—
4	33	33	33	33	33	33	33	35	35	35	35	35	40	40	80	40	40	40	40	40	—
5	46	43	46	48	48	43	46	48	77	62	51	43	74	80	80	62	74	62	48	48	—
6	31	31	31	28	28	28	28	31	43	43	43	40	43	43	43	43	43	43	43	43	—
7	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	—
8	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
9	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	—
10	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	—
11	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	—
12	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
13	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
14	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
15	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
17	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
18	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
19	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
20	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	—
	36	37	36	38	38	38	38	39	42	42	43	43	46	47	49	53	55	55	58	55	14

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IN G.

MINUTE.

DATE.	45	30	15	11	10	15	30	45	9	15	30	45	8	15	30	45	7	15	30	45	5
JUNE																					
14	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	—
15	8	8	8	8	8	10	10	11	10	10	10	11	10	10	10	10	10	10	10	10	—
16	8	8	8	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	—
17	8	8	8	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	8·6	8·6	8·0	9·5	9·0	10·5	10·0	11·0	11·0	11·0	11·0	11·0	13·5	11·0	15·0	14·0	15·6	15·6	15·0	14·0	22·0

DATE.	45	30	15	10	11	15	30	45	9	15	30	45	8	15	30	45	7	15	30	45	5
APRIL																					
27	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	—
28	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	—
29	48	48	48	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	—
30	104	104	104	107	107	107	107	107	107	107	107	107	107	107	107	107	107	107	107	107	—
MAY																					
1	48	48	48	51	51	51	51	54	54	54	54	54	54	54	54	54	54	54	54	54	—
2	97	—	—	100	111	—	—	97	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	46	48	43	51	54	54	54	51	54	54	54	54	54	54	54	—
6	—	—	—	—	—	77	61	54	61	61	61	61	61	61	61	61	61	61	61	61	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	77	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	67	66	61½	61	57	59	60	61	61	56	60½	60	64	56	56	57	59	64	64	57	10

DATE.	45	30	15	10	11	15	30	45	9	15	30	45	8	15	30	45	7	15	30	45	5
APRIL																					
27	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	760*	—
28	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	691*	—
29	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	677*	—
30	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	624*	—
MAY																					
1	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	637*	—
2	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	983*	—
3	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	967*	—
4	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	611*	—
5	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	—
6	497	497	497	497	497	497	497	497	497	497	497	497	497	497	497	497	497	497	497	497	—
7	449	449	449	449	449	449	449	449	449	449	449	449	449	449	449	449	449	449	449	449	—
8	457	457	457	457	457	457	457	457	457	457	457	457	457	457	457	457	457	457	457	457	—
9	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	705*	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	501	501	491	483	488	510	504	516	526	526	535	535	547	547	560	560	583	583	580	582	14

MORNING.

CUBIC FEET.

DATE.	APRIL	MAY	JUNE
12	46 40 51 46 43 35 51	– – – – – – –	– 40 48 46 43 35 51
15	43 48 46 49 43 35 51	– – – – – – –	– 40 48 46 43 35 51
30	49 46 48 46 49 35 51	– – – – – – –	– 40 48 46 43 35 51
45	46 46 46 49 43 35 51	– – – – – – –	– 51 46 46 43 35 51
1	43 46 48 46 43 33 51	– – – – – – –	– – 48 46 43 33 51
15	43 46 48 46 43 33 51	– – – – – – –	– – 48 46 43 33 51
30	49 46 40 46 31 31 48	– – – – – – –	– – 40 46 31 31 48
45	43 46 – – 46 31 48	– – – – – – –	– – – – 46 31 48
2	43 45 – – 40 31 48	– – – – – – –	– – – – 40 31 48
15	43 46 – – 46 31 50	– – – – – – –	– – – – 46 31 50
30	49 46 – – 46 33 67	– – – – – – –	– – – – 46 33 67
45	43 48 – – 46 33 64	– – – – – – –	– – – – 46 33 64
3	43 50 – – 33 50	– – – – – – –	– – – – 33 50
15	43 50 – – – 31 51	– – – – – – –	– – – – – 31 51
30	40 51 – – – 31 48	– – – – – – –	– – – – – 31 48
45	40 51 – – – 31 48	– – – – – – –	– – – – – 31 48
4	40 46 – – – 31 48	– – – – – – –	– – – – – 31 48
15	40 48 – – – 31 48	– – – – – – –	– – – – – 31 48
30	40 48 – – – 31 48	– – – – – – –	– – – – – 31 48
45	46 48 – – – 31 51	– – – – – – –	– – – – – 31 51
5	43 46 – – – 31 –	– – – – – – –	– – – – – 31 –
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EVENING.

DATE.	APRIL	MAY	JUNE
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10	49 46 – – 46 33 67	– – – – – – –	– – – – 46 33 67
15	43 48 – – 46 33 64	– – – – – – –	– – – – 46 33 64
30	43 50 – – 33 50	– – – – – – –	– – – – 33 50
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EVENING.

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15	43 48 – – 46 33 64	– – – – – – –	– – – – 46 33 64
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18	46 48 – – – 31 –	– – – – – – –	– – – – – 31 –
19	46 48 – – – 31 –	– – – – – – –	– – – – – 31 –
20	46 48 – – – 31 –	– – – – – – –	– – – – – 31 –

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

ESSEX-STREET SEWER.

MORNING.

CUBIC FEET PER MINUTE.

DAY	3	3 45	5	5 15	5 30	5 45	6	6 15	6 30	6 45	7	7 15	7 30	7 45	8	8 15	8 30	8 45	9	9 15	9 30	9 45	10	10 15	10 30	10 45	11	11 15	11 30	11 45	12	12 15	12 30	12 45	1	1 15	1 30	1 45	2	2 15	2 30	2 45	3	3 15	3 30	3 45	4	4 15	4 30
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	2	38	38	38	38	38	38	38	38	38	38	48	59	90	151	206	193	184	176	168	172	172	168	168	144	90	80	74	121	147	151	110	107	132	–	–	–	–	–	–	–	–	–	–	–	–	–	107	1
	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	159	151	155	144	147	144	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
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	5	38	38	38	38	38	38	38	38	38	38	48	59	90	151	206	193	184	176	168	172	172	168	168	144	90	80	74	121	147	151	110	107	132	–	–	–	–	–	–	–	–	–	–	–	–	–	107	1
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	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	144	151	132	136	140	140	107	100	121	100	96	118	110	121	121	93	93	121	144	132	170	64	62	54	54	59	62	59	62	62	144	
	16	46	43	46	43	43	46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	140	136	100	96	93	83	103	140	163	168	140	132	132	151	168	151	132	107	77	70	74	74	70	64	62	62	62		
	17	48	46	46	46	48	48	48	43	43	43	46	46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	43	43	43	35	35	33	46	35	35	35	33	33	38	33	33	33	33	33	31	
	18	26	26	26	26	26	26	26	26	26	26	26	35	31	110	151	172	147	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118	114	136	144	107	77	80	80	83	83	80	80	74	86	86		
	19	26	26	26	26	26	26	26	26	26	26	26	31	62	90	118	103	90	107	107	118	110	110	–	–	–	–	–	–	–	–	–	–	–	–	–	90	74	62	54	59	62	67	80	83	93	107	118	1
	20	28	28	26	26	26	26	28	28	28	28	31	33	33	121	155	121	147	132	118	107	107	136	132	103	100	96	80	132	141	–	–	–	–	–	–	–	–	–	–	46	46	48	51	51	46	59	64	46	
	21	28	28	28	31	43	80	46	38	38	33	48	43	80	144	147	132	118	118	107	107	103	100	100	96	93	90	90	83	140	144	144	–	–	–	–	–	–	–	–	–	–	–	–	59	51	51	62	83	
	22	26	26	26	26	26	28	28	26	31	99	100	100	110	132	132	110	110	132	132	114	133	93	96	93	90	90	83	140	144	144	140	118	–	–	–	–	–	–	–	–	–	–	–	–	–	–	93	86	
	23	26	28	28	28	28	28	26	31	31	28	28	26	67	100	147	118	118	118	107	107	103	100	100	742	214	118	121	114	140	140	132	136	136	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
	24	35	35	35	38	38	38	22	35	35	31	31	31	51	103	136	144	132	118	118	118	118	83	83	80	80	70	70	118	147	147	132	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
	25	–	22	22	22	22	22	22	22	22	22	22	31	31	144	172	151	132	100	100	110	114	114	107	100	93	93	90	83	83	96	132	144	83	114	114	163	172	132	144	–	–	–	–	–	–	–	–	–	
	26	–	31	31	31	31	40	40	51	51	51	43	43	77	86	114	103	100	110	114	114	107	100	93	93	90	83	83	96	132	144	147	118	96	140	147	168	147	80	67	51	54	–	–	–	–	–	–	–	
	27	–	31	31	31	31	31	31	33	33	31	31	31	70	118	172	147	140	140	214	155	151	144	188	159	147	144	144	147	147	132	144	147	151	151	103	172	200	206	172	90	70	70	74	83	83	–	–	–	
	28	–	–	–	35	35	33	33	33	33	33	48	74	80	114	172	147	118	144	168	184	159	147	144	144	147	147	147	132	144	147	155	151	151	151	140	155	155	100	100	62	54	59	59	59	77	90	–	–	–	
	29	–	–	–	–	–	–	–	35	35	35	35	43	51	59	93	114	147	140	132	118	151	155	118	118	151	155	151	155	118	176	184	184	193	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
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	2	33	33	33	33	33	33	40	35	33	40	48	54	132	184	188	147	147	144	172	163	163	–	–	–	–	–	–	–	–	–	–	–	–	144	144	140	103	77	67	77	107	132	140	140	140	151	144	118	
	3	24	24	24	24	24	24	24	24	26	26	38	43	51	100	140	147	168	136	140	136	144	144	155	–	–	–	–	–	–	–	–	–	–	–	–	–	93	74	62	64	64	67	67	80	83	83	
	4	28	28	28	28	28	28	28	31	31	33	33	33	51	132	151	155	121	140	140	132	155	155	132	140	140	140	144	–	–	–	–	–	–	–	–	–	–	–	–	77	77	80	90	80	96	103	
	5	147*	93*	70*	59*	43	33	33	33	31	31	28	31	31	86	107	86	90	96	147	140	155	159	144	147	151	132	144	155	168	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	107	114	
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	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
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	29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
	30	28	28	28	28	28	33	31	38	28	31	31	40	90	132	155	118	93	107	107	93	90	90	70	64	74	77	67	90	132	144	132	74	74	103	107	103	103	103	–	–	–	–	–	–	–	–	–	–	
	31	–	26	26	26	26	26	31	31	26	24	26	31	54	118	140	132	103	96	100	90	96	70	64	67	74	74	59	100	132	132	90	100	118	132	136	110	110	–	–	–	–	–	–	–	–	–	–	–	
	1	–	–	–	–	28	28	28	31	31	28	28	43	83	110	144	151	140	90	83	90	90	86	93	83	80	74	90	100	90	121	96	86	114	114	110	90	83	40	35	35	–	–	–	–	–	–	–	–	–	
	2	–	–	–	–	–	–	–	–	–	40	26	35	51	140	176	172	147	159	151	132	147	155	136	96	100	93	74	90	147	147	140	90	107	118	118	114	77	70	59	62	62	70	70	–	–	–	–	–	
	3	–	–	–	–	–	–	31	31	28	26	26	35	54	83	132	151	132	103	107	90	96	107	103	83	83	86	83	74	100	147	147	132	103	132	136	121	110	74	59	51	54	51	64	64	59	59	59	–	
	4	–	–	–	–	–	–	–	–	40	40	38	54	83	132	151	132	103	107	90	96	107	103	83	83	86	83	74	100	147	147	132	103	132	136	121	110	74	59	48	38	54	64	70	74	67	59	64	86	
	5	26	26	26	–	–	–	–	–	–	–	–	–	59	46	70	77	77	62	64	64	70	64	64	70	70	62	62	77	110	110	74	54	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	46	46	
	6	35	35	35	35	40	–	–	–	–	–	–	–	–	–	–	–	–	132	86	77	83	64	64	64	70	70	64	64	77	54	96	110	107	93	86	107	107	86	77	74	62	54	59	54	59	54	51	48	46	74	
	7	26	26	26	26	26	26	26	26	26	–	–	–	–	–	–	–	–	–	–	–	–	–	59	59	64	67	54	64	48	86	136	147	110	93	86	107	107	86	77	74	62	54	59	54	74	80	74	74	86	
	8	26	26	26	26	26	26	31	31	28	38	48	80	77	103	132	110	93	90	–	–	–	–	–	–	–	–	67	80	90	151	163	132	132	163	132	132	107	70	64	80	70	74	80	90	90	86	74	
	9	24	24	24	24	24	24	24	59	74	74	64	96	147	172	172	163	155	110	96	103	107	132	118	83	96	110	–	–	–	–	118	77	77	107	103	110	114	77	54	43	40	35	35	59	54	54	40	43	
	10	43*	43*	70*	46*	46*	83*	140*	132*	110*	180*	180*	172*	172*	163*	163*	155	155	110	96	103	107	132	118	83	96	110	–	–	–	–	–	–	–	–	–	–	59	51	48	43	46	40	40	38	35	35	35	–	
	11	31	30	30	30	33	33	32	34	34	37	41	46	71	123	153	141	129	128	131	128	130	124	115	110	107	104	98	120	144	146	126	109	127	136	138	120	92	69	62	63	69	73	75	72	73	80	85	

MEAN OF THE 24 HOURS - - - - - 71 CUBIC FEET PER MINUTE.

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., Page 76.

L I S.

E V E N I N G.

45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
C U B I C F E E T P E R M I N U T E.																																										
–	–	–	–	–	–	–	–	–	–	107	136	144	140	163	163	176	184	184	147	93	80	83	83	83	62	54	54	51	48	48	48	48	46	46	43	43	43	43	43	40	24
–	–	–	–	–	–	–	–	–	–	–	–	140	140	151	151	144	163	93	70	62	62	67	70	67	93	140	144	121	77	62	59	59	59	54	51	54	54	54	48	48	25
67	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	43	43	43	43	43	46	43	40	40	43	46	40	38	38	38	38	43	43	43	43	46	46	46	46	26
96	83	77	83	–	–	–	–	–	–	–	–	–	–	–	–	–	121	107	70	62	48	43	48	51	48	48	48	46	48	48	46	46	80	46	46	43	43	43	43	43	27
100	83	74	67	107	118	118	–	–	–	–	–	–	–	–	–	–	–	–	–	83	86	80	74	67	59	59	54	48	46	48	48	46	46	43	40	40	40	40	38	38	35	28
121	93	74	67	67	77	83	86	96	144	–	–	–	–	–	–	–	–	–	–	–	–	80	77	77	70	64	59	59	62	62	62	59	59	59	59	59	59	54	54	51	29
118	90	86	77	80	83	83	86	80	80	70	136	155	151	132	–	–	–	–	–	–	–	–	–	–	54	51	51	48	46	46	48	48	48	46	46	46	46	46	46	46	30
170	64	62	54	54	59	62	59	62	62	144	90	93	132	140	144	121	121	140	90	–	–	–	–	–	–	–	–	64	64	59	62	59	54	51	51	48	51	48	48	46	1
132	107	77	70	74	74	70	64	62	62	62	62	70	121	136	140	132	121	144	147	155	147	64	54	54	54	–	–	–	–	–	–	–	–	35	31	31	31	31	31	31	2
35	35	33	33	38	33	33	33	33	33	31	31	31	31	31	31	31	33	33	31	31	31	31	31	31	33	33	31	28	28	–	–	–	–	–	–	–	–	–	28	–	3
107	77	80	80	83	83	80	80	74	86	86	96	107	118	132	136	140	151	147	147	118	121	132	93	50	38	33	33	28	28	33	35	31	31	31	–	–	–	–	–	–	4
74	62	54	59	62	67	80	83	93	107	118	140	144	147	147	147	140	140	121	121	90	59	46	40	40	40	40	31	31	31	31	33	33	33	31	28	28	–	–	–	–	5
–	–	46	46	48	51	51	46	59	64	46	59	62	90	118	121	140	151	159	140	121	48	46	46	40	38	38	38	35	31	28	28	31	31	31	31	31	31	31	–	–	6
–	–	–	–	–	–	–	59	51	51	62	83	100	114	121	132	136	140	140	144	62	46	43	43	43	43	38	38	38	38	33	31	31	31	31	31	31	31	31	31	31	7
–	–	–	–	–	–	–	–	–	93	86	90	103	107	136	144	144	151	151	118	90	86	80	77	64	62	59	46	43	43	43	43	40	40	35	35	35	35	35	35	35	8
–	–	–	–	–	–	–	–	–	–	–	121	110	110	132	132	136	144	121	59	67	48	77	74	74	59	51	43	38	31	31	31	31	28	28	28	28	28	26	26	26	9
–	–	–	–	–	–	–	–	–	–	–	–	–	31	31	31	31	38	54	48	33	33	33	33	33	33	33	33	33	33	33	33	33	31	31	31	31	31	31	31	31	10
144	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	159	151	144	86	80	70	64	62	54	54	48	48	40	35	35	33	33	31	31	33	31	31	31	31	31	31	11
80	67	51	54	–	–	–	–	–	–	–	–	–	–	–	156	147	144	147	147	144	121	114	59	59	59	59	70	80	80	67	62	62	59	48	48	43	40	40	35	33	12
90	70	70	74	83	83	–	–	–	–	–	–	–	–	–	–	–	159	140	70	64	62	62	54	51	51	51	48	48	46	46	43	43	43	43	43	43	38	38	38	38	13
100	62	54	59	59	59	77	90	–	–	–	–	–	–	–	–	–	–	–	~~144~~	140	90	74	67	59	54	59	59	59	48	48	46	46	43	40	40	38	38	38	38	38	14
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77	67	77	107	132	140	140	140	151	144	118	100	96	86	90	93	90	90	93	83	54	51	48	48	48	48	43	40	35	35	35	35	–	–	–	–	–	–	–	36	–	20
–	93	74	62	64	64	67	67	80	83	83	70	77	93	107	132*	155*	155*	155*	118*	83	67	54	48	48	48	48	43	40	40	38	38	35	35	–	–	–	–	–	–	–	21
–	–	–	–	77	77	80	90	80	96	103	107	110	114	140*	132*	132*	140*	140*	140*	155*	147*	93	93	86	83	67	62	51	51	80*	114*	107*	90*	74*	59*	51*	46*	–	–	–	22
–	–	–	–	–	–	–	–	80	107	114	118	100	93	96	107	100	103	107	107	67	48	51	51	54	77	93	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
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																																								30
																																								31
103	–	–	–	–	–	–	–	–	–	–	–	–	352*	260*	144*	110	107	93	83	64	64	64	64	40	40	46	40	40	40	40	38	33	31	28	33	35	35	35	33	33	33	1
–	–	–	–	–	–	–	–	–	–	–	–	–	107	90	103	172*	210*	172*	110*	114*	107*	83*	74*	51*	70*	96*	100*	96*	155*	118*	107*	114*	80*	51*	49*	38*	64*	260*	378*	193*	64*	2
59	59	–	–	–	–	–	–	–	–	–	–	–	–	172	188	163	132	90	74	59	48	46	40	33	46	46	51	48	48	35	35	35	35	35	33	33	33	33	33	31	31	3
83	40	35	35	–	–	–	–	–	–	–	–	–	–	–	–	–	107	90	67	54	51	40	38	43	40	40	40	40	35	35	35	35	35	33	33	33	33	33	33	33	33	4
77	70	59	62	62	70	70	–	–	–	–	–	–	–	–	–	–	–	–	–	~~132~~	118	74	59	64	62	74	80	80	80	77	62	51	48	46	46	43	48	48	48	43	46	5
74	59	51	54	51	64	64	59	59	59	–	–	–	–	–	–	–	–	–	–	–	–	77	64	46	48	67	67	48	40	43	43	43	43	35	31	28	28	28	31	31	31	6
48	48	48	48	48	48	48	48	48	46	46	43	46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	43	43	40	40	40	40	40	40	40	40	40	7
54	43	38	54	64	70	74	67	59	64	86	90	100	96	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	35	35	33	33	33	33	33	33	8
74	62	54	59	54	59	54	51	48	46	74	93	107	110	118	121	132	136	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33	33	33	33	33	33	31	9
70	64	80	70	74	80	93	96	90	86	74	70	90	100	103	103	114	114	74	64	59	67	64	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	28	28	–	10
77	54	43	40	35	35	59	54	54	40	43	67	80	83	83	80	90	103	110	114	70	67	64	64	40	43	40	38	–	–	–	–	–	–	–	–	–	–	–	–	–	11
59	51	48	43	46	40	40	38	35	35	35	35	35	35	35	35	33	35	38	40	43	40	40	40	40	132*	260*	378*	286*	224*	188*	151*	118*	–	–	–	–	–	–	–	–	12
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
92	69	62	63	69	73	75	72	73	80	85	94	102	111	122	125	125	126	117	93	82	67	64	58	55	55	53	49	47	46	43	43	42	42	39	38	38	38	36	37	36	14

tals in arriving at the Mean Results. *See* Explanation in Appendix III., Page 76.

1	15	30	45	DATE.
590	590	569	502	27 FEB.
590	590	569	569	28 FEB.
403	403	403	403	1 APRIL
447	429	429	429	2 APRIL
475	465	456	456	3 APRIL
–	–	–	–	4 APRIL
–	–	–	–	5 APRIL
–	–	–	–	6 APRIL
480	–	–	–	7 APRIL
429	429	429	429	8 APRIL
447	447	447	447	9 APRIL
512	512	502	475	10 APRIL
475	456	456	456	11 APRIL
512	502	502	502	12 APRIL
447	447	447	429	13 APRIL
734*	755*	734*	702*	14 APRIL
456	456	456	456	15 MAY
465	456	456	456	16 MAY
502	502	484	569	17 MAY
512	502	502	493	18 MAY
540*	620*	620*	799*	19 MAY
512	512	493	484	20 MAY
–	–	–	–	21 MAY
–	–	–	–	22 MAY
–	–	–	–	23 MAY
484	–	–	–	24 MAY
465	456	456	456	25 MAY
447	438	438	438	26 MAY
438	438	438	429	27 MAY
465	456	456	456	28 MAY
429	421	421	421	29 MAY
560	502	465	465	30 MAY
560	560	512	502	31 MAY
512	493	465	447	1 JUNE
465	465	447	438	2 JUNE
377	377	369	369	3 JUNE
765*	712*	693*	693*	4 JUNE
–	–	–	–	5 JUNE
–	–	–	–	6 JUNE
–	–	–	–	7 JUNE
630*	–	–	–	8 JUNE
550	550	550	502	9 JUNE
810	799	777	712	10 JUNE
–	–	–	–	11 JUNE
507	456	487	474	

APPENDIX TO REPO

M A I N D R

CUBIC FEET PER MINUTE.

MORNING.

| DATE. | FEBRUARY | | | | | | | | | | | | | | MARCH | | | | | | | | | | | | | | APRIL | | | | | | | | | | | | | APRIL | | | | | | | | | | | | | MAY | | | | | | | | | | | | | APRIL | | | | | | | | | | | | |
|---|---|---

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

FLEET SEWER.

EVENING.

30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	DATE.
T E.																																															CUBIC FEET PER MINUTE.	
																																														7 } FEB. 8 }
																																															1 2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,821	1,912	1,848	1,848	1,912	1,936	1,936	1,912	1,528	1,509	1,464	1,424	1,523	1,848	2,056	2,096	2,296	2,203	1,880	1,616	1,509	1,328	1,180	1,203	1,092	1,180	1,160	–	–	3 4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,821	1,880	1,797	1,821	1,773	1,821	1,912	1,848	1,936	2,096	2,232	2,096	1,616	1,685	1,509	1,640	1,554	1,280	1,116	1,092	1,092	–	–	1,092	5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,554	1,280	1,043	1,043	1,000	980	949	949	908	888	864	864	864	592	592	556	576	6
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,062	1,062	1,043	1,848	1,848	1,880	1,685	1,640	1,528	1,424	1,232	1,180	1,136	1,136	1,062	1,062	1,092	1,043	7
1,685	1,685	1,712	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,685	1,488	1,464	1,301	1,488	1,664	1,180	1,424	1,092	1,043	8
1,136	1,424	1,712	1,685	1,528	1,488	1,328	–	–	–	1,744	1,744	2,096	2,269	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,488	1,208	1,180	1,180	949	1,000	1,062	1,024	8
1,352	1,528	2,096	1,797	1,592	1,616	1,664	1,592	1,085	1,744	1,936	2,269	2,448	2,352	2,352	2,352	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,301	1,062	1,062	1,024	980	9
1,464	1,821	1,685	1,744	1,685	1,554	1,528	1,554	1,848	1,936	2,269	2,448	2,352	2,352	2,352	2,203	2,178	2,232	2,203	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,092	1,092	1,092	10
1,464	1,744	1,821	1,685	1,616	1,640	1,554	1,616	1,712	1,821	1,848	1,912	1,848	2,128	2,203	2,152	2,352	2,416	2,206	2,203	2,056	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
1,464	1,488	1,821	1,744	1,744	1,773	1,685	1,554	1,712	1,848	1,848	2,152	2,178	2,178	2,152	2,178	2,416	2,178	2,269	2,203	2,352	2,152	1,936	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
2,269	2,178	2,504	2,416	2,328	2,203	2,128	2,128	1,880	1,848	1,848	2,096	1,821	2,352	2,416	2,178	2,178	2,269	2,203	2,352	2,152	1,936	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
																																														14
1,744	1,936	1,685	1,821	1,797	1,821	1,797	1,685	1,685	1,640	1,404	1,328	1,328	1,328	1,328	1,328	1,136	1,043	980	1,000	949	980	980	908	908	864	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
–	–	1,797	1,744	1,821	1,821	1,797	1,797	1,797	1,848	1,773	1,821	1,912	2,128	1,936	1,936	1,821	1,912	1,848	2,232	2,269	2,128	1,848	1,744	1,616	1,616	1,509	1,640	1,616	1,712	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16
–	–	–	–	1,744	1,712	1,616	1,744	1,880	1,936	2,128	2,232	2,128	2,056	2,096	2,328	2,448	2,128	2,269	2,056	2,096	1,744	1,640	1,616	1,707	1,712	1,554	1,616	1,712	1,640	1,640	1,616	2,096	1,912	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17
–	–	–	–	–	–	–	–	1,685	1,616	1,616	1,744	2,128	2,203	2,128	2,128	2,128	2,096	2,128	2,128	1,936	1,712	1,664	1,640	1,528	1,592	1,848	1,797	1,616	1,712	1,664	1,640	1,616	2,052	2,056	1,936	1,848	1,744	1,640	1,640	1,464	1,464	1,160	1,160	1,160	1,528	1,062	1,062	–	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,744	1,744	2,152	2,152	2,178	2,056	1,912	1,880	1,712	1,664	1,554	1,592	1,797	1,712	1,528	1,797	1,797	1,797	1,712	1,712	1,848	1,797	1,936	1,880	1,848	1,821	1,640	1,616	1,424	1,380	1,301	1,136	1,024	980	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,936	1,640	1,664	1,664	1,664	1,712	1,712	1,848	1,797	1,936	1,880	1,848	1,821	1,640	1,616	1,424	1,380	1,301	1,136	1,024	980	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	840	888	1,043	1,043	1,092	1,116	1,685	1,464	1,424	1,280	1,160	908	908	864	864	688	688	592	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,712	1,685	1,821	1,848	1,797	1,664	1,554	1,464	1,404	20
540	540	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,640	1,424	1,208	1,160	1,092	1,116	1,043	20
1,640	1,592	1,592	1,554	1,528	1,404	1,380	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,160	1,116	1,024	980	903	888	709	21
1,328	1,328	1,404	1,712	2,056	2,096	1,592	1,640	1,797	1,880	1,912	1,821	1,797	1,821	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,116	1,043	949	1,000	1,180	22
1,380	1,744	1,936	1,797	1,592	1,592	1,488	1,685	1,685	1,592	1,554	2,056	1,880	1,821	1,821	2,056	2,128	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,404	1,301	1,256	23
1,488	1,773	1,773	1,744	1,616	1,554	1,528	1,424	1,640	1,712	1,744	1,848	1,821	1,685	1,712	1,880	1,821	1,848	1,848	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
1,640	2,096	2,128	1,880	1,797	1,685	1,528	1,685	1,685	1,848	1,848	1,936	1,821	1,773	1,773	1,821	1,848	1,848	1,912	1,912	1,821	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25
2,178*	2,178*	2,203*	2,206*	2,388*	2,448*	2,416*	2,388*	2,600*	2,728*	2,728*	2,948*	2,416*	2,128*	2,152*	2,152*	2,269*	2,232*	2,388*	2,600*	2,476*	2,476*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
2,328*	2,232*	2,152*	2,178*	1,797*	2,096*	2,128*	2,950*	1,797*	1,664*	1,554*	1,554*	1,554*	1,912*	3,360*	5,420*	5,220*	3,792	3,048	2,352	1,936	1,821*	1,821*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
–	1,301	1,328	1,404	1,488	1,464	1,509	1,509	1,509	1,352	1,685	1,821	2,056	1,848	1,821	1,821	1,821	1,848	1,880	1,848	1,848	1,821	1,821	1,821	1,821	1,821	1,936	1,640	1,554	1,528	1,488	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28
–	–	–	–	–	–	1,592	1,964	1,797	1,912	2,352	2,476	2,328	2,203	1,936	1,880	1,880	1,912	1,912	2,056	1,848	1,821	1,821	1,821	1,821	1,821	1,936	1,640	1,464	1,424	1,424	1,409	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29
–	–	–	–	–	–	–	–	–	–	2,096	2,203	2,352	2,269	2,096	1,773	1,912	1,912	2,178	2,388	2,203	2,269	1,936	1,744	1,640	1,640	1,640	1,640	1,616	1,616	1,616	1,528	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,232*	2,203*	2,568*	2,656*	2,416*	2,269	2,096	1,773	1,712	1,592	1,528	1,528	1,616	1,664	1,664	1,640	1,712	1,773	1,821	1,821	1,821	1,712	1,712	1,554	1,554	1,352	1,464	–	–	–	–	–	–	–	31
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,328	2,416	2,476	2,416	2,328	2,568	2,232	2,269	1,685	1,640	1,880	1,773	1,685	1,712	1,773	2,096	2,096	2,328	2,056	1,880	1,848	1,848	1,880	1,821	1,616	1,554	–	–	–	–	–	–	–	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,269	2,328	2,260	2,128	2,056	1,821	1,712	1,880	1,664	1,640	1,664	1,640	1,685	1,616	2,096	1,797	1,797	1,797	1,848	1,848	1,880	1,664	1,616	1,180	1,328	1,256	1,160	1,062	1,024	980	1,062	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,062	1,116	1,092	1,043	1,000	1,000	1,062	1,062	1,043	949	888	864	888	864	840	764	764	688	592	576	576	576	–	–	–	3
1,488	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,280	1,256	1,352	1,180	1,797	1,685	1,685	1,797	1,664	1,712	1,712	1,554	1,528	1,528	1,180	1,136	1,136	1,062	1,024	980	1,062	4
1,404	1,528	1,712	1,712	1,912	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,848	1,848	1,848	1,880	1,664	1,616	1,180	1,328	1,323	1,180	1,160	1,062	1,024	980	–	–	5
1,640	1,640	1,554	1,528	1,488	1,554	1,554	1,528	1,821	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,797	1,797	1,712	1,773	1,821	1,821	1,821	2,203	2,232	1,912	1,712	1,554	1,554	1,352	1,464	–	–	6
1,424	1,464	1,528	1,528	1,616	1,685	1,685	2,056	1,821	2,056	1,848	2,152	2,208	2,232	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,096	2,096	2,328	2,056	1,880	1,848	1,848	1,880	1,821	1,616	1,554	–	–	–	–	–	–	7
1,062	1,280	1,685	1,773	1,821	1,616	1,685	1,516	1,712	1,821	1,773	2,056	2,096	2,152	2,096	1,912	1,773	1,707	1,821	2,228	2,600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
2,392	2,352	2,078	2,100	1,880	1,598	1,620	1,340	1,718	1,750	2,134	2,152	2,448	2,296	2,328	1,880	2,078	2,100	2,370	2,100	2,416	2,392	2,100	2,225	2,302	2,100	2,100	1,909	1,848	1,797	1,664	1,712	1,712	1,554	1,528	1,528	1,180	1,136	1,136	1,062	1,024	980	–	–	–	–	9
–	1,598*	1,664*	1,664*	1,718*	1,750	1,380*	1,564*	1,664*	1,750*	2,078*	2,078*	1,718*	1,554*	1,440*	1,404*	1,120	1,024	1,005	985	985	930	908	908	908	852	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
–	–	–	–	–	–	2,078	1,664	1,664	1,646	1,664	1,576	1,598	2,178	2,225	2,056	2,078	2,100	2,416	2,352	2,328	2,200	1,853	1,773	1,664	1,664	1,664	1,312	1,440	1,404	1,424	1,424	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
–	–	–	–	–	–	–	–	–	2,178	2,152	2,056	2,370	2,392	2,352	2,078	1,880	2,328	2,296	1,835	2,100	2,296	1,853	1,664	1,664	1,664	1,640	1,664	1,664	1,640	1,640	1,509	1,509	1,598	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,056	2,056	2,073	2,078	2,134	2,296	2,392	2,134	2,100	1,750	1,664	1,664	1,528	1,424	1,380	1,980	1,404	1,620	1,598	1,598	1,576	1,880	1,853	1,750	1,640	–	–	–	13
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,996*	2,020*	2,886*	2,858*	3,080*	2,996*	1,853	1,718	1,640	1,598	1,528	1,509	1,576	1,835	1,853	2,056	2,078	1,853	1,821	2,056	2,100	2,078	2,078	2,134	–	–	14
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,212*	3,180*	2,996*	2,488*	2,352*	2,225	1,853	1,797	1,664	1,598	1,554	1,509	1,468	1,404	1,380	1,356	1,180	1,120	1,094	1,024	1,024	1,024	1,005	985	–	–	15
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,225	2,203	2,246*	2,152*	2,152*	2,203*	2,296*	2,302*	2,206*	2,225*	2,203*	2,203*	3,968*	2,976*	2,734*	2,540*	2,328*	2,328*	2,540*	2,814*	2,996*	3,276*	3,645*	3,968*	4,147*	16
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,797*	1,750*	1,750*	1,718*	1,718*	1,685*	1,440*	1,440*	1,468*	1,468*	1,440*	1,424*	1,424*	1,424*	1,424*	1,440*	1,440*	1,468*	1,468*	1,468*	1,509*	1,509*	17
1,718	1,718	1,718	1,664	1,664	1,664	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,773	1,797	1,797	1,797	1,689	1,936	2,078	2,056	1,750	1,664	1,664	1,640	1,468*	1,468*	1,312	1,312	1,301	1,301	18
1,835	1,835	1,821	1,821	1,718	1,718	1,835	2,056	2,152	2,152	2,152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,056	2,056	2,056	1,835	1,797	1,440	1,440	1,424	1,440	1,440	1,312	1,301	1,301	19
1,912	1,835	1,835	1,821	1,821	1,750	1,750	1,718	1,880	1,912	2,078	2,203	2,392	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,880	1,718	1,821	1,576	1,440	1,440	1,492	1,468	1,440	20
2,296*	2,632*	2,679*	2,134*	2,056*	2,056*	2,178*	2,448*	4,027*	5,044*	5,192*	5,160*	5,024*	5,372*	3,997*	4,430*	3,276*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,312	20
1,912	1,835	1,821	1,750	1,750	1,700	1,598	1,576	1,835	2,056	2,078	2,504	2,504	2,370	2,352	2,296	2,296	2,352	2,352	2,352	2,370	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
2,246	2,056	2,134	1,821	1,773	1,750	1,718	1,718	1,685	2,296	2,328	2,370	2,352	2,600	2,448*	2,416*	2,476*	2,152	1,773	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
1,621	1,707	1,804	1,758	1,732	1,696	1,626	1,689	1,779	1,859	1,934	2,107	2,141	2,115	2,059	2,010	2,098	2,142	2,123	2,151	2,034	1,930	1,800	1,770	1,631	1,630	1,644	1,607	1,609	1,611	1,687	1,742	1,763	1,845	1,924	1,852	1,758	1,704	1,659	1,519	1,438	1,321	1,331	1,213	1,172	1,147	1,118	

MAY / JUNE

MEAN OF THE 24 HOURS - - - - - - 1,211 CUBIC FEET PER MINUTE.

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (759), also the Sunday Gaugings printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., Page 76.

N G.

R M I N U T E.

A I N

15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
,092	1,180	1,160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
,092	1,092	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
,136	1,062	1,062	1,092	1,000	1,000	980	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
592	592	556	576	576	540	540	549	520	520	–	–	–	–	–	–	–	–	–	–	–	–	–	16
,180	1,424	1,092	1,043	1,000	949	864	864	840	840	888	731	752	731	–	–	–	–	–	–	–	–	–	17
,116	1,116	1,116	1,043	1,000	930	864	840	752	709	709	688	688	652	652	652	652	612	612	592	–	–	–	18
949	1,000	1,062	1,024	1,000	864	674	731	731	688	688	688	652	632	652	632	612	592	576	592	–	–	–	19
,062	1,024	1,024	980	864	864	840	731	731	731	658	688	688	672	672	652	652	612	612	592	592	592	592	20
–	1,092	1,092	1,092	888	840	840	752	764	731	709	688	688	688	672	652	652	652	612	592	592	592	576	21
–	–	–	–	1,180	1,062	1,000	888	864	864	840	764	764	752	752	688	688	652	632	592	592	592	576	22
																							23
																							24
																							25
																							26
																							27
																							28
–	–	–	–	–	–	–	1,328	1,328	1,232	1,160	1,062	949	888	764	764	752	731	709	709	731	709	688	709	1
–	–	–	–	–	–	–	–	–	–	888	840	709	741	741	752	688	709	703	709	672	672	672	652	2
–	–	–	–	–	–	–	–	–	–	–	–	888	888	752	731	731	888	688	672	672	652	632	632	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	888	840	764	632	632	612	612	612	576	4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	540	540	540	5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
,062	1,062	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
,136	1,024	1,024	980	980	980	731	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
688	688	612	592	549	592	556	556	556	556	556	1,280	752	731	672	688	632	–	–	–	–	–	–	–	9
,664	1,554	1,464	1,404	1,301	1,160	1,000	980	949	930	1,280	752	731	672	688	632	–	–	–	–	–	–	–	–	10
,160	1,092	1,116	1,043	930	888	864	764	752	688	652	632	612	632	632	612	592	556	556	520	499	499	–	–	11
980	903	888	709	709	731	731	731	688	652	652	632	652	652	652	652	612	592	592	592	576	576	–	–	12
,043	949	1,000	1,180	1,301	1,464	1,464	1,404	1,328	1,208	1,116	1,062	1,092	1,043	1,024	1,000	1,000	1,000	1,000	1,024	980	949	949	949	13
–	1,404	1,301	1,256	1,062	980	930	908	840	731	908*	1,062*	1,136*	1,328*	1,404*	1,592*	1,592*	1,616*	1,404*	1,232*	1,116*	1,043*	930*	14
–	–	–	–	–	–	–	908	764	764	556	520	499	499	499	499	499	499	499	484	484	484	484	15
–	–	–	–	–	–	592	592	592	576	576	556	520	840	840	752	709	672	672	652	632	592	576	16
–	–	–	–	–	–	–	–	908	1,024	930	930	840	–	–	–	709	688	688	652	652	652	612	576	17
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	688	688	688	612	612	612	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,203*	1,043*	1,043*	1,203*	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	632	632	20
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
576	576	576	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
,136	1,062	1,024	980	980	980	980	980	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
,328	1,180	1,160	1,062	949	908	864	888	764	764	752	731	–	–	–	–	–	–	–	–	–	–	–	–	25
,160	1,062	1,024	980	1,000	888	864	764	764	764	752	709	688	688	688	672	652	652	612	576	–	–	–	–	26
,256	1,256	1,136	1,092	1,043	980	930	908	864	764	752	709	688	688	688	672	652	652	632	632	612	612	612	–	27
–	–	–	949	840	840	764	752	752	752	737	737	737	752	752	840	635	635	592	592	592	576	615	752	28
–	–	–	–	–	–	1,664	1,664	1,664	1,664	1,005	930	930	840	840	840	784	752	737	852	852	764	752	752	29
–	–	–	–	–	–	–	–	484	484	434	434	525	545	484	468	468	468	454	454	454	484	484	484	30
–	–	–	–	–	–	–	–	–	–	–	1,120*	908	852	852	700	688	615	605	592	592	576	576	576	31
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,440*	1,440*	1,424*	1,380*	1,301*	1,120*	949	852	852	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	615	605	592	592	592	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	852	852	852	840	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
3,968*	4,147*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
,468*	1,468*	1,509*	1,509*	1,509*	1,509*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
,640	1,312	1,312	1,301	1,256	1,208	1,236	1,120	1,094	1,043	1,024	1,094	1,062	949	–	–	–	–	–	–	–	–	–	–	9
,440	1,312	1,301	1,301	1,160	1,136	1,094	1,094	1,005	930	960	930	930	930	868	868	–	–	–	–	–	–	–	–	10
,404	1,312	1,256	1,332	1,301	1,301	1,440*	1,404*	1,356*	1,094*	1,062*	1,043*	1,043*	1,024*	985	930	908	868	852	688	–	–	–	–	11
,440	1,492	1,468	1,440	1,380	1,312	1,312	1,256	1,256	1,213	1,213	1,136	1,120	1,094	1,062	985	940	908	903	868	868	752	–	–	12
–	–	–	1,312	1,440	1,236	1,136	1,048	949	930	908	908	908	890	890	868	868	852	852	840	840	840	752	–	13
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
1,213	1,172	1,147	1,118	1,068	1,022	998	971	929	868	822	805	810	769	769	746	724	699	683	672	659	664	658		

45	10	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
–	–	–	1,065	934	922	865	865	821	755	702	702	671	650	630	609	599	590	590	569	502	27
434	1,434	1,407	–	–	–	–	934	910	821	777	755	712	712	702	650	620	590	590	569	569	28
810	842	968	–	–	–	–	–	–	–	–	438	429	429	421	421	412	403	403	403	403	1
–	934	842	–	–	–	–	–	–	–	–	–	–	550	493	475	447	447	429	429	429	2
–	–	–	910	–	–	–	–	–	–	–	–	–	–	–	–	–	–	475	465	456	3
–	–	–	842	799	799	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
–	–	–	821	777	734	693	620	599	599	550	502	493	493	–	–	–	–	–	–	–	5
–	–	–	821	734	671	640	620	599	580	550	502	502	475	–	–	–	–	–	–	–	6
213	1,089	–	888	832	765	734	702	671	630	630	630	630	630	630	599	599	580	–	–	–	7
888	888	788	475	465	456	456	456	447	438	429	429	429	429	429	429	429	429	429	429	429	8
213	1,251	1,342	934	888	788	702	660	640	620	599	599	550	512	493	475	456	447	447	447	447	9
421	1,474	1,474	854	842	799	777	734	702	693	681	640	609	590	590	590	512	512	512	502	475	10
407	1,447	1,474	865	810	744	693	660	640	599	569	569	569	502	493	475	475	475	456	456	456	11
722	1,898	1,751	1,089	876	842	810	734	702	681	640	620	590	569	569	550	550	512	502	502	502	12
652	1,737	1,751	934	865	821	799	744	671	702	650	590	550	502	465	465	456	447	447	447	429	13
751*	1,737*	1,958	–	888	865	821	810	810	832*	910*	1,029*	1,126*	1,152*	1,218*	1,126*	1,077*	934*	755*	734*	702*	14
052*	1,077*	1,101	–	–	–	–	493	484	484	484	484	475	475	456	456	456	456	456	456	456	15
381	1,381	1,542	–	–	–	–	–	755	693	650	640	599	560	560	512	484	475	465	456	456	16
610	1,407	1,447	–	–	–	–	–	–	–	650	599	590	560	560	560	550	512	502	502	484	17
461	1,542	1,597	–	–	–	–	–	–	–	–	–	–	–	609	590	590	560	512	502	502	18
–	–	2,078	–	–	–	–	–	–	–	–	–	–	–	–	671*	660*	650*	640*	620*	620*	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	512	512	493	20
–	–	–	832	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
–	–	–	475	465	465	456	456	456	456	447	438	429	–	–	–	–	–	–	–	–	22
–	–	–	865	777	765	702	671	650	599	580	550	512	493	–	–	–	–	–	–	–	23
,421	1,556	1,610	788	832	765	734	693	630	630	599	580	550	512	484	–	–	–	–	–	–	24
,610	1,624	1,638	922	865	810	799	723	702	620	580	569	512	502	502	484	484	465	456	456	456	25
,421	1,461	1,461	1,029	876	821	799	734	671	640	630	599	560	512	475	456	447	447	438	438	438	26
,200	1,188	1,251	799	765	744	702	693	650	609	580	560	502	493	475	456	456	438	438	438	429	27
,238	1,302	1,381	1,029	968	910	888	832	765	723	660	599	560	502	493	475	465	465	456	456	456	28
968	957	910	456	512	502	502	550	502	502	502	512	512	475	475	456	438	429	421	421	421	29
,013*	1,087*	1,898	1,101*	1,041*	922*	865	810	765	723	702	693	681	640	580	580	560	560	502	465	465	30
,277	1,290	1,407	–	821	810	765	723	693	712	734*	744*	702*	671*	650*	702*	580	560	560	512	502	31
,188	1,152	1,238	–	–	–	–	755	702	650	630	599	569	560	550	512	512	512	493	465	447	1
,226	1,342	1,543	–	–	–	–	–	–	–	–	560	560	560	512	502	493	465	465	447	438	2
–	1,528	1,266	–	–	–	–	–	–	–	–	–	–	–	377	377	377	377	377	369	369	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	810*	765*	712*	693*	693*	4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
–	–	–	1,114	1,029	910	865	865	865	821	–	–	–	–	–	–	–	–	–	–	–	6
,421	1,474	–	1,029	922	865	842	810	755	702	671	671	630	599	550	550	–	–	–	–	–	7
,328	1,328	1,32	1,251*	1,213*	1,213*	1,176*	1,126*	1,089*	957*	922*	865*	865*	734*	702*	671*	650*	630*	–	–	–	8
,011*	3,030*	3,01	1,474*	1,381*	1,277*	1,163*	1,101*	922*	899*	842*	810*	755*	723*	702*	599	590	550	550	550	502	9
,474	1,556	1,62	734	712	755	799	810	810	810	693	744	702	702	702	712	734	810	799	777	712	10
,488	1,381	1,60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
,400	1,407	1,45	922	848	805	776	748	713	676	632	607	580	559	543	532	519	507	456	487	474	

FEBRUARY

MARCH

APRIL

MAY

JUNE

a Black Line, thu

W. B. Hack, Engraver.

M

C U B I C F E

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45
FEB. 27	475	456	431	447	427	438	418	429	417	429	408	421	403	421	401	456	409	447	410	438	412	475	407	421
FEB. 28	560	559	512	512	512	502	484	484	475	–	–	–	456	–	–	456	–	–	–	–	–	–	–	–
MARCH 1	394	394	386	386	394	386	386	386	386	420	465	456	386	456	456	456	438	447	438	438	475	–	–	–
2	439	439	439	439	439	439	439	439	352	352	412	394	394	394	394	394	394	394	394	394	394	403	403	403
3	439	439	439	439	439	439	439	439	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
4	438	361	361	361	361	361	361	361	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
5	–	–	–	–	420	403	403	403	386	386	386	386	386	386	386	386	386	386	386	386	386	386	386	386
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	420	429	429	–	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	447	–	–	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	465	447	447	447	438	438	438	438	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	456	447	429	429	429	429	429	429	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	493	475	475	475	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456
14	429	429	491	421	421	421	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412
15	698*	671*	620*	620*	620*	620*	620*	599*	590*	580*	693*	799*	799*	1,652*	2,123*	2,710*	2,843*	–	–	–	–	–	–	–
16	456	456	498	498	429	429	429	421	421	421	421	412	412	412	412	412	412	–	–	–	–	–	–	–
17	456	456	456	447	429	429	429	429	429	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447
18	580	500	560	502	465	465	465	465	456	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447
19	484	465	465	456	456	456	456	502*	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456
20	1,039*	1,039*	1,188*	1,200*	1,080*	800*	799*	729*	660*	630*	609*	560*	550*	512*	484*	502*	493*	484*	493*	493*	493*	484*	550*	550*
21	465	447	447	447	438	438	429	429	429	429	421	421	421	421	421	421	421	421	421	421	421	429	429	429
22	569	560	512	484	475	456	456	438	421	412	412	412	412	412	412	412	403	403	403	403	403	403	403	403
23	–	–	421	421	421	–	412	412	421	421	412	412	412	412	412	412	412	412	412	412	412	412	412	412
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25	438	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438
28	421	412	419	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412
29	456	447	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438
30	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421
31	447	447	447	498	438	429	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421
APRIL 1	475	456	420	420	421	413	412	412	412	403	403	394	394	394	386	386	386	386	386	386	386	386	386	386
2	447	438	438	421	421	412	403	394	386	386	386	386	386	386	377	377	377	377	377	377	377	377	377	377
3	438	438	438	420	421	421	421	421	421	403	412	403	403	403	403	394	394	394	394	394	394	394	394	394
4	389	386	403	403	412	403	403	403	403	403	403	403	403	403	394	394	394	394	394	394	394	394	394	394
5	923*	1,009*	1,977*	1,196*	1,126*	1,114*	1,152*	957*	865*	810*	865*	864*	864*	1,977*	1,140*	1,461*	1,973*	2,947*	2,123*	2,123*	1,898*	1,528*	1,4	4
6	–	–	620*	620*	640*	660*	660*	660*	620*	560*	484*	484*	484*	465*	447	447	447	421	412	429	412	412	4	4
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
11	712	702	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45
FEB. 27	475	456	431	447	427	438	418	429	417	429	408	421	403	421	401	456	409	447	410	438	412	475	407	421
FEB. 28	560	559	512	512	512	502	484	484	475	–	–	–	456	–	–	456	–	–	–	–	–	–	–	–
MARCH 1	394	394	386	386	394	386	386	386	386	420	465	456	386	456	456	456	438	447	438	438	475	–	–	–
2	439	439	439	439	439	439	439	439	352	352	412	394	394	394	394	394	394	394	394	394	394	403	403	403
3	439	439	439	439	439	439	439	439	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
4	438	361	361	361	361	361	361	361	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
5	–	–	–	–	420	403	403	403	386	386	386	386	386	386	386	386	386	386	386	386	386	386	386	386
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	420	429	429	–	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	447	–	–	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	465	447	447	447	438	438	438	438	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	456	447	429	429	429	429	429	429	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	493	475	475	475	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456
14	429	429	491	421	421	421	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412
15	698*	671*	620*	620*	620*	620*	620*	599*	590*	580*	693*	799*	799*	1,652*	2,123*	2,710*	2,843*	–	–	–	–	–	–	–
16	456	456	498	498	429	429	429	421	421	421	421	412	412	412	412	412	412	–	–	–	–	–	–	–
17	456	456	456	447	429	429	429	429	429	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447
18	580	500	560	502	465	465	465	465	456	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447
19	484	465	465	456	456	456	456	502*	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456
20	1,039*	1,039*	1,188*	1,200*	1,080*	800*	799*	729*	660*	630*	609*	560*	550*	512*	484*	502*	493*	484*	493*	493*	493*	484*	550*	550*
21	465	447	447	447	438	438	429	429	429	429	421	421	421	421	421	421	421	421	421	421	421	429	429	429
22	569	560	512	484	475	456	456	438	421	412	412	412	412	412	412	412	403	403	403	403	403	403	403	403
23	–	–	421	421	421	–	412	412	421	421	412	412	412	412	412	412	412	412	412	412	412	412	412	412
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25	438	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438
28	421	412	419	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412	412
29	456	447	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438
30	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421
31	447	447	447	498	438	429	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421
APRIL 1	475	456	420	420	421	413	412	412	412	403	403	394	394	394	386	386	386	386	386	386	386	386	386	386
2	447	438	438	421	421	412	403	394	386	386	386	386	386	386	377	377	377	377	377	377	377	377	377	377
3	438	438	438	420	421	421	421	421	421	403	412	403	403	403	403	394	394	394	394	394	394	394	394	394
4	389	386	403	403	412	403	403	403	403	403	403	403	403	403	394	394	394	394	394	394	394	394	394	394
5	923*	1,009*	1,977*	1,196*	1,126*	1,114*	1,152*	957*	865*	810*	865*	864*	864*	1,977*	1,140*	1,461*	1,973*	2,947*	2,123*	2,123*	1,898*	1,528*	1,4	4
6	–	–	620*	620*	640*	660*	660*	660*	620*	560*	484*	484*	484*	465*	447	447	447	421	412	429	412	412	4	4
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
11	712	702	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

LONDON BRIDGE SEWER.

MORNING.

CUBIC FEET PER MINUTE.

DAY.	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4
FEBRUARY 3.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4.	–	–	–	–	–	–	–	–	–	–	–	–	–	1,708	1,680	1,569	1,514	1,597	1,461	1,407	1,434	1,434	1,407	1,342	1,342	1,354	1,315	1,290	1,251	1,238	1,381	1,394	1,447	1,666	1,315	1,315	1,277	1,213	1,315	1,140	957	1,065	1,474	1,542	2,016	2,078
5.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	788	842	788	810	842	968	1,041	957	968	922	821	842	810	854	777	702	702	702	693	681	660	640	650	640	640	650	640	599	580
6.	377	475	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	934	842	1,114	1,114	1,052	1,101	1,029	876	842	888	888	888	888	865	865	854	922	1,029	1,142	1,089	1,176	1,176	1,474	1,514	1,514
7.	394	403	403	403	403	403	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,302	1,328	2,168	2,644	2,353	1,597	1,407	1,315	1,163	1,176	1,200	1,152	1,089	1,065	968	1,152	1,089	957	1,065	922	1,302	1,213	1,238
8.	394	394	394	394	394	394	429	550	650	702	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,474	1,514	1,488	1,434	1,447	1,407	1,277	1,213	1,277	1,152	1,089	1,077	1,126	1,126	1,126	1,126	1,126
9.	327	344	344	344	344	344	344	429	599	599	599	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,020	1,126	1,101	1,065	1,077	1,077	1,213	1,342	1,277	1,213	1,238
10.	386	386	386	386	386	386	465	502	493	590	702	1,089	1,176	1,277	1,277	1,277	1,394	1,394	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,089	1,089	1,029	1,041	876	1,052	1,089	1,176	1,188	1,188	1,152
11.	369	369	369	369	369	377	386	502	630	693	1,029	1,213	1,213	1,213	1,213	1,226	1,302	1,277	1,226	1,188	1,213	1,089	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	922	1,514	1,583	1,381	1,354
12.	386	386	386	386	386	386	386	386	386	386	386	386	386	386	386	386	681	681	979	810	888	888	788	810	788	788	777	876	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	777
13.	386	386	386	386	386	386	429	502	702	755	734	957	1,065	1,152	1,407	1,407	1,381	1,354	1,152	1,152	1,213	1,251	1,342	1,315	1,302	1,277	1,277	2,168	1,277	1,368	1,407	1,407	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14.	–	–	–	403	403	429	447	475	599	712	865	1,052	1,176	1,251	1,277	1,251	1,381	1,381	1,381	1,407	1,421	1,474	1,474	1,474	1,488	1,514	1,680	1,680	1,597	1,542	1,569	1,474	1,381	1,354	1,328	1,238	1,188	–	–	–	–	–	–	–	–	–
15.	–	–	–	–	–	429	429	438	899	854	957	1,163	1,251	1,277	1,342	1,342	1,407	1,461	1,213	1,251	1,407	1,447	1,474	1,381	1,461	1,342	1,277	1,251	1,152	1,542	2,047	1,624	1,447	1,407	1,407	1,277	1,277	1,407	–	–	–	–	–	–	–	–
16.	–	–	–	–	–	–	–	–	–	702	1,065	1,176	1,213	1,407	1,434	1,354	1,474	1,583	1,381	1,434	1,722	1,898	1,751	1,737	1,765	1,784	1,680	1,597	1,502	1,407	1,652	1,514	1,461	1,407	1,315	1,277	1,251	1,213	1,152	1,126	–	–	–	–	–	–
17.	–	–	–	–	–	–	–	–	–	755	1,029	1,315	1,447	1,447	1,407	1,434	1,488	1,514	1,461	1,434	1,652	1,737	1,751	1,751	1,680	1,722	1,751	1,514	1,514	1,507	1,737	1,447	1,407	1,277	1,213	1,251	1,213	1,213	1,277	1,251*	1,213*	1,290*	–	–	–	–
18.	–	–	–	–	–	–	–	–	–	–	1,264*	1,434*	1,474*	1,542*	1,597*	1,597*	1,652*	1,652*	1,708*	1,737*	1,751*	1,737*	1,958*	2,168*	2,108*	1,928*	1,737	1,461	1,447	1,315	1,302	1,277	1,302	1,381	1,342	1,251	1,226	1,101	1,101	1,277	1,277	1,277	1,277	1,277	–	–	–
19.	–	–	–	–	–	–	–	–	–	–	–	–	–	1,065*	1,029*	957*	922*	922*	922*	1,029*	1,052*	1,077*	1,101*	1,126*	1,666*	2,354*	3,071*	3,071*	2,677*	2,339*	2,047*	1,737*	1,474*	4,277*	1,188*	1,052*	945*	899*	842*	810*	755	723	702	693	693	671
20.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,328	1,264	1,264	1,328	1,354	1,381	1,381	1,542	1,569	1,680	1,972	1,913	1,780	1,447	1,542	1,474	1,434	1,302	1,264	1,407	1,447	1,328	1,238	1,176	1,152	1,126	1,251	1,251	1,277	1,342	1,342
21.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,569	1,488	1,583	1,610	1,407	1,447	1,638	2,200	1,972	1,680	1,542	1,474	1,514	1,407	1,381	1,794	1,583	1,569	1,407	1,342	1,302	1,277	1,354	1,381	1,381	1,421	1,381	1,290	1,264
22.	447	447	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,461	1,461	1,542	1,597	1,898	1,680	1,610	1,052	1,652	1,528	1,542	1,514	1,514	1,461	1,421	1,381	1,421	1,354	1,407	1,461	1,342	1,277	1,434	1,461	1,461	1,502
23.	550*	493*	484*	484*	475*	475*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,078*	2,108*	2,108*	2,002*	1,780*	1,610	1,514	1,514	1,514	1,514	1,514	1,488	1,461	1,407	1,381	1,381	1,394	1,342	1,328	1,407	1,528	1,583	1,528	1,528
24.	493*	493*	550*	560*	580*	672*	852*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,794	2,016	1,943	1,751	1,708	1,569	1,556	1,528	1,461	1,542	1,597	1,447	1,328	1,315	1,290	1,328	1,277	1,213	1,315	1,381	1,394	1,342	1,461
25.	412	429	429	438	438	438	475	650	702	744	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26.	403	403	403	403	412	412	412	412	412	412	412	412	421	429	–	–	–	–	–	–	–	–	–	–	–	–	–	1,407	1,315	1,302	1,277	1,200	1,200	1,394	1,407	1,381	1,368	1,381	1,407	1,277	1,126	1,176	1,238	1,213	1,342	1,569
27.	412	412	412	412	421	421	550	630	650	660	1,052	1,029	1,077	1,089	1,077	1,052	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	609	609	609	620	630	660	640	630	620	620	609	599	590
28.	421	421	421	421	421	429	429	550	650	734	810	1,188	1,188	1,188	1,251	1,213	1,200	1,407	1,394	1,394	1,421	1,556	1,610	1,694	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,569	1,542	1,394	1,434	1,474	1,652	1,652	1,583	1,569
29.	412	421	421	438	447	447	484	640	631	744	888	1,200	888	1,407	1,368	1,354	1,354	1,354	1,488	1,556	1,610	1,624	1,638	1,694	1,624	1,556	1,542	1,528	–	–	–	–	–	–	–	–	–	–	–	–	–	1,200	1,251	1,302	1,238	1,238
30.	403	412	421	421	429	465	484	580	660	777	1,152	1,302	1,354	1,394	1,407	1,328	1,542	1,514	1,447	1,488	1,421	1,461	1,461	1,474	1,474	1,514	1,583	1,569	1,569	1,666	1,610	1,407	–	–	–	–	–	–	–	–	–	–	–	–	–	1,556
31.	–	386	386	386	386	386	403	569	569	712	888	1,101	1,152	1,226	1,251	1,277	1,342	1,407	1,368	1,315	1,200	1,188	1,251	1,328	1,434	1,474	1,447	1,342	1,251	1,302	1,342	1,251	1,188	1,200	–	–	–	–	–	–	–	–	–	–	–	–	–
APRIL 1.	–	–	–	377	377	386	394	590	671	734	832	1,213	1,407	1,447	1,407	1,328	1,434	1,434	1,328	1,251	1,238	1,302	1,381	1,328	1,302	1,315	1,394	1,394	1,394	1,394	1,381	1,290	1,277	1,328	1,315	1,315	–	–	–	–	–	–	–	–	–	–	–
2.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3.	–	–	–	–	–	377	377	377	377	361	361	369	377	377	386	436	599	755	765	922	968	957	910	910	865	842	799	755	744	734	702	681	650	640	630	609	620	620	–	–	–	–	–	–	–	–	–
4.	–	–	–	–	–	–	–	599	1,029*	1,077*	1,542*	1,898	1,943*	1,722*	1,722*	1,624*	1,638*	1,610*	1,583*	1,652*	1,913*	1,987*	1,898*	1,898*	1,898*	1,898*	1,943*	1,898*	1,751*	1,751*	1,794*	1,751*	1,737*	1,624*	1,652*	1,597*	1,488*	1,394*	1,188	1,077	–	–	–	–	–	–	–
5.	–	–	–	–	–	–	–	–	–	–	1,188	1,302	1,342	1,381	1,474	1,474	1,488	1,434	1,342	1,328	1,277	1,200	1,407	1,461	1,342	1,368	1,444	1,368	1,251	1,251	1,152	1,101	1,089	1,065	1,089	1,089	1,114	1,052	922	876	1,188	1,277	1,354	–	–	–
6.	–	–	–	–	–	–	–	–	–	–	–	–	–	1,176	1,213	1,238	1,328	1,328	1,188	1,188	1,188	1,152	1,238	1,315	1,328	1,328	1,354	1,780	1,354	1,328	1,277	1,342	1,342	1,342	1,342	1,342	1,152	1,126	1,200	1,213	1,152	1,213	1,213	1,238	1,238	1,238
7.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,251	1,302	1,302	1,226	1,342	1,542*	1,898*	1,928*	1,808*	1,898*	1,652	1,652	1,610	1,407	1,251	1,238	1,238	1,381	1,251	1,213	1,126	1,368	922	755	945	1,101	1,065	1,029	934
8.	386	386	386	386	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,528	1,264	1,434	1,514	1,583	1,597	1,597	1,502	1,542	1,542	1,407	1,381	1,381	1,302	1,226	1,213	1,302	1,277	1,140	1,152	1,200	1,277	1,251	1,407	1,407
9.	394	394	394	394	394	412	438	493	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,461	1,407	1,354	1,381	1,407	1,277	1,381	1,447	1,277	1,213	1,251	1,407*	1,666*	1,943*	2,200*	2,386*	2,386*	2,323*	1,898*	1,542*	1,794*	2,307*	2,354*
10.	2,123*	1,898*	1,528*	1,447*	1,328*	1,264*	1,597*	2,168*	2,759*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,188*	1,065*	957*	888*	865*	821*	799*	799*	799*	777*	777*	777*	765*	755*	734	734	723	671	671	650	630
11.	429	412	412	412	421	429	876	810	723	734	922	1,126	1,226	1,264	1,328	1,251	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,542	1,488	1,474	1,407	1,328	1,277	1,277	1,277	1,488	1,461	1,381	1,354	1,342
12.	456	447	447	447	465	493	599	723	734	865	1,176	1,277	1,277	1,251	1,342	1,381	1,407	1,381	1,461	1,447	1,421	1,474	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,152	1,152	1,251	1,277	1,251	1,251	1,354
13.	412	412	412	412	412	429	502	630	755	755	957	1,089	1,089	1,152	1,152	1,213	1,302	1,302	1,302	1,328	1,328	1,328	1,328	1,328	1,394	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,215*	2,078*	1,751*	1,680*	1,569*
14.	502	502	502	502	502	512	560	650	832	957	1,315*	2,230*	2,759*	2,677*	2,386*	2,202*	2,223*	2,354*	2,402*	2,843*	3,011*	3,039*	3,011*	3,011*	3,107*	3,520*	3,611*	3,215*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,680*	1,542*
15.	403	403	403	403	403	447	475	620	693	842	1,101	1,101	1,101	1,200	1,290	1,302	1,342	1,461	1,394	1,381	1,474	1,556	1,624	1,542	1,556	1,542	1,569	1,528	1,556	1,652	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16.	–	421	421	421	421	447	580	693	693	693	755	1,065	1,251	1,502	1,528	1,394	1,474	1,474	1,434	1,407	1,488	1,381	1,666	1,928*	1,765*	1,652*	1,652*	1,680*	1,569	1,583	1,556	1,680*	1,958*	2,153*	–	–	–	–	–	–	–	–	–	–	–	–	–
17.	406	412	407	407	410	422	489	583	679	741	935	1,155	1,205	1,305	1,339	1,318	1,391	1,415	1,359	1,366	1,400	1,407	1,452	1,494	1,487	1,529	1,529	1,508	1,417	1438	1,426	1,354	1,342	1,355	1,332	1,261	1,229	1,206	1,214	1,169	1,155	1,217	1,311	1,347	1,318	1,349

MEAN OF THE 24 HOURS - - - - - 916 CUBIC FEET PER MINUTE.

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., p

S.

I S.

EVENING.

CUBIC FEET PER MINUTE.

DATE.	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
FEB. 27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,089	1,08	1,065	934	922	865	865	821	755	702	702	671	650	630	609	599	590	590	569	502		
FEB. 28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	934	910	821	777	755	712	712	702	650	620	590	590	569	569		
MAR. 1	1,213	1,315	1,140	957	1,065	1,474	1,542	2,016	2,078	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	438	429	429	421	421	412	403	403	403	403	1	
2																															550	493	475	447	447	429	429	429		2
3	660	640	650	640	640	650	640	599	580	580	550	512	493	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
4	922	1,029	1,142	1,089	1,176	1,176	1,474	1,514	1,514	1,751	1,780	1,610	1,610	1,328	1,251	1,152	1,052	1,029	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	475	465	456	456	4
5	968	1,152	1,089	957	1,065	922	1,302	1,213	1,238	1,277	1,226	1,277	1,213	1,152	1,152	1,077	1,077	1,077	1,065	957	957	922	910	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
6	1,277	1,152	1,089	1,077	1,126	1,126	1,126	1,126	1,126	1,140	1,152	1,238	1,213	1,126	1,089	1,077	1,077	957	957	1,065	1,065	1,052	890	821	777	734	693	620	599	599	550	502	493	493	–	–	–	–	–	–	–	6
7	1,101	1,065	1,077	1,077	1,213	1,342	1,277	1,213	1,238	1,328	1,302	1,213	1,140	1,089	1,089	1,065	1,089	957	957	957	957	922	899	821	734	671	640	620	599	580	550	502	502	475	–	–	–	–	–	–	–	7
8	1,029	1,041	876	1,052	1,089	1,176	1,188	1,188	1,152	1,126	1,126	1,126	1,152	1,152	1,126	1,065	934	957	957	957	957	957	888	832	765	734	702	671	630	630	630	630	630	630	599	599	580	–	–	–	–	8
9	–	–	–	–	922	1,514	1,583	1,381	1,954	1,342	1,381	1,342	1,277	1,251	1,188	1,152	1,140	1,089	1,089	1,089	1,029	957	888	842	799	799	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
10	–	–	–	–	–	–	–	–	777	765	765	693	650	609	590	569	512	502	475	475	475	465	475	465	456	456	447	438	429	429	429	429	429	429	429	429	429	429	429	429	429	429	10
11	–	–	–	–	–	–	–	–	–	–	–	–	1,277	1,251	1,126	1,077	1,077	1,114	1,089	1,065	1,029	922	934	888	788	702	660	640	620	599	599	550	512	493	475	456	447	447	447	447	475	11
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,251	1,251	1,251	1,176	1,089	957	854	842	799	777	734	702	693	681	640	609	590	590	512	512	512	502	475	456	456	456	12
13	1,407	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,176	1,126	1,052	888	865	810	744	693	660	640	599	569	569	569	502	493	475	475	475	456	456	456	13
14	1,213	1,152	1,126	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,089	1,089	1,089	876	842	810	734	702	681	640	620	590	569	569	550	550	512	502	502	502	14
15	1,213	1,277	1,251*	1,213*	1,290*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	957	934	865	821	799	744	671	702	650	590	550	502	465	465	456	447	447	420	15
16	1,101	1,101	1,277	1,277	1,277	1,277	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	888	865	821	810	810	832*	910*	1,029*	1,126*	1,152*	1,218*	1,126*	1,077*	934*	755*	734*	702*	16
17	899*	842*	810*	755	723	702	693	693	671	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	493	484	484	484	484	475	475	456	456	456	456	456	456	456	456	17
18	1,238	1,176	1,152	1,126	1,251	1,251	1,277	1,342	1,342	1,342	1,652	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	755	693	650	640	599	560	560	512	484	475	465	456	456	18
19	1,302	1,277	1,354	1,381	1,381	1,421	1,381	1,290	1,264	1,488	1,680	2,123	1,434	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
20	1,354	1,407	1,461	1,342	1,277	1,434	1,461	1,461	1,502	1,610	1,610	1,610	1,542	1,474	1,381	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
21	1,381	1,394	1,342	1,328	1,407	1,528	1,583	1,528	1,528	1,461	1,407	1,381	1,394	1,354	1,342	1,315	1,277	1,251	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
22	1,290	1,328	1,277	1,213	1,315	1,381	1,394	1,342	1,461	1,474	1,394	1,264	1,342	1,328	1,328	1,328	1,251	1,213	1,152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
23	1,381	1,407	1,277	1,126	1,176	1,238	1,213	1,342	1,560	1,694	1,610	1,474	1,407	1,302	1,226	1,226	1,176	1,089	1,029	934	922	888	832	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
24	630	660	640	630	620	620	609	599	590	609	702	712	723	702	660	620	590	590	560	512	512	502	475	465	465	456	456	456	456	447	438	429	–	–	–	–	–	–	–	–	–	24
25	–	1,569	1,542	1,394	1,434	1,474	1,652	1,652	1,583	1,569	1,569	1,542	1,488	1,474	1,474	1,381	1,238	1,188	1,101	1,065	1,065	1,029	899	865	777	765	702	671	650	599	580	550	550	550	550	512	484	–	–	–	–	25
26	–	–	–	–	–	1,200	1,251	1,302	1,238	1,238	1,381	1,315	1,226	1,152	1,140	1,152	1,213	1,213	1,089	922	854	842	810	788	832	765	734	693	630	630	599	569	512	502	502	484	484	465	456	456	456	26
27	–	–	–	–	–	–	–	–	–	1,556	1,556	1,556	1,958	1,943	1,737	1,597	1,474	1,302	1,188	1,101	1,089	1,077	945	922	865	810	799	723	702	620	580	569	512	502	484	484	465	456	456	456	456	27
28	–	–	–	–	–	–	–	–	–	–	–	–	–	1,610	1,610	1,618	1,277	1,213	1,264	1,126	1,101	1,089	1,052	1,029	876	821	799	734	671	640	630	599	560	560	512	475	456	447	447	438	438	438	28
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,251	1,089	1,041	1,029	1,065	1,065	1,029	899	865	777	765	744	702	693	650	609	580	560	502	493	475	456	438	429	421	421	421	29
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,226	1,188	1,163	1,152	1,200	1,163	1,114	1,029	968	910	888	832	765	723	660	599	560	502	493	475	465	465	456	456	456	30
31	620	620	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	475	465	450	447	447	456	512	502	502	550	502	502	502	512	512	512	512	512	502	475	475	475	456	31
JUNE 1	488*	1,394*	1,188	1,077	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,315*	1,188*	1,101*	1,041*	922*	865	810	765	723	702	693	712	734*	744*	702*	671*	650*	702*	580	560	560	512	502	1
2	114	1,052	922	876	1,188	1,277	1,354	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	821	810	765	723	693	712	734*	744*	702*	671*	650*	702*	580	560	560	512	502	2
3	152	1,126	1,200	1,213	1,152	1,213	1,213	1,238	1,238	1,236	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
4	213	1,126	1,368	922	755	945	1,101	1,065	1,029	934	1,052	1,542	1,652	1,610	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
5	213	1,302	1,277	1,140	1,152	1,200	1,277	1,251	1,407	1,407	1,447	1,474	1,277	1,213	1,251	1,213	1,213	1,140	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
6	943*	2,200*	2,380*	2,386*	2,323*	1,898*	1,542*	1,704*	2,307*	2,354*	2,276*	2,202*	1,928*	1,765*	1,928*	2,200*	2,512*	2,957*	3,071*	3,071*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
7	777*	765*	755*	734	734	723	671	671	650	630	630	630	599	590	590	560	550	512	512	502	502	493	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
8	407	1,328	1,277	1,277	1,277	1,488	1,461	1,381	1,354	1,342	1,342	1,342	1,342	1,354	1,378	1,342	1,328	1,213	1,176	1,176	1,176	1,152	1,114	1,114	1,029	910	865	865	865	821	–	–	–	–	–	–	–	–	–	–	–	8
9	–	–	–	–	1,152	1,152	1,251	1,277	1,251	1,251	1,354	1,368	1,394	1,407	1,652*	1,542*	1,680*	1,958*	1,898*	1,583*	1,461*	1,277	1,152	1,029	1,029	922	865	842	810	755	702	671	671	630	599	550	550	–	–	–	–	–	9
10	–	–	–	–	–	2,215*	2,078*	1,751*	1,680*	1,569*	1,542*	1,680*	1,765*	1,987*	2,016*	1,597*	1,514*	1,407*	1,354*	1,328*	1,277*	1,251*	1,213*	1,213*	1,176*	1,126*	1,089*	957*	922*	865*	865*	734*	702*	671*	650*	630*	–	–	–	–	–	10
11	–	–	–	–	–	–	–	–	1,680*	1,542*	1,569*	1,461*	1,461*	1,461*	1,461*	1,474*	1,381*	1,354*	1,342*	1,328*	1,328*	1,381*	1,434*	1,474*	1,381*	1,277*	1,163*	1,101*	922*	899*	842*	810*	755*	723*	702*	599	590	550	550	550	502	11
APRIL 1	–	–	–	–	–	–	–	–	–	–	1,569*	1,461*	1,461*	1,461*	1,461*	1,474*	1,381*	1,354*	1,342*	1,328*	1,328*	1,381*	1,434*	1,474*	1,381*	1,277*	1,163*	1,101*	922*	899*	842*	810*	755*	723*	702*	702	712	734	810	799	777	712	1
2	–	–	–	–	–	–	–	–	–	–	1,238	1,177	1,126	1,114	1,052	934	922	922	922	934	899	865	821	734	712	755	709	810	810	810	810	744	702	702	702	712	734	810	799	777	712	2
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
	1,229	1,206	1,214	1,169	1,155	1,217	1,311	1,347	1,318	1,349	1,399	1,433	1,356	1,338	1,302	1,251	1,182	1,141	1,101	1,076	1,058	1,024	952	922	848	805	776	748	713	676	632	607	580	559	543	532	519	507	456	487	474	

DATE.	11	15	30	45	DATE.
FEBRUARY 17	–	–	–	–	MARCH 1
18	–	–	–	–	2
19	–	–	–	–	3
20	–	–	–	–	4
21	–	–	–	–	5
22	73	73	73	–	6
23	23	16	16	16	7
24	105	105	96	96	8
25	88	88	88	88	9
26	100	96	96	88	10
27	96	88	88	88	11
28	88	88	88	88	12
MARCH 1	73	73	73	73	13
2	–	–	–	88	14
3	–	–	–	–	15
4	–	–	–	–	16
5	–	–	–	–	17
6	–	–	–	–	18
7	–	–	–	–	19
8	–	–	–	–	20
9	96	96	96	96	21
10	88	88	88	88	22
11	96	96	96	88	23
12	96	96	96	88	24
13	96	88	88	88	25
14	132*	132*	132*	142*	26
15	80	80	80	–	27
16	96	96	96	96	28
17	–	96	96	96	29
18	–	–	–	88	30
19	–	–	–	–	31
20	–	–	–	–	APRIL 1
21	–	–	–	–	2
22	–	–	–	–	3
23	–	–	–	–	4
24	80	80	80	80	5
25	96	88	88	88	6
26	88	88	88	80	7
27	80	73	73	66	8
28	88	88	88	88	9
29	80	80	80	80	10
30	73	73	73	73	11
31	96	96	96	96	
APRIL 1	88	88	88	88	
2	–	80	80	80	
3	–	–	–	–	
4	–	–	–	–	
5	–	–	–	–	
6	132*	123	123	123	
7	123	142*	142*	142*	
8	152*	114	105	105	
9	114	123	114	114	
10	123	105	96	96	
11	105	–	–	–	
	96	93	92	91	

tals in arriving at the Mean Results. *See* Explanation in Appendix III., page 70.

MAIN D

MORNING.

CUBIC FEET PER MINUTE.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45
MAR. 31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,044	1,044	1,044	1,044	1,036	1,021	1,021	1,02
APRIL 1	382	361	345	330	319	319	319	319	319	304	304	299	310	310	310	310	304	304	304	319	345	345	345	356	356	–	–	–	–	–	–	–	–	–	–	–	–	1,183	1,183	1,191	1,19
2	340	330	330	330	330	330	330	330	330	330	325	325	325	325	319	319	314	314	330	330	335	335	335	330	335	340	382	404	432	490	502	550	544	861	–	–	–	–	–	–	–	1,082	1,0
3	330	330	325	325	319	314	310	304	310	310	304	304	299	310	299	299	299	299	304	314	319	319	325	335	351	372	399	426	490	502	550	656	715	868	–	–	–	–	–	–	–	–	–
4	325	319	314	310	310	310	310	304	304	304	299	299	299	295	290	290	290	285	285	299	325	335	319	314	314	325	335	377	415	550	656	715	868	–	–	–	–	–	–	–	–	–	–
5	449*	449*	490*	514*	514*	514*	514*	514*	519*	508*	496*	490*	490*	490*	643*	709*	840*	1,044*	1,270*	1,327*	1,500*	1,712*	1,712*	1,712*	1,712*	1,650*	1,500*	1,400*	1,303*	1,215*	1,199*	1,167*	1,136*	1,136*	1,120*	1,059*	984*	940*	940*	–	–	–	–	–
6	–	–	–	–	361*	366*	366*	366*	366*	366*	361*	351	340	330	330	330	330	325	325	325	325	325	325	330	340	345	351	393	404	443	574	656	676	709	762	847	911	911	911	926	1,021	1,059	1,036	–
7	–	–	–	–	–	–	–	–	285	285	285	200	200	200	295	295	285	280	280	299	299	310	314	319	319	319	325	345	388	426	496	550	618	702	676	749	911	926	940	940	1,036	1,036	1,051	1,05
8	–	–	–	–	–	–	–	–	–	–	–	–	285	285	285	280	280	275	275	280	290	310	314	314	314	314	325	382	443	454	562	592	599	676	709	890	890	911	890	997	933	911	890	89
9	299	299	299	–	–	–	–	–	–	–	–	–	–	–	–	–	270	270	270	290	299	290	295	295	295	299	335	382	437	580*	783*	984*	1,215*	1,230*	1,246*	1,215*	1,318*	1,335*	1,376*	1,450*	1,700*	2,040*	2,040*	2,04
10	319	319	319	319	319	319	319	–	–	–	–	–	–	–	–	–	–	–	–	–	295	299	299	310	310	310	345	345	437	437	490	580	618	643	715	911	911	955	992	1,175	1,230	1,059	977	93
11	290	290	290	290	285	285	285	275	275	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	304	304	295	361	372	490	531	531	663	696	702	882	999	1,006	984	1,006	1,014	1,021	1,014	1,00
12	299	299	280	280	280	270	270	299	299	299	299	299	299	299	–	–	–	–	–	–	–	–	–	–	–	–	–	–	275	275	280	285	285	285	290	290	295	304	310	325	325	335	345	34
13	290	285	285	285	285	280	280	280	280	280	280	299*	319*	335*	377*	404*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	715*	749*	709	776	796	882	882	911	911	911	933	93
14	508*	388*	377*	372*	372*	372*	388*	426*	490*	508*	519*	508*	460*	443*	415*	415*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	918	940	1,021	1,059	1,097	1,059	1,016	94
15	314	310	270	270	270	270	270	270	270	285	285	290	290	290	290	290	290	290	299	299	304	304	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,021	1,059	1,021	1,02
16	310	304	299	290	299	299	299	299	299	299	299	299	299	299	290	290	290	290	299	319	335	340	340	351	351	351	388	421	443	460	502	–	–	–	–	–	–	–	–	–	–	–	–
17	361	361	351	351	351	351	351	351	351	351	351	351	351	351	351	351	351	351	351	351	361	372	372	393	393	404	404	432	443	514	599	669	709	729	790	–	–	–	–	–	–	–	–	–
18	–	–	340	335	335	335	340	335	335	335	330	330	325	325	319	319	314	304	299	330	351	356	345	345	345	372	399	460	525	599	611	669	729	776	796	796	911	984	992	947	1,029	–	–	–
19	–	–	–	–	–	–	335	335	330	330	330	325	325	325	325	325	325	325	325	325	325	325	325	330	330	330	335	340	345	345	345	345	351	356	366	325	325	351	356	372	388	399	388	–
20	–	–	–	–	–	–	–	–	–	–	–	351	351	351	335	319	325	325	325	325	325	335	345	356	356	361	361	372	388	415	490	538	599	676	735	840	897	984	992	1,036	1,036	1,044	1,014	984	99
21	310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	335	335	335	319	320	335	351	361	377	388	388	388	377	404	490	568	643	690	715	742	762	–	–	969	1,021	1,082	1,175	1,190	1,175	1,17
22	275	265	265	265	265	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	319	319	319	335	351	372	377	388	426	490	519	568	580	624	690	796	918*	1,006*	1,036*	1,097*	984	1,044	1,097	1,059	1,05
23	377*	361*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	382	388	388	388	388	432	490	544	580	663	840*	854*	875*	911*	940*	1,006*	1,120*	1,175	1,215	1,175	1,175	1,21
24	330	330	325	325	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	404	415	449	562	729	783	783	840	897	947	962	1,021	1,044	1,051	1,021	1,036	98
25	330	325	325	325	377	377	377	502	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	310	310	310	377	460	580	611	656	709	776	803	875	962	999	1,040	1,097	1,183	1,335	1,360	1,37
26	330	325	325	325	314	314	310	310	310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	290	290	295	304	314	314	314	319	330	335	335	340	351	361	366	366	372	372	377	377	388	39
27	299	299	299	304	304	304	299	299	299	304	310	335	345	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	399	404	415	443	538	696	729	756	783	875	890	911	969	1,036	1,051	1,051	1,014	96
28	356	356	361	361	361	361	356	351	351	351	351	356	361	361	361	372	382	–	–	–	–	–	–	–	–	–	–	–	–	–	580	650	756	796	847	796	796	1,036	1,120	1,144	1,206	1,206	1,175	1,10
29	399	388	377	360	366	366	366	366	366	361	351	340	335	335	340	351	361	361	361	377	399	–	–	–	–	–	–	–	–	–	–	–	–	–	911	933	947	962	969	1,067	1,097	1,097	1,044	1,07
30	351	345	335	335	330	330	330	330	330	330	330	330	335	335	335	335	335	340	340	340	340	351	361	377	388	–	–	–	–	–	–	–	–	–	–	–	–	1,029	1,044	1,014	992	1,111	1,08
MAY 1	361	361	361	351	340	335	330	330	330	330	340	345	345	345	345	345	345	351	356	356	361	361	361	361	361	382	393	404	426	–	–	–	–	–	–	–	–	–	–	–	1,067	1,01
2	361	356	345	345	345	345	345	340	340	340	340	345	351	351	351	351	351	351	351	340	361	361	361	351	335	340	351	388	426	437	531	618	696	–	–	–	–	–	–	–	–	–	–
3	361	361	356	351	351	351	345	340	340	340	340	340	345	345	351	351	356	356	356	340	340	340	340	340	340	340	335	335	335	335	340	340	340	351	361	361	361	–	–	–	–	–	–
4	–	–	–	–	310	310	310	310	310	310	310	310	314	314	314	314	319	319	319	319	425	335	345	345	345	345	306	399	432	454	490	519	587	643	722	847	962	977	999	1,051	1,111	–	–	–
5	–	–	–	–	–	–	–	–	–	345	345	340	335	325	319	319	319	310	314	335	345	345	345	351	356	372	388	426	443	496	568	656	742	840	904	947	1,006	1,074	1,136	1,183	1,215	1,239	1,262	1,29
6	–	–	–	–	–	–	–	–	–	–	–	–	–	345	345	335	325	319	310	310	310	319	340	345	351	361	361	382	404	443	490	525	574	611	756	897	926	962	992	1,01	1,036	1,059	1,074	1,090	1,07
7	351	351	351	351	–	–	–	–	–	–	–	–	–	–	–	–	–	335	330	319	319	330	345	351	356	372	393	410	432	454	538	562	587	656	742	875	933	1,021	1,959	1,059	1,059	1,044	1,021	1,006	93
8	351	335	335	330	330	330	330	330	–	–	–	–	–	–	–	–	–	–	–	–	–	–	345	356	366	377	393	404	415	443	466	514	544	562	631	735	840	911	955	984	1,021	1,006	984	999	1,036	1,05
9	335	335	335	335	335	335	335	330	330	330	330	–	–	–	–	–	–	–	–	–	–	–	–	–	–	399	399	410	432	449	490	531	544	599	682	790	854	911	940	955	962	962	962	962	95
	326	324	324	323	322	329	321	313	312	313	306	326	320	327	320	320	319	316	316	324	330	336	340	363	350	355	370	404	435	495	556	620	675	725	794	870	943	974	995	1,037	1,085	1,066	1,069	1,05

MEAN

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (~~758~~), also

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

RATCLIFF-CROSS SEWER.

W. B. Hach, Engineer.

FEBRUARY — MARCH — APRIL

EVENING.

CUBIC FEET PER MINUTE.

7:30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7
–	–	–	–	–	–	1,044	1,044	1,044	1,044	1,036	1,021	1,021	1,021	1,021	1,044	1,051	1,082	1,097	1,151	1,183	1,206	1,167	1,120	1,104	1,097	1,097	1,097	1,067	1,044	1,044	1,029	1,014	1,006	1,006	999	947	933	854	796	776	762	742	–	–	–	–
–	–	–	–	–	–	–	–	–	–	1,183	1,183	1,191	1,199	1,199	1,199	1,206	1,215	1,230	1,151	1,097	1,082	1,074	1,097	1,120	1,029	999	962	933	897	875	897	868	977	1,006	992	918	861	722	722	722	676	656	643	643	631	611
–	–	–	–	–	–	–	–	–	–	–	–	1,082	1,030	1,104	1,111	1,128	1,183	1,199	1,082	1,044	1,074	1,090	1,097	1,074	1,036	999	911	911	890	962	1,021	1,067	1,044	1,014	926	897	875	840	776	722	682	650	631	624	599	580
593	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,136	1,036	1,036	1,029	1,029	1,044	1,059	1,059	1,014	933	911	897	897	875	904	933	897	868	840	840	756	742	690	690	690	676	631	599	556	531
550	544	861	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,097	1,111	1,120	1,120	1,120	1,120	1,151*	1,175*	1,275*	1,352*	1,475*	1,368	1,327*	1,303*	1,255*	1,044*	1,044*	1,044*	1,021*	1,006*	1,020*	1,059*	1,082*	1,175*	1,239*	1,456*	2,000*	2,330*
656	715	868	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	460*	460*	443*	432*	421*	415	415	410	404	404	404	404	404	399	393	393	393	388	377	372	372	361	361	361	361	361	351
1,199*	1,167*	1,136*	1,136*	1,120*	1,059*	984*	940*	940*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	933	947	933	897	854	840	840	861	875	882	897	911	911	882	861	796	756	742	696	650	599	525	508
574	656	676	709	762	847	911	911	911	926	1,021	1,059	1,036	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	933	911	868	868	868	897	926	926	926	783	742	676	656	656	624	611	611	631	599
496	550	618	702	676	749	911	926	940	940	1,036	1,036	1,051	1,050	1,059	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,021*	1,006*	969	933	911	868	776	696	656	624	593	574	568	525	519
562	592	599	676	709	890	890	911	890	997	933	911	890	890	882	933	940	962	984	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	875	861	840	776	756	729	643	587	550	525	502
783*	984*	1,215*	1,230*	1,246*	1,215*	1,318*	1,335*	1,376*	1,450*	1,700*	2,040*	2,040*	2,040*	2,040*	2,000*	1,850*	1,650*	1,500*	1,424*	1,270*	1,151*	1,097	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	550	514	502	490	437	404	388
490	580	618	643	715	911	911	955	992	1,175	1,230	1,059	977	933	926	1,183	1,183	1,183	1,136	1,059	984	984	984	962	955	955	955	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	519	490
531	531	663	696	702	882	999	1,006	984	1,006	1,014	1,021	1,014	1,006	955	1,021	1,021	1,021	1,021	984	984	1,006	1,029	1,090	1,199*	1,230*	1,191*	1,120*	1,074*	1,074*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
280	285	285	285	290	290	295	304	310	325	325	335	345	345	340	340	345	345	345	345	340	340	335	335	295	280	280	275	275	275	290	290	290	290	290	–	–	–	–	–	–	–	–	–	–	–	–
–	–	715*	749*	709	776	796	882	882	911	911	911	933	933	882	911	947	955	955	999	999	882	926	940	962	955	742	790	783	796	847	868	875	875	840	840	840	840	840	–	–	–	–	–	–	–	–
–	–	–	–	–	–	918	940	1,021	1,059	1,097	1,059	1,016	947	962	984	962	955	981	962	940	955	940	933	933	933	890	840	861	882	911	955	984	947	868	776	776	875	861	926*	1,136*	1,255*	1,215*	1,104*	984*	776*	709*	637*	593*
–	–	–	–	–	–	–	–	–	–	1,021	1,059	1,021	1,021	1,021	1,006	984	1,006	962	933	933	911	911	947	984	955	911	840	790	790	861	911	926	911	911	875	861	926*	1,136*	1,255*	1,215*	1,104*	984*	776*	709*	637*	593*
–	–	–	–	–	–	–	–	–	–	–	–	–	–	969	1,136	1,229*	1,246*	1,255*	1,239*	1,222*	1,175*	1,136*	1,175*	1,183*	1,136*	1,006*	984*	999*	1,021*	1,059*	1,136*	1,215*	1,450*	1,600*	1,750*	2,000*	2,330*	2,000*	1,750*	1,600*	1,450*	1,376*	1,246*	1,097*	933*	840*
502	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,059	1,059	1,059	1,090	1,082	1,082	1,029	999	955	911	875	840	803	933	1,021	999	911	911	911	926	933	947	1,029	911	840	690	643	611	593
599	669	709	729	790	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,082	1,090	1,104	1,104	1,104	1,059	1,014	1,014	1,006	1,006	1,044	1,059	1,021	1,021	940	897	847	796	776	756	756	742	729	702	676
611	669	729	776	796	796	911	984	992	947	1,029	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	432	426	426	415	415	415	404	404	399	399	399	393	388	382	372	366	361	340	340	340	340
345	345	351	356	366	325	325	351	356	372	388	399	388	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	984	947	911	897	962	969	962	955	911	840	742	676	611	599	580	562	550
538	599	676	735	840	897	984	992	1,036	1,036	1,044	1,014	984	999	1,006	1,059	1,036	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	~~1,059~~	947	911	947	911	840	742	676	611	599	580	562	550
643	690	715	742	762	–	–	969	1,021	1,082	1,175	1,199	1,175	1,175	1,239	1,239	1,255	1,239	1,215	1,167	1,104	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,330*	2,300*	2,250*	2,200*	2,100*	1,900*	1,500*	1,344*	1,215*
568	580	624	690	796	918*	1,006*	1,036*	1,097*	984	1,044	1,097	1,059	1,059	1,111	1,183	1,255	1,151	1,120	1,136	1,136*	1,136*	1,136*	1,183*	1,230*	1,255*	–	–	–	–	–	–	–	–	–	–	–	–	–	861	776	715	676	656	643	631	593	593
580	663	840*	854*	875*	911*	940*	1,006*	1,120*	1,175	1,215	1,175	1,175	1,215	1,215	1,199	1,175	~~1,206~~	~~1,222~~	~~1,222~~	~~1,239~~	~~1,255~~	~~1,262~~	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
562	729	783	783	840	897	947	962	1,021	1,044	1,051	1,021	1,006	984	1,021	1,074	1,104	1,067	1,021	977	977	992	1,014	1,044	1,051	1,082	1,111	1,175	1,199	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
611	656	709	776	803	875	962	999	1,040	1,097	1,183	1,335	1,360	1,376	1,360	1,318	1,262	1,215	1,191	1,159	1,064	984	1,014	1,074	1,074	1,090	1,104	1,128	1,159	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
330	335	335	340	351	361	366	366	372	372	377	377	388	399	393	382	377	377	388	399	399	410	415	415	415	415	415	415	432	443	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
538	696	729	756	783	875	890	911	969	1,036	1,051	1,051	1,014	969	962	1,006	1,104	1,090	1,021	984	947	977	1,014	1,006	992	992	969	933	911	904	897	940	977	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
580	650	756	796	847	796	796	1,036	1,120	1,144	1,206	1,206	1,175	1,104	1,082	1,136	1,120	1,074	1,059	1,044	1,044	1,021	984	1,082	1,059	1,044	947	890	890	911	933	992	1,006	1,014	933	933	933	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	911	933	947	962	969	1,067	1,097	1,097	1,044	1,074	1,120	1,136	1,136	1,111	1,097	1,036	1,036	1,036	1,036	1,097	1,120	1,097	1,074	1,021	969	955	977	1,059	1,082	1,082	1,014	984	947	933	918	897	803	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	1,029	1,044	1,014	992	1,111	1,082	1,067	1,120	1,120	1,097	1,074	1,059	1,044	1,082	1,136	1,144	1,144	1,111	1,044	1,021	969	984	1,021	1,044	1,036	1,021	1,006	992	984	947	926	868	796	776	775	696	676	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	1,067	1,044	1,111	1,175	1,136	1,120	1,097	1,104	1,067	1,044	1,044	1,090	1,082	1,021	1,111	1,021	926	911	955	984	969	977	984	999	999	992	962	933	897	783	762	742	709	690	631
531	618	696	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,128	1,120	1,120	1,159	1,175	1,136	1,044	1,021	992	984	969	933	977	962	962	947	918	933	947	933	911	868	847	756	696	663	631
340	340	340	351	361	361	361	–	–	–	–	–	–	–	–	–	–	–	–	–	415	415	415	415	415	410	410	410	415	415	415	404	404	404	404	393	388	388	382	372	372	361	361	356	356	345	340
490	519	587	643	722	847	962	977	999	1,051	1,111	–	–	–	–	–	–	–	–	–	–	–	–	1,044	1,044	1,006	940	911	796	796	847	882	854	790	769	762	742	742	729	696	676	618	637	611	593	538
568	656	742	840	904	947	1,006	1,074	1,136	1,183	1,215	1,229	1,262	1,294	~~1,327~~	–	–	–	–	–	–	–	–	–	–	–	–	–	861	882	890	897	947	933	918	911	926	911	868	840	776	715	682	643	618	580	550
525	574	611	756	897	926	962	992	1,01	1,036	1,059	1,074	1,090	1,074	1,030	1,136	1,175	1,199	1,199	–	–	–	–	–	–	–	–	–	–	–	–	–	992	969	955	955	926	911	776	756	729	715	709	682	650	618
562	587	656	742	875	933	1,021	1,059	1,059	1,059	1,044	1,021	1,006	992	1,029	1,029	1,029	1,036	1,036	1,036	1,021	1,036	1,067	–	–	–	–	–	–	–	–	–	–	–	–	875	861	854	769	729	669	631	611	587	562
544	562	631	735	840	911	955	984	1,021	1,006	984	999	1,036	1,059	1,059	1,082	1,120	1,136	1,059	1,059	1,059	1,067	1,082	1,059	1,059	1,059	–	–	–	–	–	–	–	–	–	–	–	–	656	643	631	637	650	624	587
531	544	599	682	790	854	911	940	955	962	962	962	962	955	1,014	1,014	1,044	1,059	1,082	1,097	1,111	1,104	1,090	1,067	1,059	1,059	1,059	1,059	1,051	1,036	1,074	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
556	620	675	725	794	870	943	974	995	1,037	1,085	1,066	1,069	1,059	1,056	1,097	1,104	1,100	1,080	1,055	1,049	1,037	1,048	1,060	1,054	1,034	1,002	971	939	908	923	945	963	961	942	925	907	882	845	800	724	716	693	658	633	599	568

MEAN OF THE 24 HOURS - - - 629 CUBIC FEET PER MINUTE.

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings, printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 76.

PPE

M

J

W. B. Haak, Engineer.

MINUTE.

DATE.	45	30	15	00	45	30	15	00	45	30	15	00	45	30	15	00	45	30	15	00	45	30	15	00	45	30	15	00	45	30	15	00
MAR. 31	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
APRIL 1	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
2	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
3	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
4	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
5	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
6	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
7	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
8	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
9	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
10	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
11	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
12	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
13	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
14	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
15	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
16	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
17	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
18	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
19	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
20	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
21	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
22	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
23	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
24	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
25	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
26	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
27	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
28	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
FEBRUARY 29	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
MARCH 1	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
2	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
3	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
4	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
5	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
6	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
7	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
8	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
9	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
10	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
11	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
APRIL 1	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
2	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
3	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
4	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
5	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
6	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
7	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
8	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
9	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
10	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
11	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

CUBIC

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	DATE.
FEBRUARY 17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17
18	105	105	96	96	96	96	96	96	96	96	96	96	96	96	96	96	88	88	88	88	88	88	88	88	18
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
24	46	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	24
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
28	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	28
MARCH 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
2	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	2
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
12	90	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	12
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
15	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	15
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17
18	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	18
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
28	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	28
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
31	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	31
APRIL 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
2	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	2
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
7	123	142*	105	90	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	7
8	105	90	105	105	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	8
9	114	105	90	105	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	9
10	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	10
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

FALCON BROOK SEWER.

MORNING.

CUBIC FEET PER MINUTE.

DATE	15	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45'	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15
MAR. 31		–																																															
APRIL 1	580																																																
2	508	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44	44	44	225	221	203	152	123	123	123	444	545	545	271	172	152	123	132	114	96
3	2,330	88	88	88	88	88	88	88	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	51	51	51	51	51	59	59	59	51	51	44	44	51	51	59	105	96	88	88
4	340	88	88	88	88	88	88	88	88	88	88	88	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114	105	105	105	114	123	123	172	142	153	162	132	132	123	123
5	460	88	88	88	88	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	556	–	–	–	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	44	30	23	16	16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	460	–	–	–	–	–	–	–	–	–	30	30	30	30	30	30	30	29	29	29	23	16	44	59	73	80	80	80	80	80	80	80	88	88	88	88	88	88	88	96	105	105	105	105	114	114	–	–	–	–	–	–
8	460	–	–	–	–	–	–	–	–	–	–	–	–	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	96	96	96	96	96	96	105	105	105	–	–	–	–	–
9	372	–	–	–	–	–	–	–	–	–	–	–	–	96	96	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	96	96	96	96	96	96	105	105	105	114	105	–	–	–
10	443	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	80	80	80	80	80	88	88	88	88	96	88	96	96	96	105	105	105	105	105	105	105	105	105	105	105	105	105	105	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	96	96	88	88	80	80	80	80	80	80	80	80	80	80	80	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	96	96	96	96	96	96	96	96	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
13	–	73	73	73	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	88	88	88	88	88	88	96	96	96	96	96	96	105	105	105	105	105	105	105	105
14	–	73	73	73	73	73	73	73	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15	696	73	73	73	66	66	66	66	66	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	96	96	96	96	96	105	105	105	105	105	105	105	105	105	105
16	550	80	80	80	73	73	73	73	73	73	73	73	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	562	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66
18	340	73	73	73	66	66	66	66	66	66	66	66	66	66	66	59	59	59	59	59	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66
19	531	–	–	–	–	–	–	–	–	–	–	–	–	–	–	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
20	538	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	1,082*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	73	73	73	73	73	80	80	80	80	80	80	80	80	80	80	80	80	80	80	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
22	525	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	550	80	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
24	611	132*	123*	123*	123*	123*	123*	88	88	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
25	335	–	59	59	59	59	59	59	59	59	59	59	59	59	59	59	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66
26	496	–	–	–	–	–	66	66	66	73	73	73	73	73	73	66	66	66	66	66	66	66	66	73	80	88	88	88	88	88	88	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	73	73	73	73	73	66	66	66	66	66	66	66	66	73	80	80	80	80	73	73	73	73	73	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28	–	–	–	–	–	–	–	–	–	–	80	80	73	73	73	73	73	73	73	73	80	80	80	80	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
29	–	–	–	–	–	–	–	–	–	–	–	–	–	80	80	80	80	80	80	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	73	73	73	73	73	73	66	66	66	66	66	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
MAY 1	587	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
2	587																																																	
3	335	73	73	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	88	88	88	88	88	88	96	96	96	96	96	96	105	105	105	105	105	105	96	96	96
4	519	73	73	73	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	96	96	96	96	96	96	96	96	96	96	96	96	88	88	88	88	88	88	88	88
5	525	59	59	59	59	59	51	51	51	59	59	59	59	59	59	59	59	59	59	59	59	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	96	96	96	96	105	105	105	105	96	96	96	96
6	580	66	59	51	51	51	51	51	51	59	236*	236*	236*	284*	321*	296*	308*	414*	515*	485*	373*	347*	225*	193*	172*	172*	162*	162*	162*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	142*	142*	142*
7	531	–	–	–	247*	247*	247*	247*	247*	247*	152*	152*	152*	152*	142*	142*	132*	132*	142*	142*	142*	142*	142*	142*	142*	142*	142*	142*	142*	142*	152*	152*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	556	–	–	–	–	–	96	96	96	96	96	96	96	96	96	96	96	88	88	96	96	96	96	96	96	105	105	123	132	142	152*	152*	152*	142*	142*	142*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	114*	114*	114*	114*	114*	114*	114*	114*	114*	114*	114*	114*	114*	114*	114*	114*	114*	123*	123*	123*	123*	123*	123*	123*	123*	123*	123*	123*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	525	–	–	–	–	–	–	–	–	–	–	–	–	88	88	88	88	88	88	96	96	105	105	114	114	123	123	123	114	114	114	114	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		–	–	–	–	–	–	–	–	–	–	–	–	96	96	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
		77	77	77	76	75	75	74	74	76	77	77	80	80	78	78	77	77	77	76	77	78	79	81	82	83	85	88	88	96	93	95	96	99	100	100	100	101	104	108	111	110	108	110	110	108	105		

MEAN OF THE 24 HOURS - - - 91 CUBIC FEET PER MINUTE.

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings, printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 70

ETROPOLIS.

L I S.

EVENING.

CUBIC FEET PER MINUTE.

DATE.	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
FEBRUARY 17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17
18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28
MARCH 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17
18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28
APRIL 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
	100	100	101	104	108	111	110	108	110	110	108	105	103	104	103	102	100	101	99	97	96	102	101	102	103	104	105	104	101	100	101	101	100	100	100	99	99	97	96	93	92	91	

om the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 76.

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W. E. Hall, Engineer.

0	45	DATE.
		FEBRUARY 13
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		27
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–	–	MARCH 1
–	–	2
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–	–	10
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–	–	27
–	–	28
–	–	29
–	–	30
–	–	31
–	–	APRIL 1
–	–	2
–	–	3
–	–	4
–	–	5
–	–	6
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99		

APPENDIX TO REPORT

MAIN DRAINAGE.

CUBIC FEET PER MINUTE.

DATE.	FEBRUARY 20	21	22	23	24	25	26	27	28	MARCH 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12	–	–	–	–	–	–	–	–	288	397	374	374	374	691	–	–	–	–	–	288	222	177	168	374	177	369	222	1,507*	3,692	–	–	–	–	–	–	203	212	288	99	941
15	–	–	–	–	–	–	–	–	288	374	869	869	869	546	980	–	–	–	–	288	203	177	151	269	177	890	203	1,238*	1,711	–	–	–	–	–	–	212	212	288	99	940
30	–	–	–	–	–	–	–	–	288	369	941	852	852	455	740	–	–	–	–	288	222	177	135	252	177	880	944	975*	1,948	–	–	–	–	–	–	212	212	288	99	938
45	–	–	–	–	–	–	–	–	288	341	869	852	852	397	592	–	–	–	–	288	203	177	135	155	177	840	940	820*	976	–	–	–	–	–	–	212	212	288	99	936
1	–	–	–	–	–	–	–	–	288	330	890	944	944	470	869	–	–	–	–	288	203	177	135	135	177	998	988	712*	712	–	–	–	–	–	–	212	212	288	99	940
15	–	–	–	–	–	–	–	–	288	330	890	944	944	430	944	–	–	–	–	288	203	177	155	155	177	998	988	592*	592	–	–	–	–	–	–	212	212	288	99	938
30	–	–	–	–	–	–	–	–	288	330	988	990	990	874	950	–	–	–	–	288	203	177	155	155	177	998	988	510*	516	–	–	–	–	–	–	212	212	288	99	940
45	–	–	–	–	–	–	–	–	288	330	950	990	990	2,440	960	–	–	–	–	288	203	177	177	288	177	998	988	455*	470	–	–	–	–	–	–	212	212	288	99	940
2	–	–	–	–	–	–	–	–	288	330	955	998	998	1,704	970	–	–	–	–	288	203	177	177	288	177	998	988	307*	482	–	–	–	–	–	–	212	212	288	99	940
15	–	–	–	–	–	–	–	–	288	330	999	998	998	1,564	988	–	–	–	–	288	203	177	177	288	177	998	988	363*	997	–	–	–	–	–	–	212	212	288	99	940
30	–	–	–	–	–	–	–	–	288	330	999	998	998	1,981	990	–	–	–	–	288	203	177	177	288	177	998	988	380*	952	–	–	–	–	–	–	212	212	288	99	940
45	–	–	–	–	–	–	–	–	288	330	999	998	998	1,006	990	–	–	–	–	288	203	177	177	288	177	998	988	298	940	–	–	–	–	–	–	212	212	288	99	940
3	–	–	–	–	–	–	–	–	288	330	999	998	998	1,738	990	–	–	–	–	288	203	177	177	288	177	998	988	288	940	–	–	–	–	–	–	212	212	288	99	940
15	–	–	–	–	–	–	–	–	288	330	999	998	998	1,694	990	–	–	–	–	288	203	177	177	288	177	998	988	288	940	–	–	–	–	–	–	212	212	288	99	940
30	–	–	–	–	–	–	–	–	288	330	999	998	998	1,931	990	–	–	–	–	288	203	177	177	288	177	998	988	288	940	–	–	–	–	–	–	212	212	288	99	940
45	–	–	–	–	–	–	–	–	288	330	999	998	998	1,666	990	–	–	–	–	288	203	177	177	288	177	998	988	288	940	–	–	–	–	–	–	212	212	288	99	940
4	–	–	–	–	–	–	–	–	288	330	999	998	998	840	990	–	–	–	–	288	203	177	177	288	177	998	988	288	940	–	–	–	–	–	–	212	212	288	99	940
15	–	–	–	–	–	–	–	–	288	330	999	998	998	1,801	990	–	–	–	–	288	203	177	177	288	177	998	988	288	940	–	–	–	–	–	–	212	212	288	99	940

DATE.	MARCH 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
15	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
30	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
45	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
1	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
15	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
30	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
45	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
2	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
15	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
30	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
45	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
3	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
15	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
30	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
45	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
4	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298
15	222	198	184	180	101	208	201	214	200	218	216	220	225	234	224	217	193	169	177	214	231	223	232	200	256	242	230	251	272	272	316	326	311	300	297	291	277	280	273	284	292	298

DATE.	APRIL 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	MAY 1	2	3	4	5	6	7	8	9
12	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
15	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
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4	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
15	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298

This sewer being shut up on the return of every flood tide, the quantity then accumulated is gauged during the next ebb; so that the whole of the sewage is gauged. Taking the average quantity of the whole each day, and the same for the number of days, the result should agree with that obtained by adding up the normal flow of each hour; which it does very nearly as shown in the following Table.

Date.	Quantity, in Cubic Feet, per Fifteen Minutes.	
21 Feb.	289	The quantities struck out are rejected as
23 „	282	
24 „	451	

MEAN OF

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also t

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

HEATH-WALL SEWER.

W. B. Hack, Engineer.

EVENING.

DATE.	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7
	CUBIC FEET PER MINUTE.																																													
FEBRUARY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	288	288	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	565	455	443	492	408	374	363	–	–	–	–	–	–	–	–	–	–
	330	288	250	240	231	231	231	231	231	231	231	231	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,959	2,461	1,182	945	754	684	541	479	443	408	397	385	374	352	352	5
	288	288	288	288	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,111	1,543	1,182	885	684	504	397	374	341	310	288	5
	726	579	516	455	432	397	385	374	363	363	363	363	363	363	363	363	–	782	618	516	420	397	397	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,557	2,212	1,561	–	–	–	712	7
	397	385	1,454	1,472	975	796	553	467	408	385	516	1,053	1,132	991	699	782	618	516	341	341	341	341	341	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,531	3,093	2,674	2,232	8
	2,699	1,696	1,489	1,198	960	826	712	565	504	455	408	385	363	341	341	341	341	352	352	352	352	352	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
	–	–	2,461	1,711	1,417	1,182	945	826	712	579	516	479	449	408	397	397	374	352	352	352	352	352	352	352	352	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	–	–	–	2,652	2,032	1,543	1,165	960	826	684	553	516	491	455	408	397	363	352	352	352	352	341	330	320	320	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
	–	–	–	–	–	–	3,438	2,826	2,567	2,132	1,896	1,561	1,454	1,053	960	796	592	504	432	397	363	341	320	310	288	288	288	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
	–	–	–	–	–	–	–	–	1,858	1,454	1,040	670	605	528	470	449	408	374	352	341	330	320	310	288	288	288	288	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
	–	–	–	–	–	–	–	–	–	–	2,674	2,253	1,896	1,634	1,367	1,059	665	754	605	516	491	374	374	363	352	341	330	320	310	310	310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
	–	–	–	–	–	–	–	–	–	–	–	–	–	2,588	2,071	1,634	1,367	1,085	885	796	712	592	516	455	420	385	374	363	341	341	330	320	310	298	288	288	288	288	–	–	–	–	–	–	–	7
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9,484	2,171	1,690	1,694	1,417	1,215	1,040	945	826	726	592	516	491	455	420	397	397	397	369	352	341	330	330	330	330	–	8
	397	397	397	397	385	374	374	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,012	1,820	1,489	1,198	975	811	684	593	504	455	432	408	397	385	374	369	352	
	177	177	177	177	177	177	177	177	177	177	–	–	–	–	–	–	–	–	–	–	9,484	2,915	2,102	1,549	930	–	–	–	–	–	–	–	–	–	–	–	2,232	1,437	1,040	811	605	491	397	374	352	2
	374	363	352	341	310	298	288	250	250	231	231	231	231	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,531	2,913	1,620	3
	2,691	1,826	1,579	1,367	1,132	960	826	726	605	541	516	491	467	432	408	385	352	352	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,695	2,052	1,507	4
	455	420	397	385	374	352	330	310	288	288	288	288	288	288	288	288	288	288	288	288	298	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,300	2,313	5
	1,689	1,215	1,065	609	826	684	579	516	455	408	397	374	352	341	330	320	310	298	298	298	298	298	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
	2,052	1,454	1,006	826	691	528	467	432	397	363	341	330	320	310	298	288	288	288	288	288	288	288	288	288	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
	–	–	2,013*	1,401*	1,101*	930*	782*	684*	553*	516*	479*	455*	432*	408*	397*	385*	363*	352*	352*	352*	330	320	310	310	310	288	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
	–	–	–	3,484*	2,524*	2,071*	1,782*	1,507*	1,182*	1,022*	930*	754*	712*	684*	684*	712*	754*	739*	712*	698*	618*	553*	541*	467*	432*	420*	374*	352*	352*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
	–	–	–	–	–	–	2,959	2,652	1,694	1,384	1,085	945	796	618	553	491	443	420	408	385	374	363	341	320	298	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	–	–	–	–	–	–	1,995	1,454	1,040	870	712	528	479	432	397	374	341	330	320	310	298	288	260	250	240	231	222	212	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
	–	–	–	–	–	–	–	–	2,695	2,152	1,782	1,454	1,148	1,006	796	684	592	516	479	432	397	374	363	352	341	330	310	288	288	288	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
	–	–	–	–	–	–	–	–	–	–	2,695	2,013	1,579	1,264	1,022	854	712	541	467	432	397	374	352	341	330	320	320	310	298	288	288	288	288	–	–	–	–	–	–	–	–	–	–	–	–	3
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,015	2,524	1,745	1,401	1,069	870	726	565	504	449	397	369	341	320	310	288	250	240	231	222	222	222	222	222	222	–	–	–	–	–	–	–	4
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,959	1,915	1,248	975	796	618	516	432	385	341	310	288	288	288	288	288	288	288	–	–	–	–	–	–	–	5
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,739	1,820	1,543	1,101	945	796	631	516	455	397	363	260	240	231	231	231	231	231	–	6
	203	177	177	–	–	–	212	212	212	212	212	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,674	1,745	1,489	1,069	699	553	479	467	455	420	397	222	240	212	203	7
	341	310	288	250	250	250	250	240	240	231	231	231	231	231	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,739	2,071	8
	288	250	240	231	222	222	212	212	222	232	221	231	250	250	250	240	240	240	240	240	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	565	9
	1,182	840	684	516	443	397	352	330	320	298	298	288	260	250	240	222	212	212	212	212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,415	2,091	1,264	945	698	2,111	10
	2,253	1,711	1,291	870	684	541	491	449	397	374	341	330	320	320	298	288	260	250	288	288	260	260	250	250	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
	–	–	–	–	2,091	1,543	1,215	1,006	854	726	605	528	479	432	385	341	310	288	260	240	222	212	203	188	177	177	177	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
	–	–	–	–	–	–	2,462	1,728	1,417	1,053	870	726	592	516	455	397	352	330	310	310	298	288	288	250	231	231	231	231	231	231	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
	316	316	326	311	309	297	291	277	280	273	284	292	293	302	312	316	306	306	303	323	319	323	313	309	302	297	302	294	289	294	297	290	290	279	266	266	266	266	255	320	341	330	330	330	345	352	7

MARCH

APRIL

Date.	Quantity, in Cubic Feet, per Fifteen Minutes.	
21 Feb.	280	
23 „	282	
24 „	451	
25 „	443	
26 „	326	
27 „	294	
28 „	329	
2 March	296	
3 „	341	
4 „	200	
5 „	300	
6 „	294	
7 „	366	
8 „	287	
9 „	350	
10 „	306	
11 „	293	
12 „	296	
13 „	323	
16 „	304	
17 „	317	
18 „	285	
19 „	304	
20 „	254	
21 „	240	
23 „	256	
24 „	204	
25 „	213	
26 „	245	
27 „	294	
28 „	287	
29)	7,327	
30 „	281	

This sewer being shut up on the return of every flood tide, the quantity then accumulated is gauged during the next ebb; so that the whole of the sewage is gauged. Taking the average quantity of the whole each day, and the same for the number of days, the result should agree with that obtained by adding up the normal flow of each hour; which it does very nearly as shown in the following Table.

The quantities struck out are rejected, as tidal water was most probably let in for flushing.

Sundays, and days on which rain fell to affect the gaugings, are omitted.

MEAN OF THE 24 HOURS - - - - - - 271 CUBIC FEET PER MINUTE.

The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (759), also the Sunday Gaugings, printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 76.

ENGINEER'S MINUTE.

DATE.	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45
FEBRUARY 20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	985	974	352	352	352	352	352	352	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	374	341	310	288	250	240	240	240	240	240	240	—	—	—	—	—	—	—	—	—	—	—	—
23	1,215	991	826	712	579	516	455	408	385	668	668	990	310	208	208	208	—	—	—	—	—	—	—
24	3,531	3,693	2,674	2,593	1,839	1,779	1,525	1,193	1,059	1,067	1,085	1,193	565	455	432	208	—	—	—	—	—	—	—
25	—	—	—	3,531	2,393	1,745	3,059	2,264	1,615	2,102	1,417	2,915	2,193	1,680	1,384	1,085	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MARCH 1	330	330	330	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	335	374	369	352	341	330	320	330	320	320	—	—	—	—	—	—	—	—	—	—	—	—	—
3	374	341	352	352	341	341	330	330	330	320	—	—	—	—	—	—	—	—	—	—	—	—	—
4	491	991	374	352	300	288	240	222	203	320	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	3,531	2,674	2,593	1,839	1,779	1,525	1,193	1,059	1,067	1,085	1,193	565	455	432	208	—	—	—	—	—	—	—
6	—	2,695	2,652	1,597	1,248	1,669	1,525	1,264	1,615	2,102	1,417	2,915	2,193	1,680	1,384	1,085	—	—	—	—	—	—	—
7	—	—	3,300	2,313	1,469	1,649	2,059	2,264	1,615	2,102	1,417	2,915	2,193	1,680	1,384	1,085	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	231	231	231	208	188	168	168	168	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	240	212	212	208	188	168	168	168	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	2,739	2,739	2,677	1,417	1,022	1,022	1,022	770	641	420	369	241	241	241	241	241	241	241	241	241	241	241
14	945	698	698	565	491	430	397	941	310	288	240	222	212	212	212	203	188	188	188	188	188	188	188
15	—	—	—	2,111	1,684	1,291	975	754	579	470	397	941	298	200	200	222	212	203	203	203	203	203	203
16	—	—	—	—	2,319	1,745	1,417	1,669	840	665	467	2,319	1,745	1,480	1,316	975	764	570	455	212	212	212	212
17	—	—	—	—	—	—	—	—	—	—	—	1,148	930	684	408	341	250	212	177	177	151	135	290
18	—	—	—	—	—	—	—	—	—	—	1,507	—	—	—	1,543	1,132	665	789	570	546	455	397	114
19	—	—	—	—	—	—	—	—	—	1,973	—	—	—	—	—	—	—	—	—	—	—	—	963
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

MORNING TIDES.

CUBIC FEET

DATE.	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
FEBRUARY 15	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	15
16	250	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	16
17	579	576	455	406	406	406	406	406	406	406	406	406	406	406	406	406	406	406	406	17
18	1,930	1,579	1,454	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	1,392	18
19	2,232	1,745	1,525	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504	19
20	—	—	2,503	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	2,724	20
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28
MARCH 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	31

MORNING TIDES.

CUBIC FEET

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	DATE.
FEBRUARY 13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28
MARCH 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	31
APRIL 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

UPPER GAUGE.—EFFRA SEWER.

CUBIC FEET PER MINUTE.

DAT	MORNING. 30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4
FEBRUARY 27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	206	202	206	196	186	186	186	226	237	226	206	206	206	206	206	206	237	237	237
28	82	74	74	74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	206	206	219	237	237	237	206	206	196	186	186	186	206	206	206
MARCH 1	74	74	74	74	74	74	74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	247	226	176	167	157	157	157	186	206	219	219
2	82	82	82	82	82	82	82	82	74	74	74	74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	206	186	186	226	226	226	237	259	259	259
3	82	82	82	82	82	82	82	82	74	74	113	113	113	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	206	237	259	259	259	105
4	89	89	89	89	82	82	82	82	82	82	167	196	206	206	196	130	130	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	97	97	97	97	97	97	97	97	97	97	97	97	97	121	121	121	130	130	130	139	157	157	157	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	74	74	74	74	74	74	74	97	113	113	121	121	130	130	130	130	148	130	130	130	130	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	105	105	105	105	113	113	130	139	139	139	139	139	157	157	167	176	176	186	186	186	186	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	97	97	97	105	113	113	113	121	130	130	113	113	130	130	157	176	176	167	157	157	148	148	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	148	157	167	167	176	176	196	206	206	219	219	206	206	206	196	196	226	237	219	206	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	280*	250*	280*	291*	315*	315*	326*	326*	326*	326*	326*	315*	303*	303*	315*	338*	326*	315*	315*	303*	291*	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	291*	375*	505*	560*	646*	574*	505*	438*	438*	438*	438*	438*	425*	400*	350*	350*	338*	303*	259*	315*	375*	–	–	–
12	113	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	206	206	206	206	206	206	206	206	259	315	350	326	315	315	303	303	291	451	464	478	476
13	413	413	413	400	350	315	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	478	478	478	478	505	532	532	505	478	451	451	451	451	451	451	505	505	505	505
14	139*	139*	139*	139*	130*	130*	130*	130*	206*	196*	157*	157*	157*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	206	219	219	219	206	206	206	206	259	291	315	326	357	438
15	139*	139*	139*	139*	139*	139*	139*	148*	148*	148*	157*	176*	176*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	237	219	206	196	196	196	206	219	237
16	113	113	113	113	113	121	121	130	130	139	139	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	259	259	270	326	350	375	338	355	400	413
17	105	105	105	105	105	105	105	105	97	97	97	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	113	113	113	113	113	121	121	121	121
18	89	89	89	89	97	97	97	97	105	105	105	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	196	196	206	206	206	206	206	206
19	105	105	97	97	97	97	105	113	113	113	113	105	113	113	121	130	130	139	139	139	148	157	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	97	97	97	97	89	89	97	89	89	89	89	105	113	113	113	113	113	121	121	121	130	139	139	157	167	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	74	74	74	74	89	89	97	105	105	105	113	113	113	113	113	130	139	148	157	157	157	186	206	206	206	196	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	89	89	97	97	97	113	113	130	139	148	148	139	139	139	157	157	176	186	186	176	176	206	206	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	121	121	121	130	130	130	139	139	139	139	139	139	130	121	113	113	105	97	97	89	113	105	97	–	–	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	176*	186*	206*	206*	206*	206	206	196	196	196	196	186	186	186	186	206	237	219	206	196	176	–	–	–	–	–	–	–
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	196	206	196	196	186	186	186	186	226	259	237	219	206	196	186	186	186	206	219	–	–	–	–	–	–
26	74	74	74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	196	196	186	186	186	219	237	226	206	186	176	157	157	157	157	176	176	196	206	206	206
27	82	74	74	74	74	74	74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	219	226	219	206	176	157	157	157	157	176	176	186	206	206	206
28	63	63	63	63	63	63	63	63	63	63	63	63	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	350*	315*	291*	291*	291*	303*	303*
29	259*	259*	259*	270*	303*	315*	338*	375*	438*	505*	546*	518*	478*	438*	425*	413*	247*	247*	259*	259*	259*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	219*	219*	219*	–
30	219*	206*	206*	206*	206*	206*	196*	196*	196*	196*	196*	206*	206*	219*	176	176	176	176	226*	219*	219*	206*	206	186	186	196	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206
31	–	–	130	130	130	130	130	121	121	121	139	157	176	196	176	176	219*	237*	206*	206*	219*	219*	237*	237*	237*	237*	247*	259*	259*	247*	259*	247*	237*	237*	237*	237*	247*	259*	270*	303*	303*	303*	291*	280*	280*	280*	280*	280*	280*
APRIL 1	–	–	–	–	–	–	139	139	139	139	139	167	196*	206*	206*	219*	206*	206*	219*	219*	226*	226*	247*	259*	247*	259*	259*	247*	237*	237*	237*	237*	247*	237*	237*	247*	259*	280*	303*	350*	387*	375*	326*	315*	291*	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	88	85	88	89	88	89	93	97	96	97	102	107	122	116	122	126	130	132	143	153	154	154	155	163	171	194	197	197	195	195	191	185	187	198	215	227	227	216	200	189	183	187	188	200	212	218	222

MEAN OF THE 24 HOURS - - - 146 CUBIC FEET PER MINUTE.

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings, printed in Antiquated Type, thus (632), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page

O P O L I S.

E R.

EVENING.

15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
CUBIC FEET PER MINUTE.																																											
226	237	226	206	206	206	206	206	206	237	237	237	237	237	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
237	237	237	206	206	196	186	186	186	186	206	219	206	226	226	206	206	219	206	206	186	186	206	186	186	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
–	247	226	176	167	157	157	157	157	206	219	259	219	219	247	219	219	219	219	176	176	206	206	206	186	186	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
–	–	–	206	186	186	226	226	226	237	259	259	259	237	105	105	105	113	219	186	186	176	176	226	219	206	206	196	186	186	176	176	167	167	–	–	–	–	–	–	–	–	–	16
–	–	–	–	–	–	–	–	206	–	–	–	–	–	–	–	–	–	–	–	–	–	–	113	113	113	113	113	113	113	113	113	97	97	97	97	97	97	97	97	97	97	97	97	17
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	219	219	219	219	219	219	219	219	219	196	196	196	196	196	196	196	196	196	196	196	196	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	20
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	21
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	22
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	23
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	24
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	25
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	26
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	27
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	28
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	29
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	30
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186	31
105	97	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
206	237	219	206	196	176	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
259	237	219	206	196	186	186	186	206	219	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
237	226	206	186	176	176	176	176	196	206	206	206	219	219	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
226	219	206	176	157	157	157	157	176	186	196	206	206	219	206	206	206	196	196	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
–	219	196	186	167	157	157	157	176	186	206	206	206	219	206	206	219	206	206	186	186	186	167	157	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
–	–	–	–	–	350*	315*	291*	291*	291*	291*	303*	315*	315*	315*	315*	315*	315*	315*	315*	350*	375*	375*	375*	338*	315*	315*	315*	176*	176*	176*	176*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	7
–	–	–	–	–	–	315*	291*	291*	219*	219*	219*	206*	206*	206*	206*	206*	206*	206*	206*	206*	196*	186*	186*	186*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	8
–	–	–	–	–	–	–	–	–	–	–	–	206*	206*	206*	206*	206*	206*	206*	206*	206*	226*	219*	219*	210*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	9
–	–	–	–	–	–	–	–	–	–	–	–	250*	250*	250*	247*	237*	237*	237*	237*	280*	438*	400*	375*	338*	315*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	10
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	210*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	11
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
247*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
387*	375*	326*	315*	291*	280*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
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227	227	216	200	189	183	187	188	200	212	218	222	223	220	215	210	202	195	185	182	183	180	175	174	170	157	156	154	144	144	142	141	136	134	132	130	123	119	118	116	112	110	99	

DATE.

FEBRUARY: 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

MARCH: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

APRIL: 1 2 3 4 5 6 7 8 9 10 11 12 13

d from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 70.

W. B. Hach, Engineer.

DATE.

MARCH: 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 2 25 26 27 28 29 30 31

APRIL: 1 2 3 4 5 6 7 8 9 0 1

MAIN DRA

LOWER

MORNING.

CUBIC FEET PER MINUTE.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	1
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MARCH 1																																												10
MARCH 2																																												
MARCH 3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 4	108	108	108	100	100	92	92	92	84	84	84	84	84	77	77	77	77	77	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	
MARCH 5	–	–	133	133	116	116	108	100	84	84	84	84	77	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	
MARCH 6	–	–	–	–	–	–	84	77	77	77	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	
MARCH 7	–	–	–	–	–	–	–	–	–	–	–	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	
MARCH 8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	
MARCH 9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	
MARCH 10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	
MARCH 11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 12	108	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 13	100	92	92	92	92	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 14	116	116	116	116	116	108	108	108	108	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 15	151*	151*	151*	151*	151*	142*	142*	142*	142*	142*	142*	142*	142*	142*	142*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 16	108	108	108	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 17	~~151~~	~~133~~	~~133~~	~~133~~	~~133~~	~~133~~	~~133~~	~~125~~	~~116~~	116	108	108	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
MARCH 18	–	–	~~350~~	~~350~~	~~350~~	~~350~~	~~350~~	~~350~~	~~350~~	~~350~~	~~350~~	~~338~~	~~362~~	~~375~~	~~375~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	~~425~~	
MARCH 19	–	–	–	–	–	151	133	133	133	133	133	133	116	116	116	116	116	133	133	142*	142*	142*	142*	142*	142*	133*	133*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 20	–	–	–	–	–	–	–	206*	189*	189*	170*	161*	151*	151*	151*	151*	151*	151*	151*	151*	151*	151*	151*	151*	151*	142*	142*	142*	142*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 21	–	–	–	–	–	–	–	133	133	133	125	116	116	116	116	116	116	108	108	108	108	108	108	108	108	108	108	108	108	108	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 22	–	–	–	–	–	–	–	–	142	142	133	116	116	116	116	116	116	108	108	108	100	100	100	100	100	100	100	100	100	100	100	92	–	–	–	–	–	–	–	–	–	–	–	–	–	
MARCH 23	–	–	–	–	–	–	–	–	–	92	92	84	84	84	–	108	108	108	108	108	108	100	100	100	100	100	100	100	100	100	100	100	100	100	116	116	116	–	–	–	–	–	–	–	–	
MARCH 24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	100	100	100	100	100	100	92	92	92	92	92	100	100	108	116	125	133	133	133	–	–	–	–	–	–	
MARCH 25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	100	100	108	108	92	92	92	92	92	84	92	92	92	108	116	142	142	151	151	151	151	151	151	–	
MARCH 26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	108	108	100	–	–	84	84	84	84	84	84	84	84	84	100	125	116	116	133	151	170	189	189	170	1
MARCH 27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	105	116	116	108	108	100	108	125	142	142	142	151	1	
MARCH 28	108	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	100	92	84	84	100	133	142	151	1		
MARCH 29	133	132	133	125	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	189*	189*	206*	237*	237*	247*	2			
MARCH 30	77	77	77	77	77	77	77	84	84	108	92	92	84	84	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	266	206	2					
MARCH 31	151*	151*	151*	151*	151*	133	125	125	108	92	92	84	84	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
APRIL 1	116	116	108	108	108	108	108	100	100	100	92	84	84	84	84	84	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
APRIL 2	108	108	100	100	100	108	108	100	100	100	100	92	92	92	84	84	84	74	74	74	74	74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
APRIL 3	–	–	–	–	108	108	100	100	100	92	92	92	84	84	84	84	74	74	74	74	77	74	74	63	74	74	74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
APRIL 4	–	–	–	–	–	–	–	–	108	108	108	100	100	92	84	84	74	74	74	74	63	63	63	63	63	63	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
APRIL 5	–	–	–	–	–	–	–	–	–	–	–	–	226*	226*	219*	–	219*	189*	206*	375*	400*	425*	425*	387*	362*	350*	350*	425*	478*	518*	560*	574*	560*	518*	219*	219*	226*	237*	259*	–	–	–	–	–	–	–	
APRIL 6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	226*	226*	225*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	206*	
APRIL 7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	108	116	108	108	108	108	108	108	108	108	116	125	151	161	170	179	179	189	189	189	206	–	–	–	–	
APRIL 8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	133	133	133	133	142	151	151	151	161	179*	206*	219*	226*	226*	226*	226*	226*	226*	226*	226*	226*	247*	3	
APRIL 9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	179*	189*	206*	206*	219*	219*	226*	226*	237*	237*	247*	259*	2		
APRIL 10	180*	179*	179*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	189	189	189	206	219	206	206	219	2
APRIL 11	116	116	108	125	133	133	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
APRIL 12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
	106	105	106	106	105	111	106	105	102	101	98	93	91	91	92	89	88	87	84	83	84	85	86	87	90	93	90	91	91	97	99	100	101	108	116	121	131	138	141	157	168	167	171	184	1

MEAN OF TH

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (~~75S~~), also the

Appendix III.—*continued.*

MAIN DRAINAGE, METROPOLIS.

LOWER GAUGE.—EFFRA SEWER.

W. B. Hach, Engineer.

MARCH APRIL

EVENING.

CUBIC FEET PER MINUTE.

DATE.	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15
5	–	–	–	–	–	–	–	–	–	–	–	–	161	161	170	206	206	206	206	206	206	189	189	206	226	226	226	219	206	206	206	219	219	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	206	219	219	219	219	219	219	226	247	259	226	206	179	219	219	189	161	161	161	219	219	226	237	237	237	237	206	170	170	170	170	226
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	206	179	170	189	219	226	206	179	219	219	259	219	226	237	247	247	247	247	237	237	237	219	206	237	237	237	170	206
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	250	259	259	219	259	247	237	–	237	270	270	259	259	259	237	237	219	237	237	237	237	237	237	237
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	100	100	100	100	100	100	100	100	100	100	100	100
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	226	226	226	206	206	206	206	206	206	206
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	116	116	116	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	100	108	116	125	133	133	133	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	92	108	116	142	142	151	151	151	151	151	151	151	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	84	100	125	116	116	133	151	170	170	189	189	170	189	189	206	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	105	116	116	108	108	100	108	125	142	142	142	151	161	170	189	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206
6	–	–	100	100	100	92	84	84	100	133	142	151	151	142	133	133	133	133	133	133	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
7	–	–	–	–	–	–	189*	189*	206*	237*	237*	247*	247*	247*	247*	226	226	226	210	210	219	206	206	206	237	259	259	237	226	219	206	206	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	206	206	206	219	237	237	226	189	189	206	206	206	206	206	226	247	247	247	226	219	206	189	189	189	206	206	206	206	206	206	219	210	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	219	206	206	206	206	206	206	206	226	247	247	247	226	206	206	206	206	206	189	189	189	189	206	206	206	237	237	237	226	206	189	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	250	259	259	219	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	518*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	219*	219*	226*	237*	250*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	151	161	170	179	179	180	189	189	206	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	179*	206*	219*	226*	226*	226*	226*	247*	270*	291*	291*	303*	315*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	179*	206*	226*	226*	226*	226*	226*	226*	226*	247*	280*	303*	315*	326*	326*	338*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	179*	189*	206*	206*	219*	219*	226*	226*	237*	237*	247*	250*	270*	280*	291*	303*	338*	338*	387*	413*	438*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	189	189	206	206	210	206	206	210	226	237	247	259	270	270	280*	303*	315*	338*	387*	413*	438*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	101	108	116	121	131	138	141	157	168	167	171	184	192	197	211	225	224	224	212	210	204	202	214	228	242	247	237	217	214	206	201	201	209	215	222	226	230	235	231	223	216	202	199	189	176	173

MEAN OF THE 24 HOURS - - - - - - - 152 CUBIC FEET PER MINUTE.

Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., Page 70.

G.

30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
MINUTE.																						
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	116	13
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
170	170	170	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16
237	237	226	206	206	206	206	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17
100	100	100	100	100	92	92	92	92	84	84	–	–	–	–	–	–	–	–	–	–	–	18
189	189	170	170	174	170	161	161	161	161	161	161	161	151	151	116	116	116	108	–	–	–	19
206	189	170	170	170	151	151	151	151	151	151	151	151	151	151	151	151	151	142	142	125	116	20
–	–	151	151	151	151	151	151	151	151	151	151	151	151	151	125	116	133	108	100	100	100	21
–	–	–	–	–	–	–	–	–	–	–	151	151	151	151	133	133	151	125	125	125	125	22
–	–	–	–	–	–	–	–	–	–	–	–	–	–	151	151	151	151	142	142	125	151*	23
–	–	–	–	–	–	–	–	–	–	–	–	–	–	142	142	142	142	125	125	125	151*	24
–	–	–	–	–	–	–	–	–	–	–	–	–	–	179*	179*	179*	179*	179*	151*	151*	151*	25
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	116	116	108	26
247	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	151	151	27
189	189	189	189	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28
326	315	291	291	291	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29
108	108	108	108	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
219	179	170	170	151	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31
151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	1
179	179	151	151	142	133	133	133	133	133	133	133	161	133	142	142	133	133	133	133	133	133	2
219	219	219	206	189	179	161	151	151	151	151	151	151	133	133	133	133	133	116	116	116	116	3
–	–	170	170	170	161	–	151	151	151	142	142	151	133	151	151	142	133	116	133	133	108	4
–	–	–	–	–	–	–	179	179	170	161	151	151	151	151	151	142	133	133	133	133	133	5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	84	84	84	77	77	77	77	77	6
–	–	–	–	–	–	–	–	–	–	–	–	–	–	170*	170*	170*	170*	170*	170*	161*	161*	7
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	151*	151*	142*	133	–	8
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
189	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
375*	400*	400*	413*	413*	189*	189*	189*	189*	179*	219*	219*	219*	219*	206*	259*	259*	259*	259*	259*	259*	259*	2
266*	206*	189*	189*	189*	226*	226*	226*	226*	219*	315*	315*	291*	280*	259*	189*	189*	189*	189*	189*	189*	189*	3
247*	237*	226*	226*	226*	338*	219*	206*	206*	206*	206*	206*	206*	189*	189*	219*	219*	206*	206*	206*	206*	206*	4
375*	425*	425*	387*	375*	219*	247*	247*	237*	237*	226*	226*	226*	219*	219*	151	151	151	151	125	116	116	5
237*	226*	219*	219*	206*	247*	–	–	–	161	161	161	161	151	151	–	–	–	–	–	–	–	6
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
199	189	176	173	167	163½	160	153	151	150	150	147	147	143	139	135	133	129	124	122	119	118	

FEBRUARY. MARCH. APRIL.

15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
1,007	960	900	1,084	2,079	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
686	618	547	484	448	414	368	1,246	–	–	–	–	–	–	–	–	–	–	–	8
4,425	–	–	3,439	3,924	4,425	–	–	–	–	–	–	–	–	–	–	–	–	–	9
2,292	2,071	1,915	1,687	1,651	1,471	1,280	1,164	1,084	943	856	756	756	1,651	1,425	–	–	–	–	10
4,425	3,679	2,674	2,253	2,071	1,915	1,651	1,614	1,365	1,314	1,084	1,023	1,007	960	1,954	–	–	–	–	11
–	–	–	3,752	2,674	2,212	2,212	1,915	1,723	1,632	1,542	1,263	1,246	1,023	1,007	1,007	1,023	2,674	–	12
–	–	–	–	3,679	2,212	1,954	1,800	1,651	1,488	1,348	1,246	1,297	1,084	871	856	728	659	618	13
–	–	–	–	–	2,462	1,542	1,280	1,100	1,084	1,116	1,084	976	943	900	770	618	700	503	14
–	–	–	–	–	–	3,679	2,588	1,506	1,084	1,007	900	646	425	402	379	368	368	356	15
–	–	–	–	–	–	–	–	–	4,929	3,095	1,954	1,743	1,614	1,246	1,182	916	841	686	16
–	–	–	–	–	–	–	–	–	–	–	–	3,208	2,152	1,743	1,471	1,023	1,314	1,246	17
–	–	–	–	–	–	–	–	–	–	–	–	–	3,300	2,272	1,800	1,506	1,246	1,213	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,208	2,568	2,013	1,769	–	19
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
1,297	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
900	856	784	756	1,116	2,052	–	–	–	–	–	–	–	–	–	–	–	–	–	23
1,382	1,280	1,164	1,023	933	900	900	871	1,559	–	–	–	–	–	–	–	–	–	–	2
2,111	1,993	1,769	1,614	1,471	1,330	1,213	1,100	1,007	900	1,116	1,723	–	–	–	–	–	–	–	25
2,789	2,272	2,071	1,915	1,687	1,559	1,365	1,084	1,182	992	900	756	633	618	1,915	–	–	–	–	26
–	–	–	2,730	2,152	1,915	1,687	1,614	1,399	1,100	1,164	1,007	900	813	770	659	586	1,705	–	27
–	–	–	–	–	–	2,631	2,152	1,935	1,705	1471	1,263	1,213	1,036	916	756	714	586	508	28
–	–	–	–	–	–	–	–	2,152	1,614	1,246	1,084	885	618	534	484	448	402	368	29
–	–	–	–	–	–	–	–	–	–	–	1,073	1,669	1,550	1,280	1,213	1,084	992	756	30
–	–	–	–	–	–	–	–	–	–	–	–	–	1,073	1,687	1,542	1,280	1,246	1,213	31
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,524	1,800	1,595	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
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–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
436	414	586	1,743	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
916	798	728	646	573	547	2,524	–	–	–	–	–	–	–	–	–	–	–	–	7
1,180	976	943	900	813	686	686	673	618	586	2,013	–	–	–	–	–	–	–	–	8
1,651	1,524	1,382	1,314	1,084	1,148	1,100	1,007	916	671	829	1,800	–	–	–	–	–	–	–	9
2,169	2,482	2,152	1,973	1,743	1,632	1,280	1,180	1,148	1023	813	756	700	2,739	–	–	–	–	–	10
–	–	2,717	1,954	1,614	1,314	1,180	992	871	728	618	508	460	357	336	2,761	–	–	–	11
941	897	838	767	773	711	793	772	801	765	779	694	737	726	758	760	661	606	580	

MARCH. APRIL.

the

ables.

ugh

DATE.	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
FEBRUARY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
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	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28
MARCH	206	206	206	–	–	–	–	–	–	–	–	–	–	–	–	–	116	116	1
	100	92	92	92	92	84	84	–	–	–	–	–	–	–	–	–	–	–	2
	174	170	161	161	161	161	161	161	161	151	151	–	–	–	–	–	–	–	3
	170	151	151	151	131	133	133	133	133	125	116	116	116	116	108	–	–	–	4
	151	151	151	151	151	151	151	151	151	151	151	151	151	151	142	142	125	116	5
	–	–	151	151	151	151	151	151	151	151	125	125	125	116	108	100	100	100	6
	–	–	–	–	–	–	–	–	–	133	125	125	116	108	108	125	125	125	7
	–	–	–	–	–	–	–	–	–	151	142	142	142	142	125	125	151*	151*	8
	–	–	–	–	–	–	–	–	–	–	179*	179*	179*	179*	179*	151*	116	108	9
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	116	~~151~~	~~151~~	10
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
	~~291~~	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
	151	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
	151	151	151	151	151	151	151	151	133	125	125	125	125	125	133	133	133	133	16
	142	133	133	133	133	133	151	151	161	161	142	142	133	133	133	116	116	116	17
	189	179	170	151	151	151	151	142	142	133	133	133	133	133	116	116	116	108	18
	170	161	151	151	151	151	151	142	142	133	133	133	133	133	116	116	116	108	19
	–	–	179	179	170	161	161	151	151	151	151	151	142	133	133	133	133	133	20
	–	–	–	–	–	–	92	92	92	84	84	84	84	77	77	77	77	77	21
	–	–	–	–	–	–	–	–	–	–	170*	170*	170*	170*	170*	170*	161*	161*	22
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	151*	151*	142*	133	23
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25
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	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28
APRIL	413*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
	189*	189*	189*	189*	179*	219*	219*	219*	206*	–	–	–	–	–	–	–	–	–	2
	226*	226*	226*	226*	219*	219*	291*	280*	259*	259*	259*	259*	259*	259*	–	–	–	–	3
	375*	338*	326*	326*	315*	315*	206*	189*	189*	189*	189*	189*	189*	189*	189*	189*	189*	–	4
	206*	219*	206*	206*	206*	206*	206*	189*	189*	219*	219*	206*	206*	206*	206*	189*	189*	189*	5
	247*	247*	247*	237*	237*	226*	226*	219*	219*	219*	206*	206*	206*	206*	189*	189*	189*	189*	6
	–	–	–	–	161	161	161	151	151	151	151	133	133	125	125	116	116	116	7
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
	167	163	160	153	151	150	150	147	147	143	139	135	133	129	124	122	119	118	

MOR

CUBIC FEET

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30
MARCH 5	–	–	–	3,439	2,979	2,461	1,993	1,506	1,046	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	3,118	2,545	2,013	1,471	1,023	900	756	618	559	484	436	368	368	346	325	304	304
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,072	2,313	2,032	1,506	1,084	992	700	618
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,425	3,208	2,111	1,542
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14	700	3,395	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15	508	618	2,212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	325	1,651	3,073	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	573	484	425	425	521	2,461	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	976	756	841	784	756	700	708	1,595	2,717	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	1,038	829	756	673	618	547	484	646	1,723	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	1,577	1,365	1,246	1,164	1,029	939	871	756	756	756	1,705	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	3,439	2,074	2,111	1,800	1,471	1,542	1,651	1,687	1,749	1,780	1,954	2,111	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	3,208	2,071	1,800	1,800	1,471	1,280	1,084	943	933	856	784
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,954	1,246	949	813	646	573	460
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,999	1,246
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
29	484	1,116	2,013	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30	368	346	315	508	2,272	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
31	633	618	547	484	425	391	508	1,084	2,695	–	–	–	–	–	–	–	–	–	–	–	–	–	–
APRIL 1	1,038	916	798	700	618	534	484	425	402	1,559	–	–	–	–	–	–	–	–	–	–	–	–	–
2	1,399	1,263	1,084	949	829	714	618	508	448	391	521	1,559	–	–	–	–	–	–	–	–	–	–	–
3	–	2,524	1,524	1,471	1,263	1,084	798	714	633	547	484	460	425	391	728	2,013	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	2,739	1,687	1,542	1,399	1,148	992	856	742	633	534	484	425	391	368	368	368
5	–	–	–	–	–	–	–	–	–	–	–	–	–	3,050	2,313	2,013	1,723	1,614	1,506	1,348	1,246	1,148	1,084
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,171	1,542	1,132	976	685
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,111	1,614
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	520	607	577	575	587	577	524	573	560	565	502	460	425	504	559	558	485	426	386	368	446	415	377

NOTE.—The above mean, 696 cubic feet per minute,

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

DUFFIELD SEWER.

MORNING.

CUBIC FEET PER MINUTE.

DA	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45
FEBRUARY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,079	2,631	2,212	1,954	1,780	1,651	1,632	1,614	1,6
	368	346	325	304	304	304	304	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,425	3,560	2,9
	1,506	1,084	992	700	618	559	508	508	559	673	633	673	756	1,015	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	4,425	3,208	2,111	1,542	1,197	976	841	686	646	508	497	402	336	325	315	315	325	368	2,313	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	4,425	3,208	1,729	1,280	1,084	949	829	784	700	700	618	586	586	618	646	1,246	4,171	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	4,425	2,461	1,915	1,669	1,471	1,280	1,213	1,132	1,023	900	900	856	841	841	798	841	1,084	4,425	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	3,163	2,092	1,651	1,471	1,280	1,246	1,164	1,007	933	900	900	960	976	976	933	976	2,313	4,425	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	4,171	3,752	2,293	1,705	1,595	1,506	1,330	1,297	1,164	1,100	1,132	1,164	1,100	1,023	1,116	1,164	2,631	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,095	2,111	1,723	1,577	1,506	1,365	1,314	1,280	1,246	1,164	1,116	1,084	1,164	1,180	1,148	1,100	976	1,651	4,068	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,212	1,723	1,577	1,669	1,382	1,382	1,348	1,314	1,280	1,269	1,148	1,084	1,084	1,084	1,023	1,007	1,084	976	1,664	2,319	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,118	1,973	1,632	1,471	1,280	1,100	976	871	784	784	829	856	871	900	900	900	900	871	871	976	3,326	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,171	3,169	2,313	1,614	1,348	1,213	976	841	714	633	573	521	484	460	460	1,705	4,425	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,439	2,212	1,614	1,471	1,330	1,213	1,148	1,023	960	916	871	841	784	871	1,651	4,297	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,373	3,300	2,524	1,954	1,669	1,542	1,506	1,559	1,297	1,038	1,180	1,116	1,084	3,988	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,873	2,804	2,212	1,915	1,705	1,559	1,399	1,314	1,246	1,180	1,100	1,023	–	1,506	992	1,687	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,095	2,461	1,880	1,595	1,471	1,263	1,330	1,084	943	856	900	960	1,132	1,542	–	–	–	–
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,439	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,728	2,313	1,6
1	1,084	943	933	856	784	686	618	573	1,506	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	943	813	646	573	460	391	368	283	226	172	172	154	130	264	2,171	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	1,993	1,246	1,023	909	756	508	293	244	216	216	263	226	244	289	264	244	1,542	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	2,509	1,614	992	686	521	508	436	484	448	508	586	448	391	379	521	2,111	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	1,915	1,180	756	686	472	379	336	315	315	315	315	336	368	391	425	618	3,560	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	2,461	1,651	1,632	1,280	1,148	1,023	976	960	933	933	916	916	916	916	916	916	900	2,674	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,461	1,651	1,488	1,297	1,213	1,132	1,084	1,038	1,038	1,023	976	933	943	960	900	933	1,559	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,071	1,559	1,365	1,230	1,023	871	700	618	547	508	472	425	402	391	379	368	1,954	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,631	1,818	1,595	1,314	1,213	1,100	1,023	933	885	813	742	673	646	618	728	770	856	2,319	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,631	1,954	1,614	1,506	1,595	1,471	1,330	1,213	1,260	1,471	1,100	976	943	900	856	2,313	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1																																																
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,804	2,232	1,993	1,800	1,669	1,559	1,471	1,348	1,263	–	–	2,152	1,330	1,116	1,084	2,631	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,095	2,313	1,935	1,687	1,577	1,488	1,314	1,213	1,132	1,023	943	900	1,330	2,588	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,439	2,071	1,915	1,632	1,471	1,330	1,246	1,160	1,100	1,038	8
	425	391	368	368	368	368	497	2,071	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,439*	3,163*	2,461*	2,293*	1,9
	1,506	1,348	1,246	1,148	1,084	1,007	943	933	933	1,023	1,084	1,116	2,313	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1,171	1,542	1,132	976	685	756	673	618	586	547	559	600	600	600	618	646	673	1,559	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	2,111	1,614	1,330	1,116	900	784	714	646	618	559	534	508	484	460	460	460	460	618	2,588	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	2,071	1,506	1,213	900	770	646	534	497	521	646	646	646	646	646	659	813	943	2,313	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–	–	2,032*	1,542*	1,280*	1,213*	1,132*	1,023*	916*	856*	770*	756*	756*	829*	871*	900*	960*	1,743	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	2,171	1,651	1,488	1,246	1,148	992	916	856	798	742	742	714	673	673	2,013	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	2,524	1,915	1,506	1,269	1,084	933	841	784	813	813	813	813	813	813	813	2,212	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	386	362	446	415	377	476	470	469	551	610	631	612	592	575	551	536	535	582	690	690	736	809	857	891	880	911	1,003	966	947	838	852	759	814	900	958	955	878	856	967	970	922	930	–	–	–	–	85

MEAN OF THE 24 HOURS - - - - - 696 CUBIC FEET PER MINUTE.

: above mean, 696 cubic feet per minute, is the result of the figures in the Table as it stands, exclusive of the quantities between 3 and 6.30 p.m., as there were not sufficient observations to determine these; but assuming that the flow continued between 930 and 1,000 cubic feet per minute during that time, the mean of the day would be increased t

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (758), also the Sunday Gaugings, printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix II

O P O L I S.

CUBIC FEET PER MINUTE.

DATE.	EVENING. 15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45
MARCH 5	–	–	–	2,979	2,631	2,212	1,954	1,780	1,651	1,692	1,614	1,614	1,506	1,382	1,348	1,314	1,280	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	4,425	3,560	2,079	2,182	1,915	1,651	1,577	1,382	1,246	1,230	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	4,425	3,499	2,588	2,111	1,954	1,743	1,577	1,382	1,314	1,260	1,164	1,084	1,007	960	900	1,084	2,979	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,425	2,631	1,632	1,246	1,084	916	784	686	618	547	484	448	414	368	1,246	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,425	–	–	–	3,499	3,024	4,425	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,425	3,499	2,232	2,071	1,915	1,687	1,651	1,471	1,280	1,164	1,084	943	856	756	756	1,651	4,425	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,425	3,679	2,674	2,253	2,071	1,915	1,651	1,614	1,365	1,314	1,084	1,029	1,007	900	1,954	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,752	2,674	2,212	2,212	1,915	1,723	1,632	1,542	1,269	1,246	1,023	1,007	1,007	1,023	2,674	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,679	2,212	1,954	1,800	1,651	1,488	1,348	1,246	1,207	1,084	871	856	728	659	618	578	538
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,462	1,542	1,280	1,100	1,084	1,116	1,084	976	943	900	770	618	700	508	508	508
15	2,319	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,679	2,588	1,506	1,084	1,007	900	646	425	402	379	368	368	336	336	336
16	976	3,326	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,828	3,005	1,954	1,749	1,614	1,246	1,192	916	841	686	686	686
17	4,425	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,208	2,152	1,743	1,471	1,023	1,314	1,246	1,246	1,246	1,246
18	1,651	4,297	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,300	2,272	1,800	1,506	1,246	1,213	1,213	1,213	1,213
19	1,084	3,988	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,208	2,568	2,013	1,769	1,769	1,769
20	1,023	–	1,506	992	1,687	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	1,263	1,230	1,084	943	856	900	960	1,192	1,542	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	3,439	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	–	–	–	3,728	2,313	1,632	1,084	916	728	618	659	436	391	346	325	304	283	425	1,297	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,300	2,272	1,915	1,687	1,471	1,230	1,230	1,116	1,023	976	900	856	784	756	1,116	2,052	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,027	2,212	1,993	1,763	1,651	1,559	1,382	1,280	1,164	1,029	933	900	900	871	1,559	–	–	–	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,326	2,717	2,232	2,111	1,993	1,769	1,614	1,471	1,230	1,219	1,100	1,007	900	1,116	1,723	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,789	2,272	2,071	1,915	1,687	1,559	1,365	1,084	1,182	992	900	756	633	618	1,915	–	–	–	–	–	–
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,739	2,152	1,915	1,687	1,614	1,399	1,100	1,164	1,007	900	813	770	659	586	1,705	–	–	–	–	–	–
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,691	2,152	1,995	1,705	1,471	1,263	1,213	1,038	916	756	714	586	508	508	508
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,152	1,614	1,246	1,084	885	618	534	484	448	402	368	368	368	368
31	770	856	2,313	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,978	1,669	1,559	1,280	1,213	1,084	992	756	756	756
1	943	900	856	2,313	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,978	1,687	1,542	1,260	1,246	1,213	1,213	1,213	1,213
2	–	2,152	1,330	1,116	1,084	2,631	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,524	1,890	1,595	1,595	1,595	1,595
3	1,468	1,914	1,213	1,192	1,023	943	900	1,330	2,588	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	3,439	2,071	1,915	1,682	1,471	1,330	1,246	1,160	1,100	1,038	856	1,084	1,723	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	3,439*	3,163*	2,461*	2,203*	1,954*	1,743*	1,542*	1,488*	1,471*	1,330*	1,280*	1,246*	1,230*	1,330	2,152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	3,208	2,152	1,614	1,348	1,213	1,084	900	742	659	586	508	472	436	414	586	1,743	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,255	2,313	1,600	1,614	1,263	1,230	1,084	902	916	798	728	646	573	547	2,524	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,152	1,780	1,614	1,471	1,330	1,160	976	943	900	813	686	686	673	618	586	2,013	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,111	1,818	1,651	1,524	1,382	1,314	1,084	1,148	1,100	1,007	916	871	829	1,800	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,163	2,482	2,152	1,979	1,743	1,632	1,280	1,180	1,148	1023	813	756	700	2,739	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,717	1,954	1,614	1,314	1,160	992	871	728	618	508	460	357	336	2,761	–	–	–	–	–
	955	878	856	967	970	922	930	–	–	–	–	856	–	–	–	–	–	–	–	–	–	–	1,023	984	941	897	838	767	773	711	793	772	601	765	779	694	737	726	758	760	661	636	580	580	580

MINUTE.

d 1,000 cubic feet per minute during that time, the mean of the day would be increased to 733 cubic feet per minute. The former quantity, however, has been used in the general Tables.

---

xcluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 76.

om

Chelsea Water-works, Thames Bank.

Inches.

·03
·125
·065
·0175
·0425
·0175
·0350
·005
·01
·0050
·007

W. B. Hack, Engineer.

aured)

MAIN DRA

MORNING.

CUBIC FEET PER MINUTE.

DATE.	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11
MARCH 14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,471*	1,332*	1,248*	1,193*	1,148*	1,053*	1,053*	1,053*	976*	960*	960*
15	592*	579*	565*	553*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,910*	2,521*	2,167*	1,932*	1,723*	1,542*	1,383*	1,264*	1,069*	1,006*	945*	885*
16	433	410	399	376	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	645	618	579	528	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	930	826	740	685	631	592	565	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	1,069	945	870	769	672	631	579	528	460	433	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	1,436*	1,298*	1,182*	1,022*	970*	930*	826*	754*	713*	699*	672*	658*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	1,886	1,578	1,418	1,291	1,089	945	870	769	699	645	631	592	565	553	541	541	516	469	469	469	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	1,932	1,669	1,471	–	1,281	1,132	945	855	769	672	631	579	516	469	457	433	410	399	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,705	1,471	1,298	1,069	980	811	699	645	565	516	457	422	387	376	365	355	355	365	376	–	–	–	–	–	–	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,948	1,165	1,960	826	727	668	579	481	433	399	376	344	334	334	344	344	355	365	387	469	–	–	–	–	–	–	–	–
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,524	1,915	1,148	991	870	754	672	618	565	541	516	457	422	399	410	528	618	685	713	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,687	1,471	1,264	1,053	980	991	769	727	658	616	570	553	541	579	658	783	811	811	795	769	705	658
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,800	1,542	1,848	1,215	1,053	930	842	769	699	658	592	541	516	481	410	699	705	658	615
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,989	1,705	1,489	1,848	1,291	1,182	1,215	1,215	1,198	1,148	1,053	1,006	960	915	855	795
29	658	631	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,912	1,604	1,418	1,281	1,165	991	900	855	769	705	658
30	516	469	469	457	457	469	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,674	1,651	1,471	1,298	1,182	1,022	930	855
31	699	631	579	528	516	469	457	493	422	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,069	1,800	1,651	1,524	1,418	1,315	1,215
APRIL 1	685	811	769	713	658	618	592	541	516	469	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,137	1,912	1,729	1,593	1,471
2	1,281	1,132	976	870	783	699	691	565	528	457	422	410	376	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	2,375	1,989	1,769	1,471	1,264	1,038	991	685	795	754	658	618	579	541	528	516	481	481	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	2,167	1,874	1,632	1,418	1,264	1,022	980	842	740	645	605	528	481	445	422	410	376	365	355	344	344	344	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	2,417	2,048	1,855	1,669	1,489	1,383	1,281	1,215	1,148	1,053	1,022	976	930	915	885	870	855	855	842	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,780	1,542	1,382	1,198	1,088	980	842	754	685	618	565	528	481	469	457	445	445	433	433	433	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,009	1,729	1,506	1,298	1,132	960	855	754	672	618	579	541	516	516	481	481	481	516	528	541	541	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,048	1,780	1,542	1,315	1,165	991	900	811	727	645	592	553	541	553	553	541	516	481	469	457	457	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,687*	1,418*	1,248*	1,053*	930*	855*	783*	713*	699*	783*	870*	930*	976*	976*	960*	960*	976*	976*	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,167	1,855	1,682	1,436	1,291	1,192	991	900	826	789	740	699	685	672	658	672	685	699	672	672	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,951	1,687	1,489	1,315	1,182	1,022	945	685	826	783	769	754	740	727	727	727	727
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,127	1,836	1,596	1,418	1,281	1,148	991	915	826	754	699	658	618	592	565	541
13	528	528	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,896	1,604	1,436	1,281	1,148	1,022	930	870	842	783	754	727	727	727	727	727
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,187	1,912	1,687	1,542	1,383	1,281	1,165	1,089	976	960	915
15	645	605	579	541	528	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,912	1,765	1,489	1,332	1,291	1,182	1,022	960	915
16	895	811	740	699	658	618	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,069	1,743	1,560	1,389	1,264	1,148	1,053
17	1,069	976	870	783	727	672	618	592	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,009	1,763	1,593	1,471	1,348	1,215
18	1,966	1,248	1,022	885	754	699	618	565	541	469	433	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	–	–	2,088	1,818	1,632	1,383	1,281	1,132	991	915	842	769	699	645	605	592	553	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	1,298	1,038	980	811	699	618	565	516	445	422	390	370	355	344	334	334	334	334	323	323	334	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	–	–	–	–	–	–	1,818	1,560	1,366	1,165	991	870	769	669	691	579	528	469	445	410	387	376	365	365	365	365	365	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,092	1,705	1,506	1,348	1,165	1,000	915	795	718	645	592	565	528	516	481	469	457	457	481	528	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,989	1,749	1,506	1,092	1,182	991	885	811	740	685	645	605	565	565	553	541	565	618	–	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,127	1,855	1,632	1,418	1,298	1,165	1,022	930	855	811	740	699	672	645	685	699	672	672	–	–	–	–	–	–
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,855	1,604	1,436	1,291	1,192	976	900	811	769	727	699	685	685	699	727	727	727	727	727	727	727
	530	524	521	486	500	537	548	538	495	457	427	410	427	541	522	508	515	510	466	439	445	448	454	421	398	425	423	431	444	454	456	466	469	478	500	508	520	556	583	621	638	653	655	729	768

MEAN OF

NOTE.—The Gaugings marked with a *Star*, and those struck through with a Black Line, thus (~~758~~), also the Su

Appendix III—*continued.*

MAIN DRAINAGE, METROPOLIS.

EARL SEWER.

EVENING.

CUBIC FEET PER MINUTE.

15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	12	15	30	45	1	15	30	45	2	15	30	45	3	15	30	45	4	15	30	45	5	15	30	45	6	15	30	45	7	15	Inches.
–	1,471*	1,332*	1,248*	1,193*	1,148*	1,053*	1,053*	1,053*	976*	960*	960*	909*	842*	795*	754*	713*	713*	699	672	658	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2,910*	2,521*	2,167*	1,932*	1,723*	1,542*	1,383*	1,264*	1,069*	1,006*	945*	885*	870*	826*	811*	826*	855*	900*	900*	900*	900*	900*	885*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	1,723	1,506	1,948	1,215	1,059	991	915	855	795	740	699	685	658	645	618	605	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	1,803	1,651	1,471	1,332	1,215	1,059	960	885	826	769	727	713	685	672	658	645	645	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	2,029	1,800	1,614	1,436	1,298	1,108	1,059	991	990	900	855	826	795	783	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	2,029	1,800	1,604	1,471	1,315	1,215	1,069	991	945	900	855	826	795	783	745	754	740	727	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,855	1,651	1,506	1,948	1,248	1,165	1,059	1,006	960	900	855	811	769	740	699	660	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,088	1,893	1,705	1,578	1,471	1,848	1,215	1,098	960	915	842	–	–	–	–	–	–	–	–	–	–	·03
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,669	1,436	1,418	1,038	930	811	727	672	605	553	528	469	445	422	410	410	·125
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,906	1,989	1,763	1,578	1,989	1,215	1,022	915	826	740	672	618	·065
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,497	2,048	1,600	1,524	1,989	1,264	1,148	991	·0175
344	344	355	365	387	469	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,605	2,127	1,912	1,669	2,605	2,167	
457	422	399	410	528	618	685	713	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
658	616	579	553	541	579	658	783	811	811	795	769	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
990	842	769	699	658	592	541	516	481	410	699	795	885	915	930	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1,489	1,948	1,291	1,192	1,215	1,215	1,108	1,148	1,053	1,006	960	915	870	842	826	795	783	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	1,912	1,604	1,418	1,281	1,165	991	900	855	811	769	754	727	713	685	672	658	645	631	618	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	1,674	1,651	1,471	1,293	1,182	1,022	930	855	811	783	727	699	658	645	618	645	592	592	605	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	2,009	1,800	1,651	1,524	1,418	1,315	1,291	1,148	1,098	991	945	915	870	870	826	811	811	795	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	2,197	1,912	1,729	1,542	1,418	1,298	1,215	1,069	1,006	960	915	885	855	826	811	795	795	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,167	1,912	1,729	1,560	1,401	1,264	1,198	1,098	960	930	870	811	811	783	769	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,147	1,912	1,705	1,560	1,401	1,281	1,198	1,182	1,165	1,069	1,098	991	930	915	855	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,029	1,818	1,669	1,542	1,418	2,375	1,951	1,705	1,506	1,332	1,182	1,006	900	795	740	685	605	565	528	·0425
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,167	1,992	1,743	1,578	1,418	1,291	1,165	1,098	915	855	·0175
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,167	1,951	1,743	1,578	1,418	1,298	1,182	·0350
445	433	433	433	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,896	2,099	1,768	1,560	1,401	·005
516	481	481	481	516	528	541	541	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,691*	
553	541	553	553	541	516	481	469	457	457	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
699*	783*	870*	930*	976*	976*	960*	960*	976*	976*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
1,182	991	900	826	789	740	699	685	672	658	672	685	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
1,915	1,182	1,022	945	885	826	789	769	754	740	727	727	727	699	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
1,836	1,596	1,418	1,281	1,148	991	915	826	754	699	658	618	592	579	541	541	528	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
1,886	1,604	1,496	1,281	1,148	1,022	930	870	842	783	754	727	685	658	635	645	631	631	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
–	–	–	2,187	1,912	1,697	1,542	1,389	1,281	1,165	1,098	976	915	855	826	783	740	740	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
–	–	–	–	1,912	1,795	1,489	1,332	1,291	1,192	1,022	960	900	870	842	811	795	769	740	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	·01
–	–	–	–	–	–	2,009	1,748	1,560	1,389	1,264	1,148	1,006	945	885	811	783	740	699	685	672	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	2,009	1,763	1,578	1,401	1,264	1,165	1,006	930	870	811	727	699	672	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	–	–	2,071	1,880	1,578	1,332	1,291	1,148	1,006	930	870	811	754	713	672	658	645	645	645	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,687	1,453	1,264	1,038	915	811	727	645	565	516	445	422	399	376	355	344	334	323	–	–	–	–	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,769	1,560	1,401	1,291	1,069	976	870	811	740	699	672	631	592	553	–	–	–	–	–	–	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,417	2,048	1,896	1,687	1,524	1,389	1,298	1,215	1,182	991	990	870	811			
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,626*	2,398*	2,088*	1,893*	1,743*	1,604*	1,506*	1,401*	1,315*	
457	457	481	528	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,865	2,542	2,206	1,951	1,763	·0050
565	565	553	541	565	618	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,778	2,500	2,147	
655	811	740	699	672	645	685	699	672	672	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	·007
900	811	769	727	699	685	685	699	727	727	727	727	727	727	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
478	508	508	529	550	583	621	638	653	655	729	708	707	704	709	744	720	741	754	751	740	706	735	768	795	769	755	732	718	720	699	692	672	786	790	863	791	799	771	743	717	735	740	771	714	

tinued)

MEAN OF THE 24 HOURS - - - 615 CUBIC FEET PER MINUTE.

gs marked with a *Star*, and those struck through with a Black Line, thus (759), also the Sunday Gaugings printed in Antiquated Type, thus (362), are excluded from the Totals in arriving at the Mean Results. *See* Explanation in Appendix III., page 70.

rom

Chelsea Water-works, Thames Bank.

W. B. Hall, Engineer.

61

G.

	30	45	7	15	30	45	8	15	30	45	9	15	30	45	10	15	30	45	11	15	30	45	DATE.
R	M I N U T E.																						
	–	–	–	–	–	–	–	–	–	–	1,198*	1,132*	1,038*	915*	885*	783*	740*	699*	672*	645*	618*	605*	14
	–	–	–	–	–	–	–	–	–	–	1,780	1,560	1,298	1,132	991	900	783	672	605	579	528	469	15
	–	–	–	–	–	–	–	–	–	–	–	2,127	1,836	1,651	1,459	1,298	1,132	960	811	811	754	699	16
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,521	2,167	1,874	1,651	1,471	1,315	1,182	1,038	17
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,479	2,071	1,800	1,560	1,401	1,264	18
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,417	2,029	1,800	1,692	19
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
9	445	422	410	410	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
5	826	740	672	618	565	516	469	433	399	376	–	–	–	–	–	–	–	–	–	–	–	–	23
4	1,383	1,264	1,146	991	900	811	740	685	631	579	528	457	422	–	–	–	–	–	–	–	–	–	24
	2,665	2,127	1,912	1,669	1,453	1,298	1,182	1,096	915	826	754	672	618	565	481	–	–	–	–	–	–	–	25
	–	–	2,665	2,167	1,899	1,687	1,506	1,348	1,215	1,022	930	811	749	672	605	541	457	422	410	–	–	–	26
	–	–	–	–	–	2,500	2,088	1,836	1,692	1,458	1,298	1,165	1,006	915	811	727	658	605	565	541	528	516	27
	–	–	–	–	–	–	–	–	2,626	2,313	1,951	1,743	1,578	1,436	1,298	1,165	1,022	930	855	795	740	672	28
	–	–	–	–	–	–	–	–	–	–	1,855	1,596	1,418	1,264	1,069	945	870	769	699	645	592	541	29
	–	–	–	–	–	–	–	–	–	–	–	–	2,206	1,912	1,687	1,489	1,348	1,215	1,053	930	842	769	30
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,479	2,029	1,800	1,692	1,459	1,298	1,148	974	31
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,187	1,855	1,651	1,496	1
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
2	826	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
0	685	605	565	528	469	457	445	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
1	1,165	1,038	915	855	795	754	727	699	672	645	–	–	–	–	–	–	–	–	–	–	–	–	6
8	1,578	1,418	1,298	1,182	1,038	945	885	826	783	740	699	685	658	–	–	–	–	–	–	–	–	–	7
6	2,089	1,763	1,560	1,401	1,264	1,165	1,006	900	826	760	713	658	605	553	528	481	–	–	–	–	–	–	8
	–	–	–	2,691*	2,417*	2,042*	1,836*	1,651*	1,489*	1,348*	1,231*	1,132*	991*	915*	855*	795*	740*	–	–	–	–	–	9
	–	–	–	–	2,954	1,989	1,743	1,542	1,401	1,264	1,098	976	900	811	769	740	699	685	645	–	–	–	10
	–	–	–	–	–	–	2,822*	2,500*	2,167*	1,932*	1,743*	1,560*	1,401*	1,281*	1,165*	1,022*	945*	900*	842*	795*	754*	–	11
	–	–	–	–	–	–	–	1,855	1,596	1,401	1,231	1,132	976	885	811	727	672	645	605	579	553	528	12
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
	–	–	–	–	–	–	–	–	–	–	2,563	2,088	1,855	1,604	1,401	1,281	1,165	1,022	900	826	769	699	14
	–	–	–	–	–	–	–	–	–	–	–	–	–	2,521	2,147	1,893	1,687	1,506	1,366	1,215	1,069	976	15
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,098	2,626	2,206	1,970	1,769	1,560	1,401	1,264	16
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,313	1,951	1,723	1,506	1,418	17
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
2	553	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
2	991	930	870	811	795	754	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
3*	1,601*	1,506*	1,401*	1,315*	1,248*	1,182*	1,053*	1,006*	960*	–	–	–	–	–	–	–	–	–	–	–	–	–	22
5	2,542	2,206	1,951	1,769	1,578	1,436	1,348	1,215	1,069	1,006	930	885	–	–	–	–	–	–	–	–	–	–	23
	–	2,778	2,560	2,147	1,912	1,743	1,596	1,471	1,315	1,215	1,069	991	915	855	811	754	699	–	–	–	–	–	24
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25
7	735	740	771	714	718	674	645	606	621	622	646	618	608	597	596	648	628	571	540	668	679	620	

MARCH

APRIL

Appendix III.—*continued.*

G.—TABLE, showing the RAINFALL, in Inches, at various Places of Observation within the Metropolitan Boundary, from 10th March to 1st July 1857, taken with reference to the Sewer Gaugings.

DATE. Day.	Hour.	Northumberland Street.	Highgate Hill.	Brixton Hill.	Lough-borough Road.	Bricklayers' Arms.	Horseferry Road, Westminster.	The Master's Garden, Charterhouse.	Zoological Gardens, Regent's Park.	Westbourne Lodge, Harrow Road.	Kensington Canal Basin.	Chelsea Water-works, Thames Bank.
		Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1857: March 10	6 a.m.	– –	– –	– –	– –	– –	March 8: ·095					
	12 a.m.											
	6 p.m.											
	12 p.m.											
11	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
12	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
13	6 a.m.											
	12 a.m.	– –	– –	– –	– –	– –	·02					
	6 p.m.	– –	– –	·055	– –	– –		– –	·03			
	12 p.m.	– –	– –	·005	– –	·0225						
14	6 a.m.	– –	– –	·06	– –	·025	·05	– –	·04	·095		
	12 a.m.	– –	– –	·04	·08	·0225	·05	– –	·03			
	6 p.m.											
	12 p.m.	– –	– –	– –	·03	·0725	·06	– –	– –	– –	– –	·03
15	6 a.m.	– –	– –	·18	– –	·165	·125	·10	·33	– –	– –	·125
	12 a.m.	– –	– –	·04	·28	·0425	– –	·10	– –	·32	– –	·065
	6 p.m.	– –	– –	– –	·01	·0475	– –	– –	·08	– –	– –	·0175
	12 p.m.											
16	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
17	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
18	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
19	6 a.m.	– –	– –	·035	·04	·04	·03	·06	·15	– –	– –	·0425
	12 a.m.	– –	– –	·025	·04	·0325	·165	·05	·0225	·11	– –	·0175
	6 p.m.	– –	– –	– –	– –	– –	– –	– –	– –	·015		
	12 p.m.	– –	– –	·05	– –	·0175	·115	·05	– –	– –	– –	·0350
20	6 a.m.	– –	– –	·015	·10	·0325	·015	·02	·1275	·15	– –	·005
	12 a.m.	– –	– –	– –	·01							
	6 p.m.											
	12 p.m.											
21	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
22	6 a.m.											
	12 a.m.	– –	– –	– –	·01	– –	·01					
	6 p.m.	– –	– –	·03	·02	– –	– –	– –	·01	– –	– –	·01
	12 p.m.											
23	6 a.m.											
	12 a.m.	– –	– –	·005	·01							
	6 p.m.											
	12 p.m.											
24	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.	– –	– –	– –	·01	– –	– –	– –	– –	– –	– –	·0050
25	6 a.m.	– –	– –	– –	– –	·0075	– –	·02				
	12 a.m.	– –	– –	·005	·02	– –	– –	·02	·01	·03	– –	·007
	6 p.m.	– –	– –	– –	– –	·01	– –	·02				
	12 p.m.	– –	– –	·0025	·01							

No Observations taken.

No Observations taken.

61 W. B. Hoch, Engineer.

Appendix III.—*continued.*

C.—TABLE, showing the RAINFALL, in Inches, at various Places of Observation within the Metropolitan Boundary, from 10th March to 1st July 1857, taken with reference to the Sewer Gaugings.

DATE. Day.	Hour.	Northumberland Street.	Highgate Hill.	Brixton Hill.	Loughborough Road.	Bricklayers' Arms.	Horseferry Road, Westminster.	The Master's Garden, Charterhouse.	Zoological Gardens, Regent's Park.	Westbourne Lodge, Harrow Road.	Kensington Canal Basin.	Chelsea Waterworks, Thames Bank.
1857: March 10	6 a.m.	*Inches.* - -	*Inches.* - -	*Inches.* - -	*Inches.* - -	*Inches.* - -	*Inches.* March 8: ·095	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
	12 a.m.											
	6 p.m.											
	12 p.m.											
11	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
12	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
13	6 a.m.											
	12 a.m.	- -	- -	- -	- -	- -	·02					
	6 p.m.	- -	- -	·055	- -	- -	- -	- -	·03			
	12 p.m.	- -	- -	·005	- -	·0225						
14	6 a.m.	- -	- -	·06	- -	·025	·05	- -	·04	·095		
	12 a.m.	- -	- -	·04	·08	·0225	·05	- -	·03			
	6 p.m.											
	12 p.m.	- -	- -	- -	·03	·0725	·06	- -	- -	- -	- -	·03
15	6 a.m.	- -	- -	·18	- -	·165	·125	·10	·33	- -	- -	·125
	12 a.m.	- -	- -	·04	·28	·0425	- -	·10	- -	·32	- -	·065
	6 p.m.	- -	- -	- -	·01	·0475	- -	- -	·08	- -	- -	·0175
	12 p.m.											
16	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
17	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
18	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
19	6 a.m.	- -	- -	·035	·04	·04	·03	·06	·15	- -	- -	·0425
	12 a.m.	- -	- -	·025	·04	·0325	·165	·05	·0225	·11	- -	·0175
	6 p.m.	- -	- -	- -	- -	- -	- -	- -	- -	·015		
	12 p.m.	- -	- -	·05	- -	·0175	·115	·05	- -	- -	- -	·0550
20	6 a.m.	- -	- -	·015	·10	·0325	·015	·02	·1275	·15	- -	·005
	12 a.m.	- -	- -	- -	·01							
	6 p.m.											
	12 p.m.											
21	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
22	6 a.m.											
	12 a.m.	- -	- -	- -	·01	- -	·01					
	6 p.m.	- -	- -	·03	·02	- -	- -	- -	·01	- -	- -	·01
	12 p.m.											
23	6 a.m.											
	12 a.m.	- -	- -	·005	·01							
	6 p.m.											
	12 p.m.											
24	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.	- -	- -	- -	·01	- -	- -	- -	- -	- -	- -	·0050
25	6 a.m.	- -	- -	- -	- -	·0075	- -	·02				
	12 a.m.	- -	- -	·005	·02	- -	- -	·02	·01	·03	- -	·001
	6 p.m.	- -	- -	- -	- -	·01	- -	·02				
	12 p.m.	- -	- -	·0025	·01							

No Observations taken.

No Observations taken.

Appendix III.—*continued.*

6.—TABLE, showing the Rainfall, in Inches, at various Places of Observation within the Metropolitan Boundary, &c.—*continued.*

DATE. Day.	Hour.	Northumberland Street.	Highgate Hill.	Brixton Hill.	Loughborough Road.	Bricklayers' Arms.	Horseferry Road, Westminster.	The Master's Garden, Charterhouse.	Zoological Gardens, Regent's Park.	Westbourne Lodge, Harrow Road.	Kensington Canal Basin.	Chelsea Waterworks, Thames Bank.
1857:		*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
March 26	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
27	6 a.m.	- -	- -	·015								
	12 a.m.											
	6 p.m.											
	12 p.m.	- -	- -	·02								
28	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
29	6 a.m.											
	12 a.m.	- -	- -	·03	·06	·045	·01	·05	·04	- -	·06	·0325
	6 p.m.	- -	- -	- -	- -	- -	- -	- -	- -	·06		
	12 p.m.	- -	- -	- -	·01							
30	6 a.m.	- -	- -	·02	- -	·0275	- -	·02	- -	·06	- -	·0075
	12 a.m.	- -	- -	·035	·05	·01	·035	- -	·01	- -	·06	·0150
	6 p.m.	- -	- -	·035	·04	·0525	·065	·07	·045	·08	·06	·0550
	12 p.m.	- -	- -	·05	·02	·035	·020	·02	- -	- -	- -	·0075
31	6 a.m.	- -	- -	·01	·01	·03	- -	·02	- -	·04	- -	·0150
	12 a.m.	- -	- -	·01	·01	- -	·015	- -	- -	- -	·03	·0050
	6 p.m.	- -	- -	- -	- -	- -	- -	- -	- -	·01		
	12 p.m.	- -	- -	·01	·02	·0075	·015	·02	- -	- -	- -	·0125
TOTAL - - -		- -	- -	·782	·890	·754	·895	·640	·925	·970	·210	·530
April - 1	6 a.m.	- -	- -	- -	- -	- -	- -	- -	·04	·05	·013	
	12 a.m.	- -	- -	- -	·01							
	6 p.m.	- -	·10									
	12 p.m.	- -	- -	·005								
2	6 a.m.	- -	- -	·015	- -	·02	·01	·02	- -	- -	- -	·005
	12 a.m.	- -	- -	·010	·03	- -	·025	·02	·01	·02	·05	·0225
	6 p.m.	- -	·12	- -	- -	- -	- -	- -	- -	·05		
	12 p.m.	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	·01
3	6 a.m.	- -	- -	- -	·01	- -	- -	- -	·04	- -	·05	
	12 a.m.	- -	- -	·03	·02	- -	·015	- -	- -	·06	·06	·01
	6 p.m.	- -	·14	·02	·02	·01	- -	- -	- -	- -	- -	·01
	12 p.m.	- -	- -	- -	- -	·005						
4	6 a.m.	- -	- -	- -	- -	·0025	- -	- -	·06			
	12 a.m.	- -	- -	·0025	- -	·005	- -	·09	- -	- -	·02	
	6 p.m.	- -	·12	·1125	·013	·08	·235	- -	·135	·08	- -	·115
	12 p.m.	- -	- -	·06	·06	·075	·045	·23	- -	·10	- -	·065
5	6 a.m.	- -	- -	·1525	·13	·1075	·150	- -	·235	- -	·44	·115
	12 a.m.	- -	- -	·005	·01	·015	.065	·10	- -	·27	- -	·045
	6 p.m.	- -	·48	·005								
	12 p.m.	- -	- -	·05	·05	- -	·035	- -	- -	- -	- -	·025
6	6 a.m.	- -	- -	- -	- -	·095	- -	·05	·04	·07	·04	·01
	12 a.m.	- -										
	6 p.m.	- -	·05									
	12 p.m.	- -										
7	6 a.m.											
	12 a.m.											
	6 p.m.	- -	- -	·05	·05	·0475	·015	- -	- -	- -	·10	·03
	12 p.m.	·04	- -	·0225	·01	- -	- -	- -	- -	·045		
8	6 a.m.	- -	- -	- -	- -	·0125						
	12 a.m.	- -	- -	·05								
	6 p.m.	·075	·09	- -	- -	- -	·115	·02	·075	·115	·11	07
	12 p.m.	- -	- -	- -	- -	- -	- -	·10				
9	6 a.m.											
	12 a.m.	·047	- -	- -	·07	·0925	·040	·07	·12	·12	·14	·09
	6 p.m.											
	12 p.m.											
10	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
11	6 a.m.	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	·01
	12 a.m.	·007	- -	·0375	·06	- -	- -	·06	·03	·08	·04	·025
	6 p.m.	·06	·02	·05	·03	·08	- -	·06	·04	- -	·04	·04
	12 p.m.	·003										

Appendix III.—*continued.*

6.—TABLE, showing the Rainfall, in Inches, at various Places of Observation within the Metropolitan Boundary, &c.—*continued.*

DATE. Day.	Hour.	Northumberland Street.	Highgate Hill.	Brixton Hill.	Loughborough Road.	Bricklayers' Arms.	Horseferry Road, Westminster.	The Master's Garden, Charterhouse.	Zoological Gardens, Regent's Park.	Westbourne Lodge, Harrow Road.	Kensington Canal Basin.	Chelsea Waterworks, Thames Bank.
1857:		*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
April 12	6 a.m.	- -										
	12 a.m.	- -	- -	- -		·01	- -	·07				
	6 p.m.	- -	·08	·0025								
	12 p.m.	·032	- -	·03		·025	·005	- -	- -	- -	- -	·035
13	6 a.m.	- -	- -	- -		- -	- -	·16	- -	·055	- -	·02
	12 a.m.	·015	- -	·005		·0475						
	6 p.m.	- -	·08	·035		·015	- -	- -	·055	- -	- -	·04
	12 p.m.	·102	- -	·065		·09	- -	- -	- -	- -	·09	·085
14	6 a.m.	- -	- -	·03		·04	- -	- -	·115	·18	- -	·02
	12 a.m.	·03										
	6 p.m.	- -	·17									
	12 p.m.	- -										
15	6 a.m.	- -										
	12 a.m.	- -										
	6 p.m.	- -	·005	·0725		·0525	- -	- -	·06	·08	- -	·12
	12 p.m.	·07	- -	- -		·0475						
16	6 a.m.	- -	- -	- -		·015						
	12 a.m.	- -	- -	- -		·0075	- -	·08	·05	- -	- -	·015
	6 p.m.	·03	·045	·075		·0375	- -	·14	·035	·14	·18	·095
	12 p.m.	·09										
17	6 a.m.	- -	- -	- -		·0475	- -	- -	·125			
	12 a.m.											
	6 p.m.	- -	·16	- -	·58							
	12 p.m.											
18	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
19	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
20	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
21	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
22	6 a.m.											
	12 a.m.	- -	- -	·02		- -	- -	- -	·03	- -	·03	·01
	6 p.m.	·12	- -	·145		- -	·14	·15	·12	·12	·15	·14
	12 p.m.	·003										
23	6 a.m.	- -	- -	- -		- -	- -	·02	·01	·07	·01	
	12 a.m.	·01	- -	·02		- -	·01	- -	- -	- -	- -	·01
	6 p.m.	- -	·19									
	12 p.m.											
24	6 a.m.											
	12 a.m.											
	6 p.m.	- -	·01									
	12 p.m.											
25	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
26	6 a.m.	- -	- -	·01		- -	- -	- -	- -	- -	- -	·01
	12 a.m.	- -	- -	- -		- -	- -	- -	- -	- -	·03	
	6 p.m.	- -	- -	- -		- -	·02					
	12 p.m.											
27	6 a.m.	- -	- -	- -		- -	·01					
	12 a.m.											
	6 p.m.											
	12 p.m.											
28	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											

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Appendix III.—*continued.*

6.—TABLE, showing the Rainfall, in Inches, at various Places of Observation within the Metropolitan Boundary, &c.—*continued.*

DATE. Day.	Hour.	Northumberland Street.	Highgate Hill.	Brixton Hill.	Loughborough Road.	Bricklayers' Arms.	Horseferry Road, Westminster.	The Master's Garden, Charterhouse.	Zoological Gardens, Regent's Park.	Westbourne Lodge, Harrow Road.	Kensington Canal Basin.	Chelsea Waterworks, Thames Bank.
1857:		*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
April 29	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
30	6 a.m.											
	12 a.m.											
	6 p.m.	- -	·015									
	12 p.m.	·01	- -	·005	·0175							
TOTAL of MONTH		1·744	1·875	1.185	—	1·082	·935	1·440	1·425	1·705	1·593	1·297
May 1	6 a.m.	- -	- -	- -		- -	- -	·02				
	12 a.m.											
	6 p.m.											
	12 p.m.											
2	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
3	6 a.m.											
	12 a.m.											
	6 p.m.	·01	- -	·005								
	12 p.m.											
4	6 a.m.	- -	- -	- -		- -	- -	·01				
	12 a.m.											
	6 p.m.											
	12 p.m.											
5	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
6	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
7	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
8	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
9	6 a.m.											
	12 a.m.											
	6 p.m.	·04	- -	- -	- -	- -	- -	- -	·03			
	12 p.m.											
10	6 a.m.											
	12 a.m.	·01										
	6 p.m.											
	12 p.m.											
11	6 a.m.	·03		·04	- -	·0475	·035	·02	·07	·07		·03
	12 a.m.	·02	·10	·01	- -	- -	- -	- -	- -	·04		·01
	6 p.m.	·01		- -	- -	- -	- -	- -	·03	·06		
	12 p.m.	- -		- -	- -	- -	- -	- -	- -	- -		
12	6 a.m.	- -		- -	- -	- -	- -	- -	·03			
	12 a.m.	- -		- -	·0725	- -	- -	·01				
	6 p.m.	- -	·035									
	12 p.m.	·01		- -	- -	·035	- -	- -	- -	- -	No Observations taken.	·005
13	6 a.m.	·01		- -	- -	- -	·02	·02	- -	·045		
	12 a.m.	- -	·03									
	6 p.m.											
	12 p.m.											
14	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											

Appendix III.—*continued.*

6.—TABLE, showing the Rainfall, in Inches, at various Places of Observation within the Metropolitan Boundary, &c.—*continued.*

DATE. Day.	Hour.	Northumberland Street.	Highgate Hill.	Brixton Hill.	Loughborough Road.	Bricklayers' Arms.	Horseferry Road, Westminster.	The Master's Garden, Charterhouse.	Zoological Gardens, Regent's Park.	Westbourne Lodge, Harrow Road.	Kensington Canal Basin.	Chelsea Water works, Thames Bank.
1857:		*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
May 15	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
16	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
17	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
18	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
19	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
20	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
21	6 a.m.											
	12 a.m.	- -	- -	- -	- -	- -	- -	·01	- -	- -	·02	·025
	6 p.m.	·03	- -	·03	- -	- -	- -	·01	·03			
	12 p.m.	- -	- -	- -	- -	- -	·01	- -	- -	·04		
22	6 a.m.											
	12 a.m.	·09		·05	·13	·1225	·02	·07	·09	- -	·12	·065
	6 p.m.	·10	·03	·035	·10	·055	·110	·07	·08	·165	·06	·075
	12 p.m.	·03		·03	·06	·0025	·08	·09	·08	- -	- -	·05
23	6 a.m.	·08		·09	·11	·05	·065	- -	·14	·17	·16	·15
	12 a.m.	·01	·37	- -	-	·05	·05	·07				
	6 p.m.	- -		- -	- -	·04						
	12 p.m.	- -										
24	6 a.m.	·01	·05	·03	- -	- -	·045	- -	- -	·07	·05	·05
	12 a.m.											
	6 p.m.											
	12 p.m.											
25	6 a.m.											
	12 a.m.											
	6 p.m.	- -	- -	- -	- -	- -	·03	·07	- -	- -	- -	·06
	12 p.m.	·05	- -	·08	·19	·065	·09	·05	·07	- -	·08	·055
26	6 a.m.	- -	·07	- -	- -	- -	·005	- -	·07	·13		
	12 a.m.											
	6 p.m.											
	12 p.m.											
27	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
28	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
29	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
30	6 a.m.	·01	·025	- -	- -	- -	- -	- -	- -	·06	- -	·045
	12 a.m.											
	6 p.m.											
	12 p.m.											

(continued)

Appendix III.—*continued.*

6.—TABLE, showing the Rainfall, in Inches, at various Places of Observation within the Metropolitan Boundary, &c.—*continued.*

DATE. Day.	Hour.	Northumberland Street.	Highgate Hill.	Brixton Hill.	Loughborough Road.	Bricklayers' Arms.	Horseferry Road, Westminster.	The Master's Garden, Charterhouse.	Zoological Gardens, Regent's Park.	Westbourne Lodge, Harrow Road.	Kensington Canal Basin.	Chelsea Waterworks, Thames Bank.
		Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1857: May 31	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
TOTAL of MONTH		·550	·710	·400	- -	·527	·560	·526	·850	·790	- -	·575
June 1	12 a.m.											
	6 a.m.											
	6 p.m.											
	12 p.m.											
2	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
3	6 a.m.											
	12 a.m.	·04	- -	·01	·08	·05	- -	·04	·08	- -	·02	
	6 p.m.	- -	·22	- -	·09	·06	- -	·03	·10	·26		
	12 p.m.											
4	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
5	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
6	6 a.m.	- -	- -	- -	- -	- -	·005					
	12 a.m.											
	6 p.m.	- -	- -	·03	·04	·04	·04	·05	·03	- -	- -	·05
	12 p.m.											
7	6 a.m.	·09	- -	·11	·12	·10	·10	·10	- -	·10	·11	·10
	12 a.m.	·07	- -	·115	·12	·12	·095	·10	·23	·18	·09	·08
	6 p.m.											
	12 p.m.											
8	6 a.m.											
	12 a.m.											
	6 p.m.	·30		·35	·32	·325	·215	·23	·11	·14	·23	·38
	12 p.m.	- -		·05	- -	- -	- -	·01	·04	·065	- -	·01
9	6 a.m.	- -	- -	·01	- -	- -	·005					
	12 a.m.											
	6 p.m.	·05	·545	- -	·05	·055	·055	·06	·06	- -	·02	·055
	12 p.m.	·15		·11	·10	·12	·15	·14	·10	·115	·14	·15
10	6 a.m.	·01		·03	- -	- -	·03	- -	·01	·06		
	12 a.m.											
	6 p.m.	·01		- -	- -	- -	- -	·06				
	12 p.m.	- -		- -	- -	- -	- -	- -	·09			
11	6 a.m.											
	12 a.m.	- -	·065									
	6 p.m.											
	12 p.m.											
12	6 a.m.											
	12 a.m.											
	6 p.m.	- -	·035									
	12 p.m.											
13	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 m.											
14	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
15	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											

Appendix III.—*continued.*

6.—TABLE, showing the Rainfall, in Inches, at various Places of Observation within the Metropolitan Boundary, &c.—*continued.*

DATE. Day.	Hour.	Northumberland Street.	Highgate Hill.	Brixton Hill.	Loughborough Road.	Bricklayers' Arms.	Horseferry Road, Westminster.	The Master's Garden, Charterhouse.	Zoological Gardens, Regent's Park.	Westbourne Lodge, Harrow Road.	Kensington Canal Basin.	Chelsea Water works, Thames Bank.
		Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1857: June 16	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
17	6 a.m.	·01	- -	·04								
	12 a.m.											
	6 p.m.											
	12 p.m.											
18	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
19	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.	·05	- -	- -	·05	·05	- -	- -	- -	- -	·065	
20	6 a.m.	·90	·57	·02	·91	·93	·83	·68	·74	1·00	·44	·69
	12 a.m.	·08	- -	- -	·05	·06	·035	- -	·03	- -	·03	·02
	6 p.m.											
	12 p.m.	- -	- -	- -	- -	- -	- -	- -	- -	- -	·06	
21	6 a.m.	- -	·27	·25	·09	·15	·165	·16	·18	- -	·15	·17
	12 a.m.	- -	- -	·01	- -	- -	- -	- -	·08	·36	·02	·04
	6 p.m.											
	12 p.m.											
22	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
23	6 a.m.											
	12 a.m											
	6 p.m.											
	12 p.m.											
24	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
25	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
26	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
27	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
28	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
29	6 a.m.											
	12 a.m.											
	6 p.m.											
	12 p.m.											
30	6 a.m.	- -	- -	·01	- -	- -	·06					
	12 a.m.	- -	·07	·02	- -	- -	·025	- -	- -	·10		
	6 p.m.	- -	- -	- -	- -	- -	·04					
	12 p.m.											
TOTAL of MONTH		1·760	2·045	1·765	2·020	2·060	1·850	1·660	1·880	2·380	1·375	1·745
July 1	6 a.m.											
	12 a.m.	- -	- -	- -	- -	- -	·025					
	6 p.m.	- -	- -	·08	- -	- -	·08	- -	- -	·45		
	12 p.m.	- -	- -	·02	- -	- -	·02					
TOTAL of 1st JULY		- -	- -	·100	- -	- -	·125	- -	- -	·450		

7.—RAINFALL IN THE NEIGHBOURHOOD OF LONDON.

(1.) Rain Gauge Observations at *Kew* Observatory for 1856, taken at 10. 0. A.M.

—	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	–	–	–	–	·116	–	–	–	·054	·017	·107	—
2	–	–	–	–	·041	·003	–	–	·009	—	—	—
3	–	–	–	–	–	–	–	–	–	–	–	·150
4	–	–	–	·246	·053	–	–	–	–	·090	–	·047
5	–	–	–	–	–	–	·006	–	–	·133	–	·195
6	–	·205	·007	–	–	–	–	–	–	–	–	·035
7	–	·044	–	–	·273	–	·006	–	·138	·072	–	·090
8	–	·160	–	–	·076	–	·240	–	–	·867	–	·003
9	–	–	–	·007	·002	–	·068	·122	·004	·060	·167	·056
10	–	–	–	·393	–	–	·069	·055	·002	–	·010	·183
11	–	·013	–	·009	–	–	·003	·004	–	·455	–	·341
12	–	·270	–	·208	–	–	·025	·146	–	·033	·054	·218
13	–	·121	–	·003	1·160	·180	·008	–	·079	·009	–	·399
14	–	·172	–	–	·140	·206	–	·530	–	–	·019	—
15	–	·005	–	·156	·137	–	–	·105	·013	·274	—	—
16	–	–	–	·002	·127	·070	·326	–	–	·212	—	—
17	–	–	·703	–	·003	·002	·021	1·027	–	·066	·006	—
18	–	–	·004	–	·355	–	–	·062	·136	–	·050	·028
19	–	·051	·223	·047	·093	·190	·011	·005	–	–	·112	·030
20	–	·002	·006	·001	·001	·078	·001	·304	–	–	·020	—
21	–	·001	·008	–	–	·080	·050	·600	–	–	·038	—
22	–	–	–	–	·276	·063	·089	·034	·108	—	—	—
23	–	·010	–	–	·122	·010	·001	–	·185	—	—	—
24	–	–	–	–	·051	–	·001	–	·035	·003	–	·082
25	–	–	–	–	·011	·006	·001	·008	·185	—	—	—
26	–	–	–	·317	·150	–	–	·030	·097	–	·270	·037
27	–	·002	–	·569	·003	–	–	·003	·343	–	·253	—
28	–	·001	–	·142	·610	–	·239	·003	·485	·005	·048	—
29	–	–	–	·001	·478	–	·015	·056	·068	·002	—	—
30	–	–	–	–	–	–	·002	–	·018	·003	–	·040
31	–	–	–	–	·030	–	–	–	–	·173	–	·006
Total -	1·057	·951	2·101	4·308	·888	1·182	3·094	1·959	2·474	1·154	1·946	

Total - 21·114 - during last Eleven Months of 1856.

7.—Rainfall in the Neighbourhood of London—*continued.*

(1.) Rain Gauge Observations at *Kew* Observatory for 1857, taken at 10. 0. A.M.

—	January.	February.	March.	April.	May.	June.	July.
1	·007	·287	- -	·059	·040	·001	·074
2	·120	- -	- -	·165	·001	- -	·167
3	·123	- -	- -	·022	—	—	—
4	·010	- -	- -	·010	- -	·001	·108
5	·150	- -	- -	·677	- -	- -	·111
6	·009	·007	- -	·066	- -	- -	·031
7	- -	- -	- -	- -	- -	·239	·122
8	·030	- -	- -	·104	- -	- -	·002
9	·120	·015	·114	·212	- -	·199	—
10	·725	·073	·014	·004	- -	·162	—
11	·294	·006	·048	·006	·018	·044	·039
12	·025	·003	- -	·115	·010	·001	·002
13	·030	·007	- -	·115	·032	—	—
14	- -	- -	·165	·186	—	—	—
15	·010	- -	·129	·005	—	—	—
16	·127	- -	·112	·020	—	—	—
17	- -	- -	- -	·135	- -	·005	—
18	·025	—	—	—	—	—	—
19	·014	- -	·103	—	—	—	—
20	·019	- -	- -	·001	—	—	—
21	·265	·005	·024	—	—	—	—
22	·007	- -	- -	·001	·055	—	—
23	·075	- -	·003	·178	·355	—	—
24	·030	- -	·001	·002	·042	—	—
25	·218	·003	—	—	—	—	—
26	·084	·015	·003	·012	·089	—	—
27	·061	- -	·003	—	—	—	—
28	- -	- -	- -	- -	·001	—	—
29	- -	- -	·084	—	—	—	—
30	- -	- -	·229	- -	·014	—	—
31	- -	- -	·185	—	—	—	—
Total -	2·578	·421	1·217	2·095	·657	·652	·656

Appendix III.—*continued.*

7.—Rainfall in the Neighbourhood of London—*continued.*

(2.) Register of Rainfall abstracted from the Tables of the British Meteorological Society.

LOCALITY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1850:	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
Royal Observatory, Greenwich	1·2	1·3	·3	2·3	2·4	·9	2·9	1·9	1·3	1·6	2·2	1·4	19·7
Maidenstone Hill, Greenwich	1·1	1·3	·2	2·3	2·3	1·0	2·4	1·5	1·8	1·7	2·1	1·4	19·1
St. John's Wood	1·5	1·0	·3	2·6	2·0	1·1	2·5	·7	2·4	1·7	2·2	1·5	19·5
Chiswell-street, London	1·0	1·3	·2	2·7	1·9	·9	2·6	1·8	1·8	1·6	1·7	1·3	18·8
1851:													
Lewisham	2·8	1·1	4·2	2·1	1·0	1·3	3·8	2·4	·3	2·2	·6	·6	22·4
Royal Observatory, Greenwich	2·7	1·2	4·1	2·3	·8	1·3	2·8	1·5	·8	1·8	·6	·6	20·5
Maidenstone Hill, Greenwich	2·8	1·2	4·2	2·0	·5	1·1	4·0	2·5	·3	1·8	·5	·5	21·4
Camberwell	2·5	·9	3·2	1·7	·9	1·0	–	–	–	–	–	–	–
Chiswell-street	2·8	·9	4·1	1·9	1·0	1·1	3·4	3·3	·3	1·9	·5	·5	21·7
St. John's Wood	3·5	1·0	4·3	1·6	·6	1·2	3·7	2·9	·4	2·1	·4	·6	22·3
1852:													
Lewisham	–	–	–	–	–	–	–	–	–	4·1	6·3	1·6	–
Royal Observatory, Greenwich	3·6	·9	·2	·5	1·9	4·6	2·3	4·5	3·9	3·8	6·0	2·2	34·4
Chiswell-street	2·8	1·2	·2	·5	2·0	4·6	–	–	–	3·7	5·9	1·5	–
St. John's Wood	3·5	1·0	·3	·8	1·3	5·7	2·5	3·7	3·6	3·9	6·7	2·1	35·1
1853:													
Lewisham	2·3	1·0	1·4	3·4	1·8	2·7	5·9	2·3	2·4	4·3	1·6	·6	29·7
Royal Observatory, Greenwich	2·0	·9	1·5	3·1	1·6	2·8	6·0	2·2	2·4	4·3	1·5	·7	29·0
Paddington	–	–	–	–	1·6	2·3	–	–	–	3·9	1·3	·4	–
Chiswell-street	2·3	·5	1·1	–	–	–	4·6	1·7	1·9	–	–	–	–
St. John's Wood	2·7	1·1	1·7	3·1	2·2	2·4	5·2	1·8	2·1	4·3	1·3	·6	28·5
Kingston-on-Thames*	2·6	·9	1·6	3·4	2·4	2·6	4·5	1·9	2·8	3·6	1·1	·6	28·0
1854:													
Lewisham	1·7	1·1	·4	·7	3·6	1·2	2·1	2·3	·8	–	–	–	–
Royal Observatory	1·7	1·0	·4	·6	3·3	1·0	1·7	2·9	·7	–	–	–	–
Paddington	1·3	1·0	·4	·3	3·5	1·0	1·9	3·0	·6	–	–	–	–
St. John's Wood	2·3	1·0	·4	·4	3·7	1·1	2·7	2·8	–	–	–	–	–
Kingston-on-Thames*	1·6	·9	·3	·3	3·8	1·4	2·1	1·8	·6	2·5	1·5	1·4	18·2
1855:													
Lewisham	1·0	1·0	1·5	0·1	1·8	0·7	6·1	0·9	1·1	5·0	1·5	1·1	21·8
Royal Observatory, Greenwich	1·0	1·4	1·5	0·1	1·8	0·7	5·0	1·1	1·1	4·9	1·3	1·2	21·1
St. Thomas' Hospital	0·2	0·7	1·2	0·2	1·3	1·1	5·4	1·2	1·1	5·5	1·9	–	–
St. Mary's Hospital	0·6	1·0	1·5	0·3	1·6	1·3	5·3	1·2	1·0	5·1	1·9	1·1	21·9
St. John's Wood	0·7	1·1	1·9	0·3	1.9	1·7	5·9	–	1·1	–	–	–	–
Kingston-on-Thames*	0·8	1·3	1·8	0·3	1·7	0·9	6·4	1·3	1·2	5·6	1·8	1·3	24·4
1856:													
Royal Observatory, Greenwich	2·3	0·9	1·2	2·3	3·5	1·6	0·9	2·4	2·8	1·6	1·0	1·3	21·8
Battersea Training School	2·3	1·0	0·9	2·3	3·8	1·3	2·3	3·2	2·2	2·2	1·5	–	–
St. Mary's Hospital	1·5	1·0	1·0	1·9	3·4	1·0	1·4	3·1	2·5	2·0	1·4	1·7	21·9
St. Thomas' Hospital	2·3	0·9	0·9	1·8	3·3	1·1	1·3	3·5	2·1	1·3	1·3	1·9	21·7
Lambeth	–	–	–	1·6	3·2	0·9	1·4	2·7	2·1	–	–	–	–
Whitehall	–	–	–	–	–	–	1·4	3·2	2·2	1·8	1·5	1·6	–
Lewisham	–	–	–	–	–	–	–	–	–	1·6	1·4	1·6	–
Guildhall, City of London	–	–	–	–	–	–	–	–	–	1·6	1·3	1·6	–
Pimlico	–	–	–	–	–	–	–	–	–	2·1	1·5	2·1	–
Kingston-on-Thames*	1·9	1·0	0·7	2·6	3·7	1·3	1·2	3·3	2·2	2·2	1·0	2·1	23·2

* From a gauge kept at Westfield Lodge, Kingston-on-Thames.

Appendix III.—*continued.*

7.—Rainfall in the Neighbourhood of London, &c.—*continued.*

(2.) Register of Rainfall abstracted from the Tables of the British Meteorological Society—*continued.*

LOCALITY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1857:	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins*	*Ins.*	*Ins.*
Lewisham	2·4	0·2	0·8	–	–	–	–	–	–	–	–	–	–
Royal Observatory, Greenwich	2·6	0·2	0·8	1·4	0·6	2·1	–	–	–	–	–	–	–
Battersea Training School	2·7	0·2	1·2	–	–	–	–	–	–	–	–	–	–
St. Mary's Hospital	2·8	0·1	1·0	–	–	–	–	–	–	–	–	–	–
St. Thomas' Hospital	2·4	0·2	1·0	–	–	–	–	–	–	–	–	–	–
Whitehall	2·8	0·1	1·0	–	–	–	–	–	–	–	–	–	–
Guildhall, City of London	2·7	0·1	0·9	–	–	–	–	–	–	–	–	–	–
Pimlico	2·7	0·1	1·0	–	–	–	–	–	–	–	–	–	–
St. John's Wood	3·1	0·2	1·2	–	–	–	–	–	–	–	–	–	–
Kingston-on-Thames*	2·8	0·1	1·2	1·6	0·6	2·4	–	–	–	–	–	–	–

* From a gauge kept at Westfield Lodge, Kingston-on-Thames.

8.—RAINFALL at GREENWICH, KENT.

(Supplied by Mr. *James Simpson*, jun.)

40 Years' Observations.

Position of Gauge:

Height above the mean level of the sea	155·3 feet.
Latitude	51° 28′ 38″
Longitude	0° 0′ 0″

General Summary of the Table.

	Winter.	Spring.	Summer.	Entire Year.
	in.	*in.*	*in.*	*in.*
Mean annual fall	7·86	7·25	10·47	25·48
Maximum fall; being the mean of five of the wettest years during the period	11·05	10·86	14·96	34·00
Minimum fall; being the mean of five of the dryest years during the period	5·22	4·05	6·80	18·40

The year is divided into three periods, winter, spring, and summer; the winter period being November, December, January, and February. The "Winter" column, therefore, in the tables contains the rain-fall of the November and December of each preceding year; while the "Entire Year" column applies to the regular year, from January to December.

61 H. W. Hoch, Engineer.

RAINFALL AT GREENWICH, KENT: FORTY YEARS' OBSERVATIONS.

YEARS.	1817.	1818.	1819.	1820.	1821.	1822.	1823.	1824.	1825.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854	1855.	1856.
January -	in. 3·10	in. 1·87	in. 2·31	in. 1·87	in. 2·42	in. ·20	in. 1·54	in. ·00	in. 1·10	in. ·33	in. 1·21	in. 4·29	in. ·44	in. 1·05	in. 1·10	in. 1·21	in. 1·10	in. 3·08	in. ·66	in. 1·87	in. 2·04	in. ·88	in. 1·21	in. 2·42	in. 2·10	in. 1·00	in. 1·40	in. 2·40	in. 2·40	in. 2·80	in. 1·40	in. 1·20	in. 1·00	in. 1·20	in. 2·70	in. 3·0	in. 2·0	in. 1·7	in. 1·0	in. 2·3
February	1·32	1·08	2·07	·00	·04	1·10	3·02	2·53	·09	1·87	·00	1·10	1·32	2·33	3·08	- -	3·03	·44	2·04	1·76	1·05	1·08	1·54	1·21	1·30	1·10	2·40	2·30	·00	1·50	1·40	2·00	2·20	1·30	1·20	·0	·0	1·0	1·4	·0
March -	2·00	3·85	1·70	- -	3·95	1·54	1·54	1·87	1·43	1·87	2·01	·00	·66	·33	2·20	1·43	·00	·66	2·53	2·20	·55	·00	1·70	·33	1·30	1·00	·50	2·00	1·50	·00	·80	3·10	·50	·30	4·10	·2	1·5	·4	1·5	1·2
April -	·05	3 30	3 08	1·05	1·08	2·80	1·08	2·00	1·09	1·10	1·32	2·42	4·64	3·08	3·41	·44	1·21	·55	1·10	2·75	1·21	·55	1·45	·00	1·00	·40	1·70	·40	·00	3·10	1·00	3·40	2·20	2·30	2·30	·5	3·1	·0	·1	2·3
May -	4·02	2·75	3·30	3 00	2·42	2·00	·77	4·18	3 30	2·75	2·01	1·05	·55	2·20	1·05	1·54	·22	·00	3·08	1·32	·00	1·54	1·05	2·00	2·10	2·10	3·60	·40	2·20	1·50	1·40	·40	3·00	2·40	·80	1·0	1·0	3·3	1·8	3·5
June -	1·43	·00	2·53	2·31	2·42	·88	1·21	3·85	·77	1·10	·00	2·00	1·03	2·0	2·00	3·30	2·09	1·04	2·42	1·10	1·10	5·00	1·87	1·54	2·70	1·00	1·30	1·80	1·00	·50	1·50	3·50	·20	·00	1·30	4·0	2·8	1·0	·7	1·0
July -	4·20	·77	2·20	4·84	3·03	4·51	3·03	1 09	·11	2·01	1·43	7·04	4·18	1·87	3·41	·00	1·05	0·28	·33	1·87	1·54	1·08	3·74	1·05	3·00	3·00	2·40	2·80	1·00	1·50	·70	2·00	2·00	2·00	2·80	2·3	6·0	1·7	5·0	0·0
August -	2·75	·11	·44	1·87	2·00	1·08	2·07	4·10	2·75	1·87	1·21	4·18	4·51	3.00	1·08	3·41	1·76	3·30	1·10	2·04	4·02	·00	2·75	1·10	2·20	1·80	3·00	2·00	3·10	4·00	2·00	4·30	·50	1·00	1·50	4·5	2·2	2·0	1·1	2·4
September	·88	4·18	3·41	2·42	3·74	1·54	·00	3·52	2 80	3·41	3·86	2·04	3·03	3·52	2·20	·44	1·87	·88	4·18	3·10	1·21	2·80	4·05	2·80	4·00	4·00	·50	1·20	2·10	1·80	1·00	2·40	3·30	1·30	·30	3·0	2·4	0·7	1·1	2·8
October -	2·01	2·09	2·31	2·86	2·01	3 00	4·40	2·01	2·07	1·87	4 20	1·54	1·87	·77	5·50	2·53	1·32	·44	4·18	4·18	2·53	1·03	1·87	1·05	0·00	1·40	4·50	4·00	1·40	5·10	2·00	3·50	2·70	1·40	1·80	3·8	4·3	2·6	4·0	1·0
November	1·08	2·75	2·07	1 08	4·73	4·07	1·70	4·20	3·10	2·75	1·32	·00	1·43	3·41	4·13	1·05	2·31	1·32	2·20	2·42	1·05	3·10	4·40	2·80	3·70	4·20	2·30	4·30	2·10	1·50	2·00	1·20	1·50	2·50	·60	0·0	1·5	1·4	1·3	1·0
December	3·85	1·43	3·85	1·76	5·17	2·33	2·75	3·00	3·10	1·42	3·03	2·53	·11	1·21		1·10	4·84	1·10	·44	1·76	1·32	1·70	2·42	·44	2·40	·70	·40	·40	2·00	1·10	2·00	2·00	2·40	1·30	·60	2·2	·7	1·4	1·2	1·3
TOTALS	29·10	25·74	31·13	26·18	34·53	27·32	27·06	30·39	24 64	22·00	24·80	31·40	29·10	27·17	30·75	17·71	22·09	19·58	24·86	27·06	21·01	23·76	29·59	18·34	33·30	22·00	24·00	24·00	22·40	25·30	17·80	30·20	23·00	19·70	29·30	34·4	29·0	18·7	21·1	21·8
Mean of 5 Years	29·34					27·66.					27·88.					22·44.					25·18.					23·06.					22·42.					25·00.				

MEAN OF 40 YEARS - - 25·48

WINTER	10·50	0·08	0·46	0·35	0·20	11·26	11·66	8·03	10·34	8·58	0·05	10·34	5·28	5·72	8·80	5·34	7·48	10·07	5·72	6·27	8·47	5·83	7·70	10·45	0·70	8·20	8·70	7·40	8·00	8·70	5·40	7·60	7·00	6·40	7·70	11·7	11·1	4·9	5·2	5·7
Mean of 5 Years	0·05.					0·07.					7·24.					7·00.					7·83.					8·20.					6·98.					6·52.				

MEAN OF 40 WINTERS - - 7·86

SPRING	8·20	10·50	10·07	7·02	10·07	7·37	5·50	11·00	7·48	6·82	7·20	7·15	7·70	8·25	9·35	0·71	4·51	3·74	9·13	7·37	3 85	8·14	0·71	4·05	8·00	5·40	7·30	5·50	6·20	6·00	4·70	10·40	9·80	5·90	8·50	7·2	9·0	5·3	4·1	8·0
Mean of 5 Years	9·00.					7·83.					7·94.					6·20.					6·15.					6·08.					7·26.					6·84.				

MEAN OF 40 SPRINGS - - 7·25

SUMMER	10·50	7·15	8·36	11·00	11·56	11·09	11·09	12·54	8 60	9·79	10·78	15·40	14·19	10·12	13·00	7·04	6·00	9·00	9·70	11·86	9·00	7·81	13·31	7·20	15·80	10·20	10·80	10·00	8·50	12·40	6·30	12·20	9·40	7·50	9·00	14·5	14·9	7·0	12·1	7·7
Mean of 5 Years	9·92.					11·00.					12·71.					9·04.					10·81.					10·38.					8·46.					11·42.				

MEAN OF 40 SUMMERS - - 10·47

Appendix III.—*continued.*

9.—RECORD of EXPERIMENTS made by Mr. *Bailey Denton*, C.E., upon the Percolation of Water in an Agricultural District.

HINXWORTH DRAINAGE.—MONTHLY RECORDS

From 1st October 1856 to 31st May 1857.

W. B. Hach, Engineer.

HINXWORTH DRAINAGE.—Record of the Month of October 1856.

DAY of the MONTH.	1. Rainfall. Per Diem. — Inches dec.	2. Rainfall. Per Acre. — (Per Diem.) In Gallons	3. Barometer. Height at the time of recording the Discharge from the Outlets, 8 o'clock a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. Occasional Drainage.—Fields Nos. 18, 19, 20. 40 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining. Nos. 19 and 20 only, containing 25 acres, drained at this time. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Holes 6 feet deep. Higher Side. — Distance from Drain to Drain 59 yards. Depth of Drains 4 feet 11 inches.	5. Occasional Drainage.—Fields Nos. 18, 19, 20. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Holes 6 feet deep. Lower Side. — Distance from Drain to Drain 57 yards. Depth of Drains 4 feet 4 inches.	6. Occasional Drainage.—Fields Nos. 18, 19, 20. Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1. Per Minute. — In Gallons.	7. Occasional Drainage.—Fields Nos. 18, 19, 20. Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1. Per Acre. — In Gallons (per diem).	8. Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 5 inches. Commenced running, October 12. Per Minute. — In Gallons.	9. Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 5 inches. Commenced running, October 12. Per Acre. — In Gallons (per diem).	10. Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year. Per Minute. — In Gallons.	11. Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Per Acre. — In Gallons (per diem).	12. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes dug 5 feet deep. Drained Land. Higher Side. — 25 feet apart and 4 feet deep. No. 31.	13. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Drained Land. Lower Side. — 25 feet apart and 4 feet deep. No. 31.	14. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Undrained Land. No. 33.	15. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running November 27. Per Minute. — In Gallons.	16. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Per Acre. — In Gallons (per diem).	17. Temperature. At Half-past Seven A.M. Undrained Land. Of Air 9 inches above surface. No. 33.	18. Temperature. At Half-past Seven A.M. Undrained Land. Of Soil 18 inches below ground. No. 33.	19. Temperature. At Half-past Seven A.M. Undrained Land. Of Soil 42 inches below ground. No. 33.	20. Temperature. At Half-past Seven A.M. Drained Land. Of Air 9 inches above surface. No. 31.	21. Temperature. At Half-past Seven A.M. Drained Land. Of Soil 18 inches below ground. No. 31.	22. Temperature. At Half-past Seven A.M. Drained Land. Of Soil 42 inches below ground. No. 31.	Day of the Month.
1	- -	- -	No record of the changes of the barometer made before 21st October 1856.	5 11	5 4	1 1/4	75	Nil -	Nil -	1 1/4	75	Nil -	Nil -	Nil -	Nil -	No observations made this month.	Nil -	Nil -	No observations made this month on the temperature of the soil.					1
2	- -	- -		5 10	5 3	1 1/4	105	Nil -	Nil -	1 1/4	75	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						2
3	- -	- -		5 9	5 2	1 1/2	80	Nil -	Nil -	1 1/4	75	4 9 1/2	4 9	Nil -	Nil -		Nil -	Nil -						3
4	·105	2,375		5 8	5 0	1 1/2	90	Nil -	Nil -	1 1/4	75	4 9	4 9 1/2	Nil -	Nil -		Nil -	Nil -						4
5	·200	4,525		5 6	4 10	2	120	Nil -	Nil -	1 1/4	80	4 8 1/2	4 8	Nil -	Nil -		Nil -	Nil -						5
6	·060	1,355		5 3 1/2	4 8	1 1/2	80	Nil -	Nil -	1 1/4	105	4 9	4 8 1/2	Nil -	Nil -		Nil -	Nil -						6
7	·080	1,810		5 2	4 5	2	120	Nil -	Nil -	1 1/4	160	4 10	4 9 1/2	Nil -	Nil -		Nil -	Nil -						7
8	·185	4,185		5 0	4 3 1/2	2 1/2	160	Nil -	Nil -	19 1/4	1,160	4 10	4 9 1/2	Nil -	Nil -		Nil -	Nil -						8
9	·040	905		4 10	4 2	4	235	Nil -	Nil -	6 1/4	405	4 10 1/2	4 10	Nil -	Nil -		Nil -	Nil -						9
10	·060	1,355		4 9	4 1	6 1/4	360	Nil -	Nil -	6 1/4	405	4 11	4 10 1/2	Nil -	Nil -		Nil -	Nil -						10
11	·195	4,410		4 8	3 11	9	530	Nil -	Nil -	6 1/4	390	4 11 1/2	4 11	Nil -	Nil -		Nil -	Nil -						11
12	·415	9,390		4 6	3 7	27 1/2	1,585	1/4	20	30	1,700	4 10 1/2	4 10	Nil -	Nil -		Nil -	Nil -						12
13	·005	115		4 5	3 8	24	1,410	1/4	20	8 1/2	470	4 11	4 11	Nil -	Nil -		Nil -	Nil -						13
14	- -	- -		4 4	3 9	19 1/2	1,115	1/4	10	3 1/2	210	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						14
15	·115	2,600		4 4 1/2	3 9 1/2	15	880	1/4	10	4	235	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						15
16	·070	1,585		4 5	3 10	10 1/2	605	1/4	10	6	350	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						16
17	·100	2,260		4 5 1/2	4 0	10	580	1/4	10	6	350	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						17
18	·005	115		4 6	4 2	9	530	1/4	10	7	400	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						18
19	- -	- -		4 6 1/2	4 2	8 1/2	495	1/4	10	6	350	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						19
20	- -	- -		4 7	4 2	8	470	1/4	10	4	235	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						20
21	- -	- -	30·12	4 7	4 2	8	470	1/4	9	3 1/4	210	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						21
22	- -	- -	30·28	4 7 1/2	4 2 1/2	7	400	1/4	9	3 1/4	195	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						22
23	- -	- -	30·26	4 8	4 3	6 1/2	375	1/4	8	3	180	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						23
24	- -	- -	30·38	4 8 1/2	4 3	6	350	1/4	7	3	180	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						24
25	- -	- -	30·40	4 9	4 3	6	350	1/4	5	2 3/4	165	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						25
26	- -	- -	30·39	4 9	4 3	5	285	1/4	5	2 1/2	150	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						26
27	- -	- -	30·36	4 9 1/2	4 3	4 1/4	250	1/4	5	2 1/4	140	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						27
28	·002	45	30·28	4 10	4 3	4	235	1/4	5	2	130	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						28
29	·003	70	30·20	4 10	4 3	3 3/4	220	1/4	5	2	120	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						29
30	- -	- -	30·10	4 10	4 3	3	175	1/4	5	2	120	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						30
31	·005	115	30·05	4 10	4 3	3	175	1/4	5	1 3/4	105	Nil -	Nil -	Nil -	Nil -		Nil -	Nil -						31
Total Rainfall	1·645	37,215		Total quantity of Water per Acre discharged - - -			12,910	- -	178	- -	8,915	- -	- -	- -	- -		Nil -	Nil -						
				Remainder unaccounted for -			24,305		37,037		28,800													
				Total Rainfall - -			37,215		37,215		37,215													

HINXWORTH DRAINAGE—Record of the Month of November 1856.

DAY of the MONTH.	1. Rainfall. Per Diem. — Inches dec.	2. Rainfall. Per Acre. — (Per Diem.) In Gallons.	3. Barometer. Height at the time of recording the Discharge from the Outlets, 8 o'clock a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. Occasional Drainage.—Fields Nos. 18, 19, 20. 40 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining. Nos. 19 and 20 only drained up to Nov. 10, when the draining of No. 18 was commenced. It was finished Nov. 29. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Holes 6 feet deep. Higher Side. — Distance from Drain to Drain 59 yards. Depth of Drains 4 feet 11 inches.	5. Occasional Drainage.—Fields Nos. 18, 19, 20. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Holes 6 feet deep. Lower Side. — Distance from Drain to Drain 57 yards. Depth of Drains 4 feet 4 inches.	6. Occasional Drainage.—Fields Nos. 18, 19, 20. Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1. Per Minute. — In Gallons.	7. Occasional Drainage.—Fields Nos. 18, 19, 20. Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1. Per Acre. — In Gallons (per diem).	8. Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running, Oct. 12. Per Minute. — In Gallons.	9. Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running, Oct. 12. Per Acre. — In Gallons (per diem).	10. Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year. Per Minute. — In Gallons.	11. Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Per Acre. — In Gallons (per diem).	12. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midwaybetween the Drains. (See also Temperature.) Holes 5 feet deep. Drained Land. Higher Side. — 25 feet apart and 4 feet deep. No. 31.	13. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Drained Land. Lower Side. — 25 feet apart and 4 feet deep. No. 31.	14. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Undrained Land. No. 33.	15. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running, Nov. 27. Per Minute. — In Gallons.	16. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Per Acre. — In Gallons (per diem).	17. Temperature. At Half-past Seven A.M. Undrained Land. Of Air 9 inches above surface. No. 33.	18. Temperature. At Half-past Seven A.M. Undrained Land. Of Soil 18 inches below ground. No. 33.	19. Temperature. At Half-past Seven A.M. Undrained Land. Of Soil 42 inches below ground. No. 33.	20. Temperature. At Half-past Seven A.M. Drained Land. Of Air 9 inches above surface. No. 31.	21. Temperature. At Half-past Seven A.M. Drained Land. Of Soil 18 inches below ground. No. 31.	22. Temperature. At Half-past Seven A.M. Drained Land. Of Soil 42 inches below ground. No. 31.	Day of the Month.
1	·312	7,058	30·28	4 10	4 3	9 1/2	555	1/4	10	2 3/4	165	Nil -	Nil -	No observations made prior to Nov. 27.	Nil -	Nil -	No observations made this month on the temperature of the soil.							1
2	·003	68	30·29	4 10	4 3	5	285	1/4	9	1 3/4	105	Nil -	Nil -		Nil -	Nil -								2
3	- -	- -	30·19	4 10	4 3	3	175	1/4	8	1 1/2	90	Nil -	Nil -		Nil -	Nil -								3
4	- -	- -	30·18	4 10	4 3	3	175	1/4	8	1 1/4	75	Nil -	Nil -		Nil -	Nil -								4
5	- -	- -	30·30	4 10	4 3	3	175	1/4	8	1	60	Nil -	Nil -		Nil -	Nil -								5
6	- -	- -	30·40	4 10	4 3	3	175	1/4	8	1	60	Nil -	Nil -		Nil -	Nil -								6
7	·005	113	30·50	4 10	4 3	3	175	1/4	8	1	60	Nil -	Nil -		Nil -	Nil -								7
8	- -	- -	30·37	4 10	4 3	3	175	1/4	8	1 1/2	90	Nil -	Nil -		Nil -	Nil -								8
9	·355	8,030	30·06	4 10	4 3	12	700	1/4	60	6	360	Nil -	Nil -		Nil -	Nil -								9
10	·005	113	29·50	4 10	4 3	5 5/8	Field No. 18 being drained and added to this outlet, and the daily measurements were only approximately taken.	1/4	30	5 1/4	330	Nil -	Nil -		Nil -	Nil -								10
11	- -	- -	29·30	4 10	4 3	5		1/4	30	5 1/4	330	Nil -	Nil -		Nil -	Nil -								11
12	·215	4,864	29·60	4 9	4 3	6 7/8		1/4	40	5	300	Nil -	Nil -		Nil -	Nil -								12
13	·002	45	29·70	4 9	4 3	7		1/4	30	4 3/4	285	Nil -	Nil -		Nil -	Nil -								13
14	·003	68	29·79	4 9	4 3	7 1/8		1/4	30	4 3/4	285	Nil -	Nil -		Nil -	Nil -								14
15	- -	- -	29·80	4 9	4 3	7 1/4		1/4	20	3 1/2	210	Nil -	Nil -		Nil -	Nil -								15
16	- -	- -	30·10	4 9	4 3	8		1/4	20	2 1/2	150	Nil -	Nil -		Nil -	Nil -								16
17	- -	- -	30·10	4 9	4 3	9		1/4	20	2 1/2	150	Nil -	Nil -		Nil -	Nil -								17
18	·040	905	30·00	4 9	4 3	9		1/4	20	2 1/4	135	Nil -	Nil -		Nil -	Nil -								18
19	·072	1,628	30·04	4 9	4 3	12 1/2		1/4	25	2 1/4	135	Nil -	Nil -		Nil -	Nil -								19
20	·053	1,199	29·99	4 9	4 3	15		1/4	40	2 1/4	135	Nil -	Nil -		Nil -	Nil -								20
21	·005	113	30·15	4 9	4 3	15 3/8		1/4	40	2 1/4	135	Nil -	Nil -		Nil -	Nil -								21
22	- -	- -	30·17	4 9	4 3	16		1/4	25	2 1/4	135	Nil -	Nil -		Nil -	Nil -								22
23	- -	- -	29·70	4 9	4 3	16		1/4	30	2 1/4	135	Nil -	Nil -		Nil -	Nil -								23
24	- -	- -	29·60	4 9	4 3	17		1/4	25	2 1/4	135	Nil -	Nil -		Nil -	Nil -								24
25	- -	- -	29·50	4 9	4 3	17		1/4	30	2 1/4	135	Nil -	Nil -		Nil -	Nil -								25
26	·015	339	29·60	4 9	4 2 1/2	17 3/4		1/4	25	3 1/4	195	Nil -	Nil -		Nil -	Nil -								26
27	·540	12,216	29·58	4 8	4 2	33		11 1/4	900	12 1/4	735	4 11	4 11	3 0	2 3/4	135								27
28	·005	113	29·68	4 7	4 0	34 1/4		3	240	5	300	4 11 1/2	4 11 1/2	2 10	1 1/4	65								28
29	- -	- -	29·68	4 7 1/2	4 1	32		2	160	4	240	Nil -	Nil -	2 10	1 1/4	65								29
30	- -	- -	29·69	4 7 1/2	4 1	30		2	160	3	180	Nil -	Nil -	2 9 1/2	1 1/4	65								30
Total Rainfall	1·630	36,872		Total quantity of water per acre discharged - - -			27,000	- -	2,077	- -	6,015	- -	- -	- -	- -	330								
				Remainder unaccounted for -			9,872	- -	34,795	- -	30,857	- -	- -	- -	- -	36,542								
				Total Rainfall -			36,872	- -	36,872	- -	36,872	- -	- -	- -	- -	36,872								

W. B. Hack, Engineer.

HINXWORTH DRAINAGE.—Record of the Month of December 1856.

DAY of the MONTH.	1. Rainfall. Per Diem. — Inches dec.	2. Rainfall. Per Acre. — (Per Diem.) In Gallons.	3. Barometer. Height at the time of recording the Discharge from the Outlets, 8 o'clock a. m. — *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. 5. 6. 7. Occasional Drainage.—Fields Nos. 18, 19, 20. 46 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep. Higher Side. — Distance from Drain to Drain 59 yards. Depth of Drains 4 feet 11 inches.	Lower Side. — Distance from Drain to Drain 57 yards. Depth of Drains 4 feet 4 inches.	Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	8. 9. Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water, from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 5 inches. Commenced running, October 12. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	10. 11. Parallel Drainage. Fields 13 and part 14, 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	12. 13. 14. 15. 16. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the drains. Test Holes dug 5 feet deep. Drained Land. Higher Side. — 25 feet apart and 4 feet deep. No. 31.	Lower Side. — 25 feet apart and 4 feet deep. No. 31.	Undrained Land. No. 33.	Quantity of Water from Outlet No. 15 which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running November 27. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	17. 18. 19. 20. 21. 22. Temperature. At Half-past Seven A. M. Undrained Land. Of Air 9 inches above surface. No. 33.	Of Soil 18 inches above ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Drained Land. Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.	Day of the Month.
1	- -	- -	29·80	4 8	4 1	28 ½	895	1 ½	120	4 ⅞	295	Nil -	Nil -	2 9	1 ¼	65							1
2	- -	- -	29·80	4 8	4 1	25	780	1 ⅝	140	3 ⅞	210	Nil -	Nil -	2 7	1 ¼	55							2
3	- -	- -	29·69	4 8	4 1 ½	22 ½	695	1 ⅞	150	2 ¼	135	Nil -	Nil -	2 6		30							3
4	- -	- -	29·90	4 8	4 1 ½	20	620	1 ⅞	150	2	120	Nil -	Nil -	2 6		30							4
5	·073	1,651	29·59	4 8	4 1 ½	25 ½	795	1 ⅞	150	3 ⅜	200	Nil -	Nil -	2 5		40							5
6	·027	610	29·40	4 8	4 1 ½	24 ½	735	1 ⅞	150	3 ⅜	200	Nil -	Nil -	2 5 ½		40							6
7	·050	1,131	29·49	4 8	4 1 ½	25 ½	795	2	160	4	235	Nil -	Nil -	2 5		45							7
8	- -	- -	29·40	4 8	4 1 ½	24 ½	735	2 ¼	180	3 ¾	225	Nil -	Nil -	2 4 ½		45							8
9	·080	1,810	29·40	4 8	4 1 ½	27	830	3	240	5	300	Nil -	Nil -	2 4		45							9
10	·060	1,357	29·30	4 8	4 1 ½	26 ¼	820	3	240	5 ¼	315	4 11 ½	4 11	2 4	1	50							10
11	·075	1,696	29·40	4 8	4 1 ½	24	755	6	480	15	900	4 11	4 11	2 4	2	100							11
12	·085	1,923	29·27	4 8	4 1 ½	22 ½	695	8	640	22 ½	1,350	4 10 ½	4 10	2 3 ½	3 ½	160							12
13	·452	10,225	28·89	3 8	2 11	77 ½	2,420	19	1,520	47 ½	2,850	4 9	4 9	6	19 ½	975							13
14	·023	520	29·40	3 10	3 0	55	1,715	10	800	25	1,500	4 9	4 8	7	15	750							14
15	- -	- -	30·20	3 10	3 2	47 ½	1,485	6	480	15 ¾	945	4 9	4 8	7	13 ½	675	No observations made this month in the temperature of the soil.						15
16	- -	- -	30·49	4 0	3 7	47 ½	1,485	6	480	10 ½	630	4 9	4 8	10	7 ¼	375							16
17	- -	- -	30·37	4 1	4 0	46 ¾	1,455	6	480	9	540	4 9	4 8	10 ½	8 ¼	415							17
18	- -	- -	29·80	4 0 ½	4 0 ½	40	1,245	5 ⅝	450	6 ¾	405	4 9	4 8	11	3 ¾	185							18
19	·100	2,262	30·30	4 2	4 2	34 ½	1,085	6 ⅞	550	8	480	4 9	4 8	1 0	4 ¼	225							19
20	·005	113	30·38	4 2	4 2	37	1,145	6 ½	520	7 ½	450	4 9	4 8	1 1	3 ⅛	160							20
21	- -	- -	30·39	4 2	4 2	35	1,095	5 ¾	460	7 ⅛	450	4 9	4 8	1 1	3	150							21
22	- -	- -	30·09	4 2 ½	4 2 ½	33	1,030	5 ½	420	7 ⅛	450	4 9	4 9	1 2	2 ¼	125							22
23	- -	- -	29·90	4 4	4 4	33	1,030	4 ⅞	395	7 ½	450	4 8	4 9	1 4	2 ¼	110							23
24	·045	1,018	29·40	4 3	4 3	35	1,095	4 ⅜	380	7	420	4 8	4 9	1 4	2	100							24
25	- -	- -	28·80	4 5	4 5	30	935	4 ¼	360	6	360	4 8	4 10	1 4	2	100							25
26	- -	- -	28·70	4 6	4 6	26 ¼	820	4 ¼	340	5 ¼	315	4 8	4 10	1 4	1 ¾	95							26
27	- -	- -	29·19	4 6	4 6	21	660	3 ½	280	4	235	4 9	4 10	1 4	1 ¼	65							27
28	- -	- -	29·46	4 6 ½	4 6 ½	19	595	3	240	3	180	4 9	4 10	1 4	1	50							28
29	- -	- -	29·80	4 7	4 7	15 ½	935	2 ¾	180	2 ⅜	160	4 9	4 10	1 4	⅞	40							29
30	·150	3,393	30·10	4 6	4 6	19	595	5	400	6 ⅛	390	4 7	4 9	1 3	6	300							30
31	·010	226	30·14	4 6 ½	4 2	18 ⅝	590	4 ½	360	5 ⅝	340	4 6 ½	4 9	1 3	4 ½	225							31
Total Rainfall	1·235	27,935		Total quantity of Water per acre discharged - - - -			30,565	- -	11,895	- -	15,935	- -	- -	- -	- -	5,825							
				Rainfall - - - -			27,935	Difference unaccounted for -	26,040	- -	12,000	- -	- -	- -	- -	22,110							
				Excess discharged from the soil -			2,630	Rainfall	27,935	- -	27,935	- -	- -	- -	- -	27,935							

HINXWORTH DRAINAGE.—Record of the Month of January 1857.

DAY of the MONTH.	1. Rainfall. Per Diem. — Inches dec.	2. Rainfall. Per Acre. — (Per Diem.) In Gallons.	3. Barometer. Height at the time of recording the Discharge from the Outlets, 8 o'clock a. m. — *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. 5. 6. 7. Occasional Drainage.—Fields Nos. 18, 19, 20. 46 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep. Higher Side. — Distance from Drain to Drain 59 yards. Depth of Drains 4 feet 11 inches.	Lower Side. — Distance from Drain to Drain 57 yards. Depth of Drains 4 feet 4 inches.	Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem)	8. 9. Part Occasional and part Wide Parallel Drainage. Field No. 22. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 5 inches. Commenced running, Oct. 12. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	10. 11. Parallel Drainage. Fields 13 and part 14, 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	12. 13. 14. 15. 16. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep. Drained Land. Higher Side. — 25 feet apart and 4 feet deep. No. 31.	Lower Side. — 25 feet apart and 4 feet deep. No. 31.	Undrained Land. No. 33.	Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	17. 18. 19. 20. 21. 22. Temperature. At Half-past Seven A. M. Undrained Land. Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Drained Land. Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.	Day of the Month.
1	·005	113	30·20	4 6	4 2	16	500	2 ⅛	200	4 ¼	250	4 6	4 6	1 2	2	100							1
2	·020	452	29·48	4 6	4 2	21	660	3 ⅝	300	5	300	4 6	4 6	1 2	3 ⅜	170	No observations made prior to the 6th of this month.						2
3	·042	950	29·20	4 6	4 2	24	750	5	400	9 ¼	550	4 5	4 5	1 2	8	400							3
4	·151	3,416	29·07	4 6	4 1	20	900	14 ⅛	1,150	33	1,900	4 4	4 4	1 2	18	900							4
5	·162	3,665	29·64	4 6	4 1	31	980	15 ⅞	1,260	40 ⅛	2,430	4 3	4 3	1 1 ½	21	1,050							5
6	- -	- -	30·09	4 5 ¼	4 0 ½	30	930	11 ¼	900	19 ½	1,170	4 3	4 3 ½	1 3	12	600	31	- -		31	- -		6
7	- -	- -	30·20	4 5	4 0	31 ½	995	7 ¼	580	18 ¼	1,130	4 3	4 3 ½	1 2 ½	4 ½	225	32	34		33	34		7
8	- -	- -	30·24	4 5	4 1	28 ½	895	5 ¼	420	9	540	4 3	4 3	1 3	3	150	34	34		36	35		8
9	·035	792	30·13	4 4 ½	4 0	29	910	5	400	8	480	4 3	4 3 ½	1 3	2 ⅝	125	37	35		38	36		9
10	·542	12,261	29·46	3 5	2 8	62	1,945	45	3,600	101 ½	6,060	4 0	4 0	0 5	103	5,150	44	36		44	37		10
11	·300	6,787	28·80	3 0	2 2	57 ½	1,800	40	3,200	75	4,500	4 0	4 0	0 5	88	4,000	37	37		43	38		11
12	·162	3,665	29·19	2 1	1 11	53 ¾	1,680	30 ⅜	2,460	46 ½	2,790	3 11	3 11	0 4	40	1,990	37	37		32	38		12
13	- -	- -	29·39	2 7	2 5	55	1,720	22 ⅛	1,800	35	2,085	4 0	4 0	0 5	25	1,250	32	37		31	37		13
14	- -	- -	29·80	3 2	2 11	55	1,720	12 ⅝	1,020	18	1,080	4 0	4 0	0 6	12	600	28	36		29	37		14
15	- -	- -	29·90	3 6	3 3	50	1,560	9	720	11 ¼	660	4 0	4 0	0 9	7 ½	375	32	35		33	35		15
16	·135	3,054	29·90	3 10	3 8	52 ¼	1,640	9 ¾	780	14 ¼	840	4 1	4 1	1 0	8 ¼	410	27	34		31	35		16
17	- -	- -	30·20	4 1 ½	4 0	51 ½	1,605	9	720	13 ½	840	4 1 ½	4 2	1 0	7 ½	375	29	31		33	34		17
18	·005	113	30·19	4 2	4 0	48	1,500	9	720	14 ¼	850	4 1	4 2	1 0	7 ¼	375	43	30		44	35		18
19	·005	113	30·17	4 3 ½	4 1	45	1,395	9	720	15 ¾	945	4 1	4 2	1 0	7 ⅜	375	41	36		42	36		19
20	- -	- -	29·69	4 3	3 11 ½	43 ¾	1,350	9 ¾	780	16 ¼	1,005	4 0	4 0	1 0 ½	8 ¼	410	38	32		39	37		20
21	·065	1,470	29·40	4 2	3 11	50	1,560	10 ⅓	1,320	24	1,440	3 10 ½	3 10	1 0	13 ½	680	32	31		32	36		21
22	·120	2,714	29·69	4 1	3 10	52 ½	1,64	17 ¼	1,380	24 ⅜	1,485	3 10	3 10	0 10	19 ¾	985	29	32		30	37		22
23	·062	1,402	29·28	4 0 ½	3 9	53 ¾	1,680	18	1,440	24	1,440	3 9	3 9	0 9	19 ¾	985	32	31		34	35		23
24	·035	792	29·04	4 1	3 10	52 ½	1,640	16 ½	1,320	22 ¼	1,310	3 9 ½	3 9	0 10	18	900	35	33		36	37		24
25	·145	3,280	29·27	4 0	3 8	61	1,900	37 ½	3,000	56 ¼	3,400	3 8	3 9	0 10	54	2,700	34	32		35	36		25
26	·130	2,940	29·59	3 7	3 7	62 ½	1,960	45	3,600	57 ½	3,450	3 5	3 9	0 10	55	2,750	31	32		32	34		26
27	·112	2,534	29·70	3 7	3 3	57 ½	1,800	21	1,680	41 ½	2,460	3 2 ½	3 2 ½	1 0	35	1,750	28	33		29	35		27
28	- -	- -	29·79	3 9	3 5	56 ¼	1,770	11	880	20 ⅛	1,200	3 3	3 3	1 0	15	750	17	33		18	35		28
29	- -	- -	29·70	3 10 ½	3 6 ½	51 ¼	1,595	10 ½	840	16 ⅜	995	3 3 ½	3 3 ½	1 0	11 ¼	560	16	32		17	34		29
30	- -	- -	29·73	4 0	3 9	45	1,305	9	720	13 ¼	795	3 4	3 4	1 0	6 ¾	340	21	31		22	33		30
31	·100	2,262	29·58	4 0 ½	3 8	47 ½	1,480	9 ¼	780	15	900	3 3	3 3	0 11	7 ½	375	30	33		31	34		31
Total Rainfall	2·333	52,775		Total quantity of Water per Acre discharged - - - -			43,855	- -	39,090	- -	49,250	- -	- -	- -	- -	31,805							
				Remainder unaccounted for - -			8,920	- -	13,685	- -	3,525	- -	- -	- -	- -	20,970							
				Total Rainfall - - -			52,775	- -	52,775	- -	52,775	- -	- -	- -	- -	52,775							

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W. B. Hack, Engineer.

HINXWORTH DRAINAGE.—Record of the Month of February 1857.

DAY of the MONTH.	1. Rainfall. Per Diem. — Inches dec.	2. Rainfall. Per Acre. — (Per Diem.) In Gallons.	3. Barometer. Height at the time of recording the Discharge from the Outlets, 8 o'clock a. m. — *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. 5. Occasional Drainage.—Fields Nos. 18, 19, 20. 46 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep. Higher Side. — Distance from Drain to Drain 59 Yards. Depth of Drains 4 feet 11 inches.	5. Lower Side. — Distances from Drain to Drain 57 Yards. Depth of Drains 4 feet 4 inches.	6. 7. Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 3 inches. Commenced running October 1. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	8. 9. Part Occasional and part Wide Parallel Drainage. Field No. 22. 16 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 3 inches. Commenced running, October 12. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	10. 11. Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the Year. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	12. 13. 14. 15. 16. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep. Drained Land. Higher Side. — 25 feet apart and 4 feet deep. No. 31.	Lower Side. — 25 feet apart and 4 feet deep. No. 31.	Undrained Land. No. 33. Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running November 27. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	17. 18. 19. 20. 21. 22. Temperature. At Half-past Seven A.M. Undrained Land. Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Drained Land. Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.	Day of the Month.
1	- -	- -	29·79	4 1	3 8	40	1,245	7	560	12	720	- -	- -	1 0	7	350	27	32		28	33	39	1
2	- -	- -	29·59	4 2	3 8½	33¾	1,055	6¾	540	8¼	495	3 1½	3 3½	1 0	6	300	25	32		26	33	39	2
3	- -	- -	29·60	4 3½	3 9	32½	1,015	6	480	6¾	405	3 2	3 4	1 1	5½	260	21	32		22	33	38	3
4	- -	- -	30·07	4 5	3 10	32½	1,015	4½	360	5¾	315	3 3	3 5	1 2	3⅝	185	24	31		25	32	38	4
5	- -	- -	30·08	4 6	3 11½	35	1,095	6	480	6¾	405	3 4	3 6	1 2	5¼	265	26	32		27	33	38	5
6	·100	2,262	29·77	4 5	3 11	38¾	1,210	12¾	1,020	9½	570	3 2	3 4	1 2	9	450	27	32		28	33	38	6
7	·025	565½	29·67	4 4	3 10	50	1,560	16½	1,320	31½	1,890	2 10	3 0	1 0	25	1,250	40	31		41	33	38	7
8	- -	- -	29·59	4 4	4 0	45	1,395	12	960	18	1,080	2 10	2 11	1 0	17	850	38	32		39	34	38	8
9	- -	- -	29·58	4 4	4 1	41½	1,285	9	720	10½	630	2 10	2 11	1 0	12	600	44	32		45	33	38	9
10	·022	497½	29·57	4 5	4 2	40	1,245	9	720	9½	585	2 10	2 11	1 1	9	450	35	33		36	34	37	10
11	·020	452½	29·69	4 6	4 3	37½	1,175	8½	660	10½	630	3 0	2 11	1 2	7½	375	35	34		36	35	37	11
12	·010	226¼	30·20	4 7	4 4	36½	1,150	6¾	540	9¾	585	3 1	3 0	1 2	7½	375	31	35		32	36	38	12
13	- -	- -	30·20	4 7½	4 4	37½	1,175	6¾	540	9¾	585	3 2	3 1	1 2	7½	375	32	35		33	36	38	13
14	- -	- -	30·20	4 8	4 4	35	1,090	6¾	540	9	540	3 3	3 2	1 2½	7½	375	40	34		40	35	38	14
15	- -	- -	30·16	4 8	4 4	32	1,000	6	480	8¾	525	3 3	3 2	1 3	6½	325	32	34		33	35	38	15
16	- -	- -	30·05	4 9	4 4	30	935	6	480	8¾	525	3 4	3 3	1 3	6	300	25	35		25	36	39	16
17	- -	- -	30·00	4 9½	4 4	27½	860	4½	360	7½	450	3 4½	3 4	1 3	5¼	260	42	35		41	35	40	17
18	- -	- -	29·90	4 10	4 4	27½	860	4½	360	6¼	375	3 5	3 5	1 3½	4½	225	40	35		40	36	40	18
19	- -	- -	30·09	4 10½	4 4	26½	820	4¾	360	6¼	375	3 5½	3 6	1 3½	3¾	185	42	35		41	37	40	19
20	·015	339¾	30·14	4 10½	4 4	25	780	4½	360	5	300	3 6	3 6½	1 3½	3¾	185	40	36		39	38	40	20
21	- -	- -	30·18	4 11	4 4	23¾	745	4	320	5	300	3 6½	3 7	1 4	3	150	42	37		40	39	41	21
22	- -	- -	30·19	4 11	4 4	22	690	4	320	4	240	3 7	3 8	1 5	3	150	42	37	39	42	39	41	22
23	- -	- -	30·19	4 11	4 4	21	660	4	320	3¾	225	3 7	3 8	1 5½	3	150	34	37	39	34	39	41	23
24	- -	- -	30·20	4 11	4 4	21	660	3½	300	3	180	3 7½	3 8	1 6	3	150	40	37	39	40	39	41	24
25	- -	- -	30·10	4 11	4 4	21	660	3½	300	3	180	3 8	3 8½	1 6	3	150	30	37	39	31	39	41	25
26	- -	- -	30·38	4 11	4 4	21	660	3½	300	3	180	3 8	3 9½	1 6	3	150	23	37	39	23	39	41	26
27	- -	- -	30·37	4 11	4 4	21	660	3½	300	3	180	3 8	3 10½	1 6	2¼	110	36	37	39	36	39	41	27
28	- -	- -	30·39	4 11	4 4	21	660	3½	300	3	180	3 8½	3 11½	1 6	2¼	110	43	37	39	43	39	41	28
Total Rainfall	·192	4,343		Total quantity of Water per Acre discharged - - - -			27,360	- -	14,320	- -	13,650	- -	- -	- -	- -	9,060							
				Rain-fall - - - - -			4,343	- -	4,343	- -	4,343	- -	- -	- -	- -	4,343							
				Excess discharged from the Soil -			23,017	- -	9,977	- -	9,307	- -	- -	- -	- -	4,717							

HINXWORTH DRAINAGE.—Record of the Month of March 1857.

DAY of the MONTH.	1. Rainfall. Per Diem. — Inches dec.	2. Rainfall. Per Acre. — (Per Diem.) In Gallons.	3. Barometer. Height at the time of recording the Discharge from the Outlets 8 o'clock a.m. — *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. 5. Occasional Drainage.—Field No. 40. 16 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Very wet before Draining. (The fields are changed because Coprolites were raised in No. 19 this month, and interfered with the discharge.) Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test holes 8 feet deep. Higher Side. — Distance from Drain to Drain 75 yards. Depth of Drains 7 feet 6 inches.	5. Lower Side. — Distance from Drain to Drain 33 yards. Depth of Drains 6 feet.	6. 7. Quantity of Water from Outlet No. 8, which discharges the Drain Water from Field No. 40. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	8. 9. Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 5 inches. Commenced running, Oct. 12. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	10. 11. Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem.)	12. 13. 14. 15. 16. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep. Drained Land. Higher Side. — 25 feet apart and 4 feet deep. No. 31.	Lower Side. — 25 feet apart and 4 feet deep. No. 31.	Undrained Land. No. 33. Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	17. 18. 19. 20. 21. 22. Temperature. At Half-past Seven A.M. Undrained Land. Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Drained Land. Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.	Day of the Month.
1	- -	- -	30·49	4 2	5 6½	4½	405	3¾	300	3	180	3 9	3 11	1 6	2¼	110	35	37	39	36	40	41	1
2	- -	- -	30·48	4 2½	5 6½	4½	405	3¾	300	3	180	3 9	3 11	1 6	2¼	110	43	37	39	44	40	41	2
3	- -	- -	30·39	4 2⅔	5 6½	4½	405	3⅓	250	3	180	3 9	4 0	1 6	2¼	110	43	38	40	44	41	42	3
4	- -	- -	30·08	4 3	5 6½	4½	405	3	240	3	180	3 9½	4 0	1 6	2¼	110	44	38	40	43	41	42	4
5	- -	- -	30·28	4 3½	5 6½	4½	405	2⅞	210	3	180	3 9¾	4 0	1 6	2¼	110	24	38	40	25	41	42	5
6	- -	- -	30·00	4 4	5 6½	5¼	472½	3¾	300	4½	270	3 9½	4 0	1 6	3	150	45	38	40	45	41	42	6
7	- -	- -	29·85	4 4½	5 6½	5¼	472½	3¾	300	4½	270	3 9½	4 0	1 6	3	150	34	38	40	34	41	42	7
8	- -	- -	29·49	4 5	5 6½	5	450	3¾	300	4½	270	3 10	4 0	1 6	3	150	47	38	40	46	41	42	8
9	·030	675	29·66	4 5	5 7	4½	405	2⅞	210	4½	270	3 10	4 0	1 6	3	150	38	37	40	39	40	42	9
10	·050	1,130	29·90	4 6	5 7	4½	405	3	240	5¼	315	3 10	4 0	1 6	3¾	190	27	36	39	28	39	41	10
11	·065	1,470	29·80	4 7	5 7	5¼	472½	3½	280	6	360	3 10	4 0	1 6	4½	225	31	36	39	32	38	41	11
12	- -	- -	29·89	4 8	5 7	5¼	472½	4½	360	6	360	3 10	4 0	1 6	4½	225	32	36	39	32	38	41	12
13	- -	- -	29·79	4 9	5 7	5¼	472½	4¼	360	5¼	315	3 10	4 0	1 6	3¾	190	31	36	39	31	38	41	13
14	·060	1,360	29·00	4 9½	5 7	5¼	472½	5¼	420	5¼	315	3 10	4 0	1 6	3¾	190	42	36	40	42	39	41	14
15	·033	746	29·25	4 9½	5 7	5	450	4½	360	4	240	3 10	4 0	1 6	3	150	43	37	40	44	40	41	15
16	- -	- -	29·79	4 10	5 7	3	270	3¾	300	3	180	3 10	4 0	1 6	2¼	112	37	38	40	37	40	41	16
17	- -	- -	29·80	4 11	5 7	2¼	200	3¾	300	2½	135	3 10	4 0	1 6	1½	75	42	38	40	42	40	41	17
18	- -	- -	29·69	5 0	5 7	1½	135	4½	360	3	180	3 10	4 0	1 6½	1½	75	46	38	40	46	40	41	18
19	·040	905	29·79	5 1	5 7		67½	3¾	300	1½	90	3 11	4 0	1 7		37	49	40	41	48	42	42	19
20	·100	2,262	29·80	5 1½	5 7		67½	2¼	180	1½	90	3 11½	4 0	1 7½		38	47	41	41	47	43	42	20
21	- -	- -	30·00	5 2	5 7		67½	2¼	180	1½	90	4 0	4 0	1 7½		38	36	41	41	37	43	42	21
22	- -	- -	29·80	5 2	5 7		67½	2¼	180	1½	90	4 0	4 0	1 7½		38	34	40	41	35	42	42	22
23	·122	2,760	29·60	5 2½	5 7	1½	135	2¼	180	1½	90	4 0	4 0	1 7		38	33	39	41	34	41	42	23
24	·010	227	29·59	5 3	5 7	1½	135	2¼	180	2¼	135	4 0	4 0	1 7	1½	75	38	38	41	38	40	42	24
25	·015	339	29·40	5 3	5 7	1½	135	2¼	180	2¼	135	4 0	4 0	1 7	1½	75	43	38	41	43	40	42	25
26	·005	113	29·59	5 3	5 7		67½	2¼	180	1½	90	4 0	4 0	1 7		38	38	38	41	38	40	42	26
27	- -	- -	29·88	5 3	5 7		67½	2¼	180	1½	90	4 0	4 0	1 7		38	41	39	41	42	41	42	27
28	- -	- -	30·00	5 3½	5 7		70	2⅓	200	1½	90	4 0	4 0	1 7		38	42	40	41	43	42	42	28
29	·030	678	29·78	5 3	5 6	1	90	2¼	200	2	120	4 0	4 0	1 6	1	50	41	40	41	41	42	42	29
30	·180	4,072	29·28	5 3	5 6	1½	135	3	240	3	180	4 0	4 0	1 5	2¼	112	42	40	42	42	42	43	30
31	·080	1,810	29·18	5 3	5 6	1½	135	3	240	3	180	3 11½	3 11½	1 4	2¼	113	42	41	42	43	43	43	31
Total Rainfall	·820	18,547		Total quantity of water per acre discharged - - - -			8,415	- -	7,830	- -	5,850	- -	- -	- -	- -	3,310							
				Remainder unaccounted for -			10,132	- -	10,717	- -	12,697	- -	- -	- -	- -	15,237							
				Total Rainfall - - -			18,547	- -	18,547	- -	18,547	- -	- -	- -	- -	18,547							

HINXWORTH DRAINAGE.—Record of the Month of April 1857.

DAY of the MONTH.	1. Rain-fall. Per Diem. — Inches dec.	2. Rain-fall. Per Acre. — (Per Diem.) In Gallons.	3. Barometer. Height at the time of recording the Discharge from the Outlets, 8 o'clock a. m. — *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. Occasional Drainage.—Field No. 40. 16 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Very wet before Draining. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 8 feet deep. Higher Side. — Distance from Drain to Drain 75 yards. Depth of Drains 7 feet 6 inches.	5. Occasional Drainage.—Field No. 40. Lower Side. — Distance from Drain to Drain 33 yards. Depth of Drains 6 feet.	6. Occasional Drainage.—Field No. 40. Quantity of Water from Outlet No. 8, which discharges the Drain Water from Field, No. 40. Per Minute. — In Gallons.	7. Occasional Drainage.—Field No. 40. Per Acre. — In Gallons (per diem).	8. Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 5 inches. Commenced running, Oct. 12. Per Minute. — In Gallons.	9. Part Occasional and part Wide Parallel Drainage. Per Acre. — In Gallons (per diem).	10. Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay, with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year. Per Minute. — In Gallons.	11. Parallel Drainage. Per Acre. — In Gallons (per diem).	12. 13. 14. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep. Drained Land. Higher Side. — 25 feet apart and 4 feet deep. No. 31.	13. Close Parallel Drainage. Drained Land. Lower Side. — 25 feet apart and 4 feet deep. No. 31.	14. Close Parallel Drainage. Undrained Land. No. 33.	15. 16. Close Parallel Drainage. Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	17. 18. 19. Temperature. At Half-past Seven A.M. Undrained Land. Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	20. 21. 22. Temperature. At Half-past Seven A.M. Drained Land. Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.	Day of the Month.
1	·050	1,131	29·37	5 3	5 6	2	67	2 1/4	180	1 1/2	90	3 11 1/2	3 11 1/2	1 3	2 1/4	110	45	41	42	45	43	43	1
2	- -	- -	29·15	5 3	5 6	2	67	2 1/4	180	1 1/2	90	3 11 1/2	3 11 1/2	1 3	1 1/2	75	46	42	42	49	44	43	2
3	·015	339	29·48	5 3 1/2	5 6	2	68	2 1/4	180	1 1/2	90	3 11 1/2	3 11 1/2	1 3	1 1/2	75	48	42	42	47	44	43	3
4	·060	1,357	29·67	5 4	5 6	2	68	2 1/4	180	1 1/2	90	4 0	4 0	1 3 1/2	1	37	47	43	42	48	45	43	4
5	·460	10,406	29·69	5 6	5 6	3	270	9	720	13 1/2	810	4 0	3 11 1/2	1 3	8 1/4	410	44	44	43	45	46	44	5
6	·035	792	29·58	5 8	5 5	3	270	9	720	13 1/2	810	4 0	3 11	1 2	8 1/4	415	42	45	43	46	47	44	6
7	- -	- -	29·80	5 8	5 5	3	270	6	480	12	720	4 0	3 11	1 2	7 1/2	375	45	46	43	46	48	44	7
8	- -	- -	29·89	5 8	5 5	3	270	6	480	10 1/2	630	4 0	3 11	1 3	6	300	46	46	44	47	48	45	8
9	·005	113	29·58	5 8	5 6	3	270	5 1/4	420	7 1/2	450	4 0	3 11	1 4	5 1/4	265	44	46	44	45	48	45	9
10	·080	1,810	29·48	5 8	5 6	2 1/4	200	4 1/4	360	6 3/4	405	4 0	3 11	1 5	4 1/4	225	45	47	44	44	49	45	10
11	·030	678	29·40	5 8	5 6	2 1/4	200	3 1/4	300	6	360	4 0	4 0	1 5	3 1/4	185	44	47	44	45	49	45	11
12	·035	792	29·35	5 8	5 6	3	270	3 1/4	300	6	360	4 0	4 0	1 4	4	205	45	46	44	46	48	45	12
13	·300	6,786	29·87	5 8	5 6	3 3/4	338	5 1/4	420	8 1/4	495	4 0	4 0	1 4	5 1/4	265	42	45	44	42	47	45	13
14	·150	3,394	29·20	5 8	5 5 1/2	3	270	6	480	15	900	4 0	4 0	1 4	11 1/4	560	37	44	44	37	45	45	14
15	·005	115	29·46	5 8	5 5 1/2	3	270	5 1/4	420	7 1/2	450	4 0	4 0	1 4	5 1/4	265	41	43	44	41	44	45	15
16	- -	- -	29·65	5 8	5 5 1/2	3	270	6	480	9	540	4 0	4 0	1 4	5 1/4	265	41	43	44	43	44	45	16
17	·005	110	29·83	5 8 1/2	5 6	3	270	4 1/2	360	7 1/2	450	4 0	4 0	1 4	4 1/2	225	43	43	44	43	44	45	17
18	- -	- -	29·83	5 8 1/2	5 6	3	270	4 1/2	360	6	360	4 0	4 0	1 4	4 1/2	225	44	42	44	44	43	45	18
19	- -	- -	29·78	5 8 1/2	5 6 1/2	2 1/2	200	4 1/2	360	5 1/4	315	4 0	4 0	1 4	4 1/2	225	46	43	44	46	44	45	19
20	- -	- -	30·10	5 8 1/2	5 6 1/2	2 1/4	200	4 1/2	360	4 1/2	270	4 0	4 0	1 4	4 1/2	225	43	44	44	43	45	45	20
21	- -	- -	30·18	5 9	5 7	2 1/4	200	4 1/2	360	4 1/2	270	4 0	4 0	1 4	4 1/2	225	42	44	44	42	46	45	21
22	- -	- -	30·00	5 8 1/2	5 6	3	270	5 1/4	420	4 1/2	270	4 0	4 0	1 4	3 3/4	185	42	45	44	42	47	45	22
23	·205	4,650	29·00	5 8	5 5	3	270	5 1/4	420	4 1/2	270	3 11 1/2	4 0	1 3	3 3/4	185	40	46	45	40	48	46	23
24	- -	- -	30·76	5 9	5 6	3	270	3 3/4	300	4 1/2	270	3 11	4 0	1 3	3	148	38	46	45	39	48	46	24
25	- -	- -	29·69	5 10	5 6	3	270	3 3/4	300	3 1/4	225	3 11 1/2	4 0	1 3	3	148	43	45	45	43	47	46	25
26	·005	113	29·80	5 10	5 6	2 1/2	225	3	240	3	180	4 0	4 0	1 3	2 1/4	110	39	44	45	39	46	46	26
27	- -	- -	30·00	5 10	5 6	2 1/4	200	3	240	3	180	4 0	4 0	1 3	2 1/4	110	37	43	45	37	45	46	27
28	- -	- -	30·03	5 10	5 6	2 1/4	200	3	240	2 1/4	135	4 0	4 0	1 3	1 1/2	75	38	42	44	38	44	45	28
29	- -	- -	30·00	5 10	5 6	2 1/4	200	3	240	2 1/4	135	4 0	4 0	1 3	1 1/2	75	41	42	44	41	44	45	29
30	- -	- -	30·00	5 10	5 6	2 1/4	200	3	240	2 1/4	135	4 0	4 0	1 3	1 1/2	75	40	42	44	40	44	45	30
Total Rainfall	1·440	32,586		Total quantity of water per acre discharged			6,683	- -	10,920	- -	10,530	- -	- -	- -	- -	6,188							
				Remainder unaccounted for			25,903	- -	21,666	- -	22,056	- -	- -	- -	- -	26,398							
				Total Rain-fall			32,586	- -	32,586	- -	32,586	- -	- -	- -	- -	32,586							

HINXWORTH DRAINAGE.—Record of the Month of May 1857.

DAY of the MONTH.	1. Rain-fall. Per Diem. — Inches dec.	2. Rain-fall. Per Acre. — (Per Diem.) In Gallons.	3. Barometer. Height at the time of recording the Discharge from the Outlets, 8 o'clock a.m. — *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. Occasional Drainage.—Field, No. 40. 16 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Very wet before Draining. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 8 feet deep. Higher Side. — Distance from Drain to Drain 75 yards. Depth of Drains 7 feet 6 inches.	5. Occasional Drainage.—Field, No. 40. Lower Side. — Distance from Drain to Drain 33 yards. Depth of Drains 6 feet.	6. Occasional Drainage.—Field, No. 40. Quantity of Water from Outlet No. 8, which discharges the Drain Water from Field No. 40. Per Minute. — In Gallons.	7. Occasional Drainage.—Field, No. 40. Per Acre. — In Gallons (per diem).	8. Part Occasional and part Wide Parallel Drainage. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 5 inches. Commenced running, October 12. Per Minute. — In Gallons.	9. Part Occasional and part Wide Parallel Drainage. Per Acre. — In Gallons (per diem).	10. Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay, with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856. Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the Year. Per Minute. — In Gallons.	11. Parallel Drainage. Per Acre. — In Gallons (per diem).	12. 13. 14. Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay with Lime infiltrated. Considered very stiff and impenetrable. Drains 25 feet apart, and 4 feet deep. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep. Drained Land. Higher Side. — 25 feet apart and 4 feet deep. No. 31.	13. Close Parallel Drainage. Drained Land. Lower Side. — 25 feet apart and 4 feet deep. No. 31.	14. Close Parallel Drainage. Undrained Land. No. 33.	15. 16. Close Parallel Drainage. Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running November 27. Per Minute. — In Gallons.	Per Acre. — In Gallons (per diem).	17. 18. 19. Temperature. At Half-past Seven A.M. Undrained Land. Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	20. 21. 22. Temperature. At Half-past Seven A.M. Drained Land. Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.	Day of the Month.
1	·040	905	30·07	5 10 1/2	5 6	1 1/2	135	3	240	2 1/4	135	4 0	4 0	1 3 1/2	1 1/2	74	42	42	44	42	44	45	1
2	·005	113	30·06	5 11	5 6	1 1/2	135	3	240	2 1/4	135	4 0	4 0	1 4	1 1/2	74	44	43	44	44	45 1/2	45	2
3	- -	- -	30·17	5 11	5 6	3	270	3	240	2 1/4	135	4 0	4 0	1 4	1 1/2	74	43	43	45	43	45 1/2	46	3
4	- -	- -	30·18	5 11	5 6	3	270	3	240	2 1/4	135	4 0	4 0	1 4	1 1/2	74	44	43	45	44	45 1/2	46	4
5	- -	- -	30·19	5 11	5 6	3	270	3	240	2 1/4	135	4 0	4 0	1 4	1 1/2	74	41	44	45	41	46	46	5
6	·010	226	30·20	5 11	5 6	3	270	3	240	1 1/2	90	4 0	4 0	1 4 1/2	1 1/2	75	38	43	45	39	45	46	6
7	- -	- -	30·19	5 11 1/2	5 6 1/2	2 1/4	200	2 1/4	180	1 1/2	90	4 0	4 0	1 4 1/2	1 1/2	75	38	43	45	38	45	46	7
8	- -	- -	30·05	5 11 1/2	5 6 1/2	2 1/4	200	2 1/4	180	1 1/2	90	4 0	4 0	1 5	1 1/4	37	40	43	45	40	45 1/2	46	8
9	- -	- -	29·79	6 0	6 6 1/2	2 1/4	200	2 1/4	180	1 1/2	90	4 0	4 0	1 5	1 1/4	37	45	44	45	45	46	46	9
10	- -	- -	29·68	6 1	6 6 1/2	1 1/2	135	2 1/4	180	2	120	4 0	4 0	1 5	1	49	44	44	45	44	46	46	10
11	·150	3,393	29·60	6 1	6 6 1/2	1 1/2	135	2 1/4	180	2 1/4	135	4 0	4 0	1 5	1 1/4	75	47	45	45	48	47	46	11
12	·050	1,131	29·80	6 1	6 6 1/2	1 1/2	135	3	240	2 1/4	135	4 0	4 0	1 5	1 1/4	75	49	46	45	50	48	46	12
13	·010	226	30·00	6 1 1/2	6 6 1/2	1 1/2	135	3	240	3	180	4 0	4 0	1 5	1 1/4	75	52	48	45	53	50	46	13
14	- -	- -	30·00	6 2	5 7	1 1/2	135	2 1/4	180	2 1/4	135	4 0	4 0	1 5 1/2	1 1/4	75	53	49	46	54	51	47	14
15	- -	- -	30·01	6 2 1/2	5 7	1 1/2	135	2 1/4	180	1 1/2	90	4 0	4 0	1 6	2 1/4	110	56	51	47	56	53	48	15
16	·055	1,245	30·10	6 3	5 7	1 1/2	135	2 1/4	180	1 1/2	90	4 0	4 0	1 6	2 1/4	110	58	52	48	58	55	49	16
17	- -	- -	30·09	6 3 1/2	5 7 1/2	1 1/2	135	1 1/2	120	3/4	45	4 0	4 0	1 6	2 1/4	110	58	52	48	58	55	49	17
18	- -	- -	30 00	6 3 1/2	5 7 1/2	1	135	1 1/2	120	1	60	4 0	4 0	1 6	2 1/4	110	60	51	48	60	54	49	18
19	- -	- -	29·95	6 4	5 8	1	67	1 1/2	120	1	60	4 0	4 0	1 6	2 1/4	110	63	50	48	63	53	49	19
20	- -	- -	29·80	6 4 1/2	5 8 1/2	1/2	23	1 1/2	120	3/4	45	4 0	4 0	1 6	2 1/4	110	63	51	48	64	54	50	20
21	- -	- -	29·60	6 5	5 9	1/2	22	1 1/2	120	3/4	45	4 0	4 0	1 6 1/2	2 1/4	110	65	54	49	65	56	51	21
22	·040	905	29·76	6 5	5 9 1/2	Nil -	Nil -	1 1/2	120	3/4	45	4 0	4 0	1 6 1/2	2 1/4	110	66	54	50	66	56	51	22
23	·170	3,845	29·60	6 6	5 10	Nil -	Nil -	2	160	1	60	4 0	4 0	1 6	3	148	64	54	50	63	56	51	23
24	·030	678	29·41	6 6	5 11	1 1/2	135	1 1/2	120	1	60	4 0	4 0	1 6	3 1/4	173	61	54	50	62	56	51	24
25	- -	- -	29·46	6 6	6 0	1 1/2	135	1 1/2	120	1	60	4 0	4 0	1 6	3 3/4	185	60	54	50	61	56	51	25
26	·180	4,074	29·48	6 6 1/2	6 3	1 1/2	135	1 1/2	120	1 1/2	90	4 0	4 0	1 6	4	198	61	54	49	60	55	51	26
27	- -	- -	29·64	6 6 1/2	6 3	1 1/2	135	1 1/2	120	1 1/2	90	4 0	4 0	1 6	4	199	62	53	49	62	55	52	27
28	- -	- -	29·70	6 6 1/2	6 4	1	90	1	180	1	60	4 0	4 0	1 6 1/2	3 3/4	185	62	53	50	61	56	52	28
29	- -	- -	29 80	6 7	6 5	1	90	1	80	3/4	45	4 0	4 0	1 6 1/2	3 3/4	185	61	53	50	60	56	52	29
30	·010	226	29·89	6 7 1/2	6 6	1	90	1	80	3/4	45	4 0	4 0	1 7	3	149	62	53	49	62	56	52	30
31	- -	- -	29·95	6 8	6 6 1/2	1	90	1	80	3/4	45	4 0	4 0	1 7	3 1/2	173	—	—	—	—	—	—	31
Total Rainfall	·750	16,967		Total quantity of water per acre discharged			4,132	- -	5,040	- - -	2,775	- -	- -	- -	- -	3,418							
				Remainder unaccounted for			12,835	- -	11,927	- - -	14,192	- -	- -	- -	- -	13,549							
				Total Rainfall			16,967	- -	16,967	- - -	16,967	- -	- -	- -	- -	16,967							

W. B. Hack, Engineer.

Appendix III.—*continued.*

SUMMARY of the foregoing RECORDS.

MONTHS.	RAINFALL. Per Diem. — Inches Dec.	RAINFALL. Per Acre. — (per diem) In Gallons.	QUANTITIES DISCHARGED FROM OUTLETS. From Outlet No. 7, from October 1st to February 28th, and from Outlet No. 8, from March 1st to May 31st, as per Column 7. — Per Acre per diem in Gallons.	From Outlet No. 9, as per Column 9. — Per Acre, per diem, in Gallons.	From Outlet No. 13, as per Column 11. — Per Acre, per diem, in Gallons.	From Outlet No. 15, as per Column 16. — Per Acre, per diem, in Gallons.	MONTHS.
October - -	1·645	37,215	12,910	178	8,915	- Nil -	October.
November - -	1·630	36,872	27,000	2,077	6,015	330	November.
December - -	1·235	27,935	30,565	11,895	15,935	5,825	December.
January - -	2·333	52,775	43,855	39,090	49,250	31,805	January.
February - -	·192	4,343	27,360	14,320	13,050	9,060	February.
March - - -	·820	18,547	8,415	7,830	5,850	3,310	March.
April - - -	1·440	32,586	6,683	10,920	10,530	6,188	April.
May - - -	·750	16,967	4,132	5,040	2,775	3,418	May.
TOTAL RAINFALL -	10·045	227,240	160,920	91,350	112,920	59,936	TOTAL discharge per Acre.
Difference between Rain-fall and discharge from the Drains - - -			66,320	135,890	114,320	167,384	
			227,240	227,240	227,240	227,240	TOTAL Rain-fall.

NOTES on the foregoing Records.

THE object I had in conducting the experiments and in tabulating the results now collected, was to gain tangible and irresistible proof of the draining capabilities of clay soils. I selected the clay lands of Hinxworth, because they presented a surface and subsoil, and had a local reputation as forbidding as any clay lands I had visited in my practice as a draining engineer.

In 1849, when I reported on the drainage of the Hinxworth Estate, I advised the owner, Mr. Clutterbuck, of Watford House (who then contemplated some partial work), not to attempt the drainage in any other way than as a whole, because I considered that nearly every part was more or less dependent on adjacent lands, and that the work would only be satisfactory and complete when effected altogether, and by a connected scheme of operations. This suggestion Mr. Clutterbuck acted upon, and when the estate is viewed geologically in its relation to the surrounding district, and the several parts of the estate considered in relation to each other, I believe the value of the decision to deal with it as a whole will be fully appreciated.

In the winter of 1855-6, Mr. Clutterbuck determined to drain the whole estate. It consists of three farms containing together about 800 acres. It lies at the base of the chalk escarpment of the London Basin, and covers a portion of the lowest bed of the chalk, the outcrop of the greensand, and a portion of the gault of the greensand formation. In several parts a superficial deposit of drifted gravel and sand overlies the older beds. The greensand separating the chalk from the gault is very thin, and if collected in a distinct layer would not exceed three inches in depth in its thickest part. The gault has gained a siliceous character where it comes immediately in contact with the greensand. It has also imbibed a calcareous quality by an infiltration of the chalk through the greensand into its bed; for a wide breadth, however, the gault is denuded, and there, although the greensand is absent, a very considerable infiltration of lime has taken place, which, I presume, may be accounted for by the fact, that the chalk escarpment rises in almost cliff-like shape immediately at the margin of the gault, and any submersion of the gault has necessarily imparted to it the character of its more prominent and overwhelming neighbour.

The

Appendix III.—*continued.*

The following are several Analyses of Professor Way:—

Of the Lower Chalk and Mixed Drift.		Of the Gault (at 24 inches deep.)		Of the Gault (at 42 inches deep.)	
Moisture and organic matter	3·27	Moisture and organic matter	5·01	Moisture and organic matter	4·28
Sand and clays	24·37				
Silicia soluble in acids	1·23	Sands	0·66	Sands	0·34
Oxide of iron	1·14				
Phosphate of lime	0·92	Clay	63·26	Clay	62·97
Sulphate of lime	0·76				
Carbonate of lime	68·31	Carbonate of lime	31·07	Carbonate of lime	32·41
	100·0		100·0		100·0

The whole of the lands, both those of the mixed open character and those of the gault clay, suffered greatly from excessive wetness before drainage; the water in each standing within a few inches of the surface during the spring months of March, April, and May. A connected system of works was adopted. The chalk and mixed drift soils were drained by occasional and wide parallel drains (from 4 to 8 feet deep), sufficient to discharge the rainfall and relieve the pressure of subterranean water passing through the soil from the higher grounds to their natural outfalls, at a cost varying from 1 *l.* 10 *s.* to 3 *l.* 10 *s.* per acre. The gault clay soils were drained uniformly by a parallel arrangement of drains 25 and 27 feet apart, 4 feet deep, at a cost varying from 5 *l.* 10 *s.* to 6 *l.* 10 *s.* per acre. The effect of the different modes of draining in lowering the water-level in each description of soil, is shown by the height of the water standing in the test-holes as set forth in columns 4, 5, 12, and 13. The discharge from the several outlets following rain is exhibited by columns 7, 9, 11, and 16. It will be observed that the discharge from the open soils was much more regular than from the clays, while the latter gave out a verylarge proportion of heavy rainfalls immediately after they occurred. A remarkable proof of the influence and penetration of atmospheric changes through soil to the depth of drains is to be seen in the fact, that all the outlets discharged an increased quantity of water on the 6th of March and 22d of April, without any fall of rain on the surface, it being observed on each occasion that a very considerable fall of the barometer had taken place within the previous 24 hours.

52, Parliament-street,
25 July 1857.

(signed) *J. Bailey Denton.*

Hoath, Engineer.

Appendix III.

Sewage, Rainfall and Population.

Rainfall and Percolation at Apsley Mill, Herts. (Supplied by Mr. James Simpson, jun.)

10.—RAINFALL and PERCOLATION at *Apsley Mill, Hertfordshire.*

(Supplied by Mr. *James Simpson*, jun.)

15 Years' Observations.

Position of Gauge:

Height above the sea - - - - - - - 257 feet.

Latitude - - - - - - - - - 51° 43′ North.

Longitude - - - - - - - - - 0° 27′ West.

General Summary of the Table.

	Winter.	Spring.	Summer.	Entire Year.
	in.	*in.*	*in.*	*in.*
Mean annual fall - - - - -	8·71	7·15	10·23	26·18
Ditto percolation - - - - -	6·66	1·26	1·82	9·38
Maximum fall; being the mean of five of the wettest years during the period	11·23	9·32	12·81	30·33
Ditto percolation - - - - -	10·17	3·04	4·33	14·32
Minimum fall; being the mean of five of the driest years during the period	6·57	5·16	7·65	22·28
Ditto percolation - - - - -	3·19	·02	·02	4·94

The year is divided into three periods, winter, spring, and summer; the winter period being November, December, January, and February. The "Winter" column, therefore, in the tables contains the rainfall of the November and December of each preceding year; while the "Entire Year" column applies to the regular year, from January to December.

RAINFALL AND PERCOLATION AT APSLEY MILL, HERTFORDSHIRE.
15 YEARS' OBSERVATIONS.

YEARS.	RAINFALL.															PERCOLATION.													
	1835.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1835.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
January - - -	1·20	2·40	·91	2·05	1·65	1·90	1·50	1·00	1·10	1·00	3·25	3·07	1·80	1·93	1·89	1·90	2·40	·91	2·05	1·65	1·90	1·60	1·00	1·10	1·00	3·25	3·07	1·80	1·93	1·89
February - - -	2·02	2·04	·70	1·60	2·20	2·18	1·02	2·02	2·42	3·02	·70	1·26	1·42	2·23	1·78	2·02	2·04	·70	1·60	2·20	2·18	1·02	2·02	2·42	3·02	·70	1·26	1·42	2·23	1·78
March - - -	·48	3·05	·75	1·05	1·92	·97	·34	1·05	·98	2·22	1·50	1·07	·98	3·57	1·07	·48	3·05	·75	1·05	1·92	·97	·34	1·05	·98	2·22	1·50	1·07	·98	3·57	1·07
April - - -	1·07	2·57	1·92	1·05	1·05	2·00	·34	1·85	2·10	·93	1·45	2·52	1·08	2·08	1·52	1·07	2·57	1·92	1·05	1·05	2·00	·34	1·85	2·10	·93	1·45	2·52	1·08	2·08	1·52
May - - -	2·05	·70	·94	1·22	2·01	2·08	2·02	1·85	5·00	·47	2·25	1·30	·91	3·10	1·30	2·05	·70	·94	1·22	2·01	2·08	2·02	1·85	5·00	·47	2·25	1·30	·91	3·10	1·30
June - - -	3·00	1·60	1·86	2·85	3·01	2·40	1·38	2·00	1·56	1·18	1·00	2·20	1·30	2·30	2·00	3·00	1·60	1·86	2·85	3·01	2·40	1·38	2·00	1·56	1·18	1·00	2·20	1·30	2·30	2·00
July - - -	·80	2·20	1·50	2·35	4·30	2·79	1·18	1·03	2·00	1·05	2·30	1·30	1·01	2·42	1·30	·80	2·20	1·50	2·35	4·30	2·79	1·18	1·03	2·00	1·05	2·30	1·30	1·01	2·42	1·30
August - - -	·35	2·24	3·00	1·38	3·05	1·88	1·90	1·40	2·00	2·72	1·07	2·25	1·21	2·88	1·21	·35	2·24	3·00	1·38	3·05	1·88	1·90	1·40	2·00	2·72	1·07	2·25	1·21	2·88	1·21
September - - -	3·82	2·60	1·38	2·47	3·22	3·80	2·31	4·50	·93	1·43	2·00	1·79	2·00	2·12	3·80	3·82	2·60	1·38	2·47	3·22	3·80	2·31	4·50	·93	1·43	2·00	1·79	2·00	2·12	3·80
October - - -	5·00	4·65	1·65	2·08	1·08	1·82	1·60	1·41	4·98	4·98	1·05	0·36	2·59	4·50	1·82	5·00	4·65	1·65	2·08	1·08	1·82	1·60	1·41	4·98	4·98	1·05	0·36	2·59	4·50	1·82
November - - -	2·10	3·05	2·05	3·55	4·40	1·92	4·25	5·77	2·45	3·07	2·04	1·47	1·70	1·12	2·70	2·10	3·05	2·05	3·55	4·40	1·92	4·25	5·77	2·45	3·07	2·04	1·47	1·70	1·12	2·70
December - - -	·24	2·21	1·70	1·68	3·03	2·50	·40	1·92	·40	·81	3·02	·90	3·40	2·02	2·50	·24	2·21	1·70	1·68	3·03	2·50	·40	1·92	·40	·81	3·02	·90	3·40	2·02	2·50
Totals - - -	27·59	31·00	21·10	23·13	31·23	24·05	21·44	32·10	20·43	23·07	24·43	20·35	23·20	29·00	24·05	7·80	17·75	0·95	8·57	14·01	11·20.	-	4·25	20·47	23·07	24·43	20·35	23·20	29·00	24·05
Mean of 5 Years - -	0·02	0·79	11·41	0·71	7·09	20·82.	12·60	7·17	9·00	8·37	7·33	11·21	5·60	9·08	8·01	1·56	2·32	2·10	·80	1·91	·74.	2·57	10·97	0·01	5·30	5·97	8·00	1·80	0·10	3·55
WINTER - - -	7·01	9·08	2·70	7·80	14·01	11·20.	-	4·25	20·47	23·07	24·43	20·35	23·20	29·00	24·05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean of 5 Years - -	1·40	1·82	·54	1·56	2·80	2·24.	-	4·25	4·09	4·81	4·89	4·07	4·64	5·80	4·81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WINTER - - -	7·01	9·08	2·70	7·80	14·01	11·20.	-	4·25	20·47	23·07	24·43	20·35	23·20	29·00	24·05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean of 5 Years - -	1·40	1·82	·54	1·56	2·80	2·24.	-	4·25	4·09	4·81	4·89	4·07	4·64	5·80	4·81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPRING - - -	·23	4·20	·01	2·73	2·08	1·80.	·55	1·02	·90	2·05	-	5·60	-	5·43	·09	·23	4·20	·01	2·73	2·08	·09	·55	1·02	·90	2·05	-	5·60	-	5·43	·09
Mean of 5 Years - -	·04	4·64	·13	·19	1·83	2·25.	·09	1·00	·91	1·13	-	5·08	-	2·08	-	·04	4·64	·13	·19	1·83	1·92.	·09	1·00	·91	1·13	-	5·08	-	2·08	-
SUMMER - - -	4·08	4·04	·13	·19	1·83	2·25.	·09	1·00	·91	1·13	-	5·08	-	2·08	-	4·08	4·04	·13	·19	1·83	1·92.	·09	1·00	·91	1·13	-	5·08	-	2·08	-
Mean of 5 Years - -	0·82	0·81	0·03	0·04	0·37	0·45.	0·02	0·20	0·18	0·23	-	1·02	-	0·42	-	0·82	0·81	0·03	0·04	0·37	0·38.	0·02	0·20	0·18	0·23	-	1·02	-	0·42	-

YEARS.	RAINFALL.															PERCOLATION.													
	1835.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1835.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
January - - -	1·20	2·40	·91	2·05	1·65	1·90	1·50	1·00	1·10	1·00	3·25	3·07	1·80	1·93	1·89	1·90	2·40	·91	2·05	1·65	1·90	1·60	1·00	1·10	1·00	3·25	3·07	1·80	1·93	1·89
February - - -	2·02	2·04	·70	1·60	2·20	2·18	1·02	2·02	2·42	3·02	·70	1·26	1·42	2·23	1·78	2·02	2·04	·70	1·60	2·20	2·18	1·02	2·02	2·42	3·02	·70	1·26	1·42	2·23	1·78
March - - -	·48	3·05	·75	1·05	1·92	·97	·34	1·05	·98	2·22	1·50	1·07	·98	3·57	1·07	·48	3·05	·75	1·05	1·92	·97	·34	1·05	·98	2·22	1·50	1·07	·98	3·57	1·07
April - - -	1·07	2·57	1·92	1·05	1·05	2·00	·34	1·85	2·10	·93	1·45	2·52	1·08	2·08	1·52	1·07	2·57	1·92	1·05	1·05	2·00	·34	1·85	2·10	·93	1·45	2·52	1·08	2·08	1·52
May - - -	2·05	·70	·94	1·22	2·01	2·08	2·02	1·85	5·00	·47	2·25	1·30	·91	3·10	1·30	2·05	·70	·94	1·22	2·01	2·08	2·02	1·85	5·00	·47	2·25	1·30	·91	3·10	1·30
June - - -	3·00	1·60	1·86	2·85	3·01	2·40	1·38	2·00	1·56	1·18	1·00	2·20	1·30	2·30	2·00	3·00	1·60	1·86	2·85	3·01	2·40	1·38	2·00	1·56	1·18	1·00	2·20	1·30	2·30	2·00
July - - -	·80	2·20	1·50	2·35	4·30	2·79	1·18	1·03	2·00	1·05	2·30	1·30	1·01	2·42	1·30	·80	2·20	1·50	2·35	4·30	2·79	1·18	1·03	2·00	1·05	2·30	1·30	1·01	2·42	1·30
August - - -	·35	2·24	3·00	1·38	3·05	1·88	1·90	1·40	2·00	2·72	1·07	2·25	1·21	2·88	1·21	·35	2·24	3·00	1·38	3·05	1·88	1·90	1·40	2·00	2·72	1·07	2·25	1·21	2·88	1·21
September - - -	3·82	2·60	1·38	2·47	3·22	3·80	2·31	4·50	·93	1·43	2·00	1·79	2·00	2·12	3·80	3·82	2·60	1·38	2·47	3·22	3·80	2·31	4·50	·93	1·43	2·00	1·79	2·00	2·12	3·80
October - - -	5·00	4·65	1·65	2·08	1·08	1·82	1·60	1·41	4·98	4·98	1·05	0·36	2·59	4·50	1·82	5·00	4·65	1·65	2·08	1·08	1·82	1·60	1·41	4·98	4·98	1·05	0·36	2·59	4·50	1·82
November - - -	2·10	3·05	2·05	3·55	4·40	1·92	4·25	5·77	2·45	3·07	2·04	1·47	1·70	1·12	2·70	2·10	3·05	2·05	3·55	4·40	1·92	4·25	5·77	2·45	3·07	2·04	1·47	1·70	1·12	2·70
December - - -	·24	2·21	1·70	1·68	3·03	2·50	·40	1·92	·40	·81	3·02	·90	3·40	2·02	2·50	·24	2·21	1·70	1·68	3·03	2·50	·40	1·92	·40	·81	3·02	·90	3·40	2·02	2·50
Totals - - -	27·59	31·00	21·10	23·13	31·23	24·05	21·44	32·10	20·43	23·07	24·43	20·35	23·20	29·00	24·05	7·80	17·75	0·95	8·57	14·01	11·20.	-	4·25	20·47	23·07	24·43	20·35	23·20	29·00	24·05
Mean of 5 Years - -	0·02	0·79	11·41	0·71	7·09	20·82.	12·60	7·17	9·00	8·37	7·33	11·21	5·60	9·08	8·01	1·56	2·32	2·10	·80	1·91	·74.	2·57	10·97	0·01	5·30	5·97	8·00	1·80	0·10	3·55
WINTER - - -	7·01	9·08	2·70	7·80	14·01	11·20.	-	4·25	20·47	23·07	24·43	20·35	23·20	29·00	24·05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean of 5 Years - -	1·40	1·82	·54	1·56	2·80	2·24.	-	4·25	4·09	4·81	4·89	4·07	4·64	5·80	4·81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPRING - - -	·23	4·20	·01	2·73	2·08	1·80.	·55	1·02	·90	2·05	-	5·60	-	5·43	·09	·23	4·20	·01	2·73	2·08	·09	·55	1·02	·90	2·05	-	5·60	-	5·43	·09
Mean of 5 Years - -	·04	4·64	·13	·19	1·83	2·25.	·09	1·00	·91	1·13	-	5·08	-	2·08	-	·04	4·64	·13	·19	1·83	1·92.	·09	1·00	·91	1·13	-	5·08	-	2·08	-
SUMMER - - -	4·08	4·04	·13	·19	1·83	2·25.	·09	1·00	·91	1·13	-	5·08	-	2·08	-	4·08	4·04	·13	·19	1·83	1·92.	·09	1·00	·91	1·13	-	5·08	-	2·08	-
Mean of 5 Years - -	0·82	0·81	0·03	0·04	0·37	0·45.	0·02	0·20	0·18	0·23	-	1·02	-	0·42	-	0·82	0·81	0·03	0·04	0·37	0·38.	0·02	0·20	0·18	0·23	-	1·02	-	0·42	-

W. B. Hack, Engraver.

Appendix III.—*continued.*

11.—REGISTER of the LEVEL of the WATER in the River *Thames*, TEMPERATURE of the same, and FALL of RAIN, at *Seething Wells, Kingston-on-Thames*, taken at 9 A.M. daily, from 1st January 1855 to 19th July 1857.

	Level of Water in the River.		Temperature of River Water.	Fall of Rain.
	Above Summer Level.	Below Summer Level.		
1855:	*Feet.*	*Feet.*	°	*Inches.*
January 1	- -	·4	39·	—
2	- -	·5	42·	·03
3	- -	·4	43·	—
4	- -	·3	43·5	—
5	- -	·3	43·	—
6	- -	·4	44·	·01
7	- -	·4	44·5	—
8	- -	·55	44·5	—
9	- -	·5	44·	—
10	- -	·5	44·	·06
11	- -	·6	42·	—
12	- -	·45	42·	—
13	- -	·5	41·	—
14	- -	·4	40·	—
15	- -	·55	39·	—
				Snow.
16	- -	·6	38·	·05
17	- -	·5	36·	·02
18	- -	·5	33·	·05
19	- -	·35	33·	·05
20	- -	·4	33·	—
21	- -	1·2	33·	·09
22	- -	1·8	33·	·07
23	- -	1·45	33·	·03
24	- -	·8	33·	—
25	- -	·8	33·5	·02
26	- -	·8	34·	·03
27	- -	·6	34·	—
28	- -	·5	34·	—
29	- -	·7	34·	—
30	- -	·55	34·	—
31	- -	·7	33·	·29
				·80
February 1	- -	1·2	33·	—
2	- -	1·5	33·	—
3	- -	1·5	33·	·29
4	- -	1·4	33·	·01
5	- -	1·2	33·	·09
6	- -	·2	35·	·05
7	·5	- -	33·5	·10
8	S. L.	S. L.	33·	·04
9	- -	·2	33·	·30
10	- -	·8	33·	—
11	- -	·9	33·	—
12	- -	·8	33·	—
13	- -	·6	33·	—
14	- -	1·4	33·	—
15	- -	1·3	33·	·01
16	- -	1·4	33·	—
17	- -	1·0	33·	—
18	- -	1·0	33·	—
19	- -	1·5	33·	—
20	- -	·8	33·	—
21	- -	·7	33·	—
22	- -	1·2	33·	—
23	- -	1·7	33·	·06
24	- -	1·6	33·	—
25	- -	1·5	33·	·18
26	·3	- -	33·	·02
27	·6	- -	33·5	·06
28	·5	- -	34·5	·08
				1·29

	Level of Water in the River.		Temperature of River Water.	Fall of Rain.
	Above Summer Level.	Below Summer Level.		
1855:	*Feet.*	*Feet.*	°	*Inches.*
March - 1	1·2	- -	35·5	·10
2	1·3	- -	38·5	·15
3	1·6	- -	40·	·20
4	2·5	- -	39·	·05
5	1·6	- -	39·	·01
6	·9	- -	39·	—
7	·4	- -	39·	—
8	- -	·6	38·5	—
9	·3	- -	38·5	—
10	S. L.	S. L.	38·	·06
11	- -	·2	37·	·08
12	S. L.	S. L.	37·5	·12
13	·5	- -	38·	·17
14	·6	- -	39·	—
15	1·3	- -	40·	·03
16	·6	- -	40·5	·19
17	·6	- -	42·	·08
18	1·3	- -	41·5	·09
19	1·5	- -	42·	·01
20	·4	- -	43·	·04
21	·9	- -	43·	—
22	·6	- -	41·5	—
23	·2	- -	39·5	·13
24	·6	- -	38·5	—
25	·6	- -	37·5	—
26	·3	- -	38·	—
27	- -	·3	39·5	—
28	S. L.	S. L.	40·5	·07
29	·5	- -	39·	·24
30	·7	- -	39·	—
31	·7	- -	40·	—
				1·82
April - 1	·9	- -	40·	—
2	·8	- -	41·	—
3	·5	- -	41·5	·01
4	·3	- -	42·5	·20
5	·4	- -	42·	—
6	·7	- -	45·	—
7	·8	- -	47·5	—
8	·3	- -	47·5	—
9	·1	- -	47·	·04
10	·1	- -	47·	—
11	·2	- -	45·5	·03
12	S. L.	S. L.	47·	·02
13	- -	·2	49·	—
14	S. L.	S. L.	50·	—
15	- -	·2	51·	—
16	- -	·4	52·5	—
17	- -	·3	55·	—
18	- -	·4	54·	—
19	- -	·4	54·	—
20	- -	·4	54·	—
21	- -	·4	54·	—
22	- -	·3	51·	—
23	- -	·5	50·	—
24	- -	·4	52·	—
25	- -	·6	52·	—
26	- -	·4	49·	—
27	- -	·3	50·	—
28	- -	·3	51·	—
29	- -	·3	51·	·01
30	- -	·4	49·	—
				·31

	Level of Water in the River.		Temperature of River Water.	Fall of Rain.
	Above Summer Level.	Below Summer Level		
1855:	*Feet.*	*Feet.*	°	*Inches.*
May - 1	- -	·4	48·5	—
2	- -	·2	47·5	—
3	- -	·2	49·	—
4	- -	·3	49·	—
5	- -	·3	46·5	—
6	- -	·3	50·	—
7	- -	·6	51·	—
8	- -	·4	51·	·06
9	- -	·5	50·	—
10	- -	·4	52·	·10
11	- -	·3	53·	·27
12	- -	·3	51·5	·12
13	- -	·2	50·	—
14	S. L.	S. L.	48·	·39
15	- -	·4	49·	—
16	·1	- -	49·	·03
17	S. L.	S. L.	49·	—
18	- -	·3	51·	·01
19	- -	·1	53·	—
20	—	—	—	—
21	—	—	—	—
22	- -	- -	- -	·01
23	—	—	—	—
24	—	—	—	—
25	—	—	—	—
26	—	—	—	—
27	—	—	—	—
28	- -	- -	- -	·25
29	- -	- -	- -	·01
30	—	—	—	—
31	- -	- -	- -	·48
				1·73
June - 1	- -	·45	51·	—
2	- -	·3	51·	—
3	- -	·3	53·	—
4	- -	·5	56·	·03
5	- -	·6	56·	—
6	- -	·5	58·	—
7	- -	·4	63·	·16
8	- -	·5	62·	—
9	- -	·7	63·	·01
10	- -	·7	62·	·10
11	- -	·4	63·	—
12	- -	·7	63·	—
13	- -	·8	63·	—
14	- -	·6	61·	·08
15	- -	·6	60·	·15
16	- -	·6	60·	·18
17	- -	·6	59·	·10
18	- -	·8	57·	·01
19	- -	·2	57·	·02
20	- -	·1	57·	—
21	- -	·5	58·	—
22	- -	·5	60·	—
23	- -	·5	63·	·01
24	- -	·6	61·	—
25	- -	·7	62·	—
26	- -	·7	61·	—
27	- -	·8	64·	—
28	- -	·8	67·	—
29	- -	·75	68·	—
30	- -	·7	70·	—
				·85

	Level of Water in the River.		Temperature of River Water.	Fall of Rain.
	Above Summer Level.	Below Summer Level.		
1855:	*Feet.*	*Feet.*	°	*Inches.*
July - 1	- -	·9	68·	—
2	- -	·85	68·	—
3	- -	·85	68·	—
4	- -	·85	69·	—
5	- -	·9	68·	—
6	- -	·95	69·	—
7	- -	·8	69·	—
8	- -	·9	68·	—
9	- -	1·15	68·	—
10	- -	·95	69·	·08
11	- -	·8	68·	·48
12	- -	·3	68·	1·20
13	- -	·1	66·	—
14	- -	·3	70·	·47
15	- -	·35	69·	—
16	- -	·6	68·	·45
17	- -	·3	66·	·22
18	- -	·2	65·	—
19	- -	·4	65·	·30
20	- -	·25	62·	·12
21	- -	·2	63·	—
22	- -	·4	66·	—
23	- -	·1	68·	—
24	- -	·4	68·	1·06
25	- -	·3	67·	·11
26	S. L.	S. L.	67·	·03
27	·6	- -	63·	·80
28	·6	- -	64·	·50
29	·7	- -	64·	·27
30	·75	- -	66·	—
31	·1	- -	66·	·29
				6·38
August - 1	·4	- -	65·	—
2	·3	- -	66·	·03
3	·5	- -	66·	·20
4	·3	- -	65·	—
5	·15	- -	65·5	·01
6	·05	- -	65·	—
7	- -	·2	65·5	·13
8	S. L.	S. L.	65·	·60
9	·1	-	64·5	·14
10	·2	- -	64·	—
11	·2	- -	65·5	—
12	- -	·1	67·	—
13	- -	·1	66·	—
14	- -	·3	65·	—
15	- -	·3	65·	—
16	- -	·3	66·	—
17	- -	·3	66·5	—
18	- -	·2	68·	—
19	- -	·3	68·	—
20	- -	·4	66·	—
21	- -	·3	64·	·01
22	- -	·3	64·	—
23	- -	1·5	66·	—
24	- -	·4	66·	·14
25	- -	·3	65·	—
26	- -	·1	64·	·01
27	- -	·1	64·	—
28	- -	·5	64·	—
29	- -	·4	64·	—
30	- -	·3	64·	—
31	- -	·3	63·	—
				1·27

(*continued*)

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W. B. Haigh, Engineer.
...mount that payment only during the continuance of the...

	Level of Water in the River.		Temperature of River Water.	Fall of Rain.
1855:	Above Summer Level.	Below Summer Level.		
	Feet.	*Feet.*	°	*Inches.*
September 1	- -	·3	64·	—
2	- -	·35	61·	—
3	- -	·5	59·	—
4	- -	·4	59·	·04
5	- -	·4	59·5	·02
6	- -	·3	57·	—
7	- -	·4	56·5	—
8	- -	·8	56·5	—
9	- -	·6	57·5	—
10	- -	·3	58·	—
11	- -	·55	58·	—
12	- -	·6	59·5	—
13	- -	·55	60·	·19
14	- -	·4	60·	·31
15	- -	·35	58·5	·01
16	- -	·4	59·	—
17	- -	·2	59·5	·04
18	- -	·45	59·5	·09
19	- -	·45	60·	—
20	- -	·4	60·	—
21	- -	·2	61·	—
22	- -	·4	61·	—
23	- -	·5	60·5	—
24	- -	·25	61·5	—
25	- -	·45	58·	—
26	- -	·5	57·	—
27	- -	·4	55·5	—
28	- -	·4	58·	—
29	- -	·4	59·	·31
30	- -	·45	59·5	·15
				1·16
October 1	- -	·15	58·5	·02
2	- -	·15	58·5	·01
3	·1	- -	58·	—
4	·15	- -	58·5	·23
5	- -	·3	57·	·81
6	·35	- -	56·5	·70
7	·8	- -	57·	·13
8	1·2	- -	56·5	—
9	·8	- -	56·	—
10	·8	- -	55·5	·13
11	·65	- -	54·	—
12	·7	- -	54·5	·02
13	·5	- -	54·	—
14	·3	- -	53·	·09
15	·5	- -	52·5	—
16	·3	- -	51·	·15
17	·5	- -	52·	·55
18	1·5	- -	52·	—
19	1·8	- -	51·5	—
20	1·25	- -	51·5	—
21	1·1	- -	52·5	—
22	·95	- -	53·	·05
23	·55	- -	54·	—
24	·65	- -	53·	—
25	·25	- -	50·5	—
26	·15	- -	52·	·24
27	·8	- -	50·	·38
28	2·1	- -	49·	—
29	1·9	- -	48·5	·02
30	1·5	- -	48·	·69
31	3 2	- -	49·5	1·43
				5·65

	Level of Water in the River.		Temperature of River Water.	Fall of Rain.
1855:	Above Summer Level.	Below Summer Level		
	Feet.	*Feet.*	°	*Inches.*
November 1	5·1	- -	46·	·10
2	5·7	- -	43·	—
3	4·8	- -	42·	·58
4	4·8	- -	41·5	·06
5	5·1	- -	41·5	·02
6	4·6	- -	32·	·01
7	3·9	- -	49·	·06
8	3·1	- -	46·	·05
9	3·4	- -	46·	·67
10	3·	- -	47·	·01
11	2·3	- -	48·	—
12	1·8	- -	48·	—
13	1·4	- -	47·5	—
14	1·3	- -	46·5	—
15	1·1	- -	44·5	—
16	1·05	- -	43·	—
17	1·	- -	43·	—
18	1·	- -	43·	—
19	·7	- -	44·	·03
20	·7	- -	43·	·05
21	·85	- -	42·5	·05
22	·7	- -	42·	—
23	·7	- -	42·	—
24	·7	- -	42·	·01
25	·7	- -	41·	·03
26	·55	- -	39·5	—
27	·35	- -	40·	—
28	·45	- -	41·5	·03
29	·5	- -	41·5	—
30	·3	- -	41·	—
				1·76
December 1	·35	- -	40·	—
2	·3	- -	40·5	0·3
3	·4	- -	39·5	—
4	·3	- -	39·5	0·3
5	·4	- -	41·	—
6	·3	- -	39·	—
7	·3	- -	37·	—
8	·35	- -	37·	—
9	·25	- -	35·5	—
10	·25	- -	36·	—
11	·1	- -	36·	0·3
12	·1	- -	35·5	—
13	·2	- -	34·	—
14	·05	- -	33·5	—
15	·15	- -	37·	0·1
16	·1	- -	37·5	—
17	S. L.	S. L.	38·	—
18	S. L.	. L.	38·	—
19	·25	- -	34·5	—
20	S. L.	S. L.	33·	—
21	- -	1·3	33·	—
22	- -	·9	33·	—
23	- -	·2	33·	·07
24	- -	·55	33·	·15
25	S. L.	S. L.	34·5	·42
26	1·1	- -	37·	·22
27	2·7	- -	40·5	·21
28	3·45	- -	41·	—
29	3·	- -	42·	—
30	2·2	- -	42·	—
31	1·6	- -	41·	·13
				1·30

	Level of Water in the River.		Temperature of River Water.	Fall of Rain.
1856:	Above Summer Level.	Below Summer Level.		
	Feet.	*Feet.*	°	*Inches.*
January 1	·8	- -	41·	—
2	·9	- -	41·5	—
3	·75	- -	42·	·03
4	·95	- -	42·	—
5	·7	- -	43·	·04
6	1·	- -	43·	·09
7	2·	- -	43·	·13
8	2·75	- -	43·	—
9	2·3	- -	42·	·05
10	2·35	- -	40·5	·35
11	3·	- -	38·	—
12	2·4	- -	37·	—
13	1·35	- -	35·	·01
14	1·4	- -	34·	—
15	·2	- -	33·	—
16	·5	- -	34·	—
17	1·	- -	35·	·06
18	1·	- -	39·	·05
19	1·9	- -	40·	·10
20	2·6	- -	43·	·25
21	3·4	- -	43·5	·05
22	3·7	- -	44·	·27
23	4·1	- -	43·5	·01
24	3·8	- -	45·	·14
25	4·1	- -	44·	·15
26	4·5	- -	43·	·02
27	4·5	- -	42·	·12
28	4·2	- -	39·5	—
29	3·8	- -	38·	—
30	3·5	- -	35·	—
31	3·	- -	34·	·02
				1·94
February 1	2·5	- -	34·	—
2	2·05	- -	34·5	—
3	1·8	- -	35·	—
4	1·6	- -	35·	—
5	1·4	- -	37·	·05
6	1·4	- -	39·	—
7	1·55	- -	43·	·03
8	2·	- -	45·	·24
9	2·3	- -	46·	—
10	2·5	- -	46·5	—
11	2·3	- -	47·	—
12	2·3	- -	47·	·23
13	2·6	- -	47·	·08
14	3·1	- -	46·5	·15
15	4·05	- -	46·	·11
16	4·	- -	45·5	—
17	3·6	- -	45·	—
18	3·55	- -	43·	—
19	3·4	- -	40·	·06
20	2·95	- -	38·5	—
21	2·4	- -	37·	·02
22	2·05	- -	36·	—
23	1·7	- -	37·	·02
24	1.7	- -	38·	—
25	1·6	- -	38·5	—
26	1·4	- -	41·	—
27	1·35	- -	43·	—
28	1·3	- -	44·	—
29	1·1	- -	44·	—
				·99

	Level of Water in the River.		Temperature of River Water.	Fall of Rain.
1856:	Above Summer Level.	Below Summer Level.		
	Feet.	*Feet.*	°	*Inches.*
March 1	1·2	- -	44·	—
2	1·2	- -	44·	—
3	1·15	- -	43·5	—
4	·9	- -	43·	—
5	·85	- -	42·5	—
6	·8	- -	43·	·01
7	·8	- -	42·	—
8	·8	- -	41·	—
9	·7	- -	41·5	—
10	·6	- -	41·5	—
11	·7	- -	42·	—
12	·5	- -	40·	—
13	·5	- -	39·	—
14	·6	- -	38·5	—
15	·45	- -	38·	—
16	·25	- -	38·	—
17	·65	- -	41·	·48
18	1·	- -	42·	—
19	1·3	- -	44·	·18
20	2·05	- -	45·	—
21	1·8	- -	45·	·01
22	1·8	- -	44·5	—
23	1·4	- -	45·	—
24	1·2	- -	45·	—
25	·6	- -	43·5	—
26	·65	- -	43·	—
27	·6	- -	42·	—
28	·6	- -	42·	—
29	·6	- -	42·	—
30	·55	- -	42·	—
31	·45	- -	43·	—
				·68
April 1	·15	- -	44·5	—
2	·3	- -	46·5	—
3	·3	- -	48·5	·01
4	·3	- -	49·	·23
5	·85	- -	49·5	—
6	·6	- -	49·	·04
7	1·	- -	49·	·05
8	·7	- -	49·5	·01
9	·8	- -	48·	·11
10	1·55	- -	49·	·49
11	2·4	- -	49·	—
12	2·1	- -	50·	·21
13	2·5	- -	51·	—
14	2·2	- -	52·5	—
15	2·2	- -	51·	·42
16	1·9	- -	49·	—
17	1·5	- -	48·5	—
18	·9	- -	48·	—
19	·55	- -	49·	·04
20	·75	- -	47·5	—
21	·7	- -	49·5	—
22	·45	- -	50·	—
23	·55	- -	50·	—
24	·35	- -	51·5	—
25	·6	- -	52·	—
26	·3	- -	54·5	·15
27	·8	- -	54·	·47
28	2·	- -	51·	·12
29	2·5	- -	51·5	—
30	1·75	- -	50·	·27
				2·62

(continued)

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W. B. Hach, Engineer.
Copy of Tables relating to the Main Drainage Works, delivered to the Select Committee on Metropolis Main Drainage Bill, 1857.

1856:	Level of Water in the River. Above Summer Level.	Level of Water in the River. Below Summer Level.	Temperature of River Water.	Fall of Rain.
	Feet.	*Feet.*	°	*Inches.*
May - 1	·9	- -	49·5	—
2	·7	- -	47·	·02
3	·7	- -	47·5	—
4	·6	- -	47·	·08
5	·6	- -	47·	—
6	·1	- -	48·	—
7	·3	- -	47·	·45
8	·7	- -	45·5	·22
9	1·	- -	45·5	—
10	·4	- -	46·	—
11	·3	- -	50·5	—
12	·3	- -	53·5	—
13	·3	- -	50·	·72
14	·65	- -	54·5	·10
15	·5	- -	54·	—
16	·6	- -	54·	·10
17	·8	- -	55·5	—
18	·6	- -	54·	·20
19	1·2	- -	53·	·24
20	1·2	- -	54·	—
21	·65	- -	56·	—
22	·4	- -	57·	·17
23	·55	- -	57·5	·20
24	·35	- -	57·5	·03
25	·6	- -	58·	·07
26	·45	- -	57·5	·01
27	S. L.	S. L.	58·5	—
28	·8	- -	60·	·53
29	3·2	- -	59·	·32
30	2·6	- -	57·	—
31	2·3	- -	54·	·26
				3·72
June - 1	2·2	- -	53·	0·7
2	2·5	- -	54·	—
3	2·	- -	57·5	—
4	1·6	- -	60·	—
5	1·	- -	62·	—
6	·6	- -	60·5	—
7	·3	- -	61·	—
8	·1	- -	62·	—
9	·3	- -	62·	—
10	S. L.	S. L.	64·	—
11	·1	- -	65·5	—
12	S. L.	S. L.	66·5	—
13	·3	- -	62·5	·15
14	·4	- -	62·5	·16
15	·55	- -	62·	·32
16	·7	- -	62·5	—
17	·5	- -	63·	—
18	·35	- -	63·	—
19	·2	- -	62·	·15
20	·1	- -	61·5	·10
21	·3	- -	60·5	·20
22	·6	- -	60·5	·03
23	·75	- -	61·	·06
24	·3	- -	61·	—
25	·5	- -	63·	—
26	·2	- -	66·	—
27	·2	- -	69·	—
28	·1	- -	70·	—
29	·1	- -	68·5	—
30	- -	·1	68·5	—
				1·24

1856:	Level of Water in the River. Above Summer Level.	Level of Water in the River. Below Summer Level.	Temperature of River Water.	Fall of Rain.
	Feet.	*Feet.*	°	*Inches.*
July - 1	- -	·1	67·	—
2	- -	·1	66·5	—
3	- -	·15	66·5	—
4	- -	·2	66·5	—
5	- -	·2	67·	—
6	- -	·15	67·	·01
7	S. L.	S. L.	66·	—
8	- -	·3	61·	·10
9	- -	·15	58·	·09
10	- -	·1	60·	·01
11	- -	·1	62·	—
12	- -	·1	62·5	·01
13	- -	·1	62·	·02
14	- -	·1	63·	—
15	- -	·15	63·5	—
16	- -	·2	65·	·40
17	S. L.	S. L.	62·5	·26
18	- -	·2	62·5	—
19	- -	·2	63·	·01
20	- -	·15	65·	—
21	- -	·2	65·	·01
22	- -	·2	66·5	·06
23	- -	·15	67·5	—
24	- -	·1	69·	—
25	·3	- -	68·	—
26	- -	·45	68·	—
27	- -	·45	68·	·03
28	- -	·4	65·	·13
29	- -	·45	67·	·06
30	- -	·5	68·	—
31	- -	·5	70·5	—
				1·20
August - 1	- -	·45	72·	—
2	- -	·5	72·5	—
3	- -	·5	73·	—
4	- -	·4	72·	—
5	- -	·7	71·	—
6	- -	·5	70·5	—
7	- -	·7	70·	—
8	- -	·5	70·	—
9	- -	·45	68·5	·02
10	- -	·45	68·	·10
11	- -	·45	70·	—
12	- -	·55	70·	·09
13	- -	·6	69·5	—
14	- -	·3	69·5	·62
15	- -	·3	67·5	·09
16	- -	·5	66·	—
17	- -	·3	65·	·95
18	- -	·2	63·	—
19	- -	·3	61·5	·03
20	S. L.	S. L.	61·	·36
21	·1	- -	61·	·52
22	·3	- -	60·	·32
23	·7	- -	59·	—
24	·3	- -	60·	—
25	·1	- -	61·	·01
26	·2	- -	61·	·04
27	·15	- -	62·	—
28	- -	·1	62·5	—
29	- -	·15	62·	·06
30	- -	·05	62·	—
31	- -	·1	62·5	·04
				3·25

1856:	Level of Water in the River. Above Summer Level.	Level of Water in the River. Below Summer Level.	Temperature of River Water.	Fall of Rain.
	Feet.	*Feet.*	°	*Inches.*
September 1	- -	·2	63·	—
2	- -	·05	62·5	—
3	- -	·4	61·	—
4	- -	·2	61·5	—
5	- -	·2	60·5	—
6	- -	·2	60·	—
7	- -	·45	60·	·16
8	S. L.	S. L.	60·	—
9	- -	·5	61·	—
10	- -	·45	61·5	—
11	- -	·3	61·5	—
12	- -	·2	61·	—
13	- -	·3	61·	·13
14	- -	·3	59·5	—
15	- -	·2	59·	—
16	- -	·3	59·	—
17	- -	·4	58·5	—
18	- -	·4	58·	·23
19	- -	·3	57·	—
20	- -	·3	55·5	—
21	- -	·3	53·5	—
22	- -	·4	54·	·17
23	- -	·4	54·5	·19
24	- -	·2	54·	·02
25	- -	·15	54·	·05
26	- -	·05	54·5	·15
27	- -	·1	54·5	·77
28	S. L.	S. L.	53·5	·24
29	·8	- -	53·5	·04
30	·9	- -	54·	- -
				2·15
October 1	·45	- -	54·	—
2	·3	- -	54·	—
3	·2	- -	55·	—
4	·2	- -	56·5	·11
5	·2	- -	57·	·19
6	1·15	- -	56·5	—
7	1·2	- -	56·	·05
8	·95	- -	56·	·58
9	1·5	- -	55·	·01
10	1·9	- -	55·	—
11	1·9	- -	55·	·40
12	1·8	- -	55·	·10
13	2·1	- -	54·	—
14	1·7	- -	54·	—
15	1·6	- -	54·	·16
16	1·9	- -	53·5	·27
17	2·15	- -	53·	—
18	1·8	- -	53·5	·07
19	1·6	- -	53·	—
20	1·3	- -	52·	—
21	1·95	- -	52·5	—
22	1·	- -	52·	—
23	·8	- -	52·5	—
24	·7	- -	53·	—
25	·45	- -	52·5	—
26	·5	- -	50·	—
27	·5	- -	48·	—
28	·25	- -	48·	—
29	·2	- -	47·5	—
30	·35	- -	47·	—
31	·4	- -	48·	·28
				2·22

1856:	Level of Water in the River. Above Summer Level.	Level of Water in the River. Below Summer Level.	Temperature of River Water.	Fall of Rain.
	Feet.	*Feet.*	°	*Inches.*
November 1	·55	- -	48·5	—
2	·65	- -	49·	—
3	·25	- -	48·5	—
4	·25	- -	47·5	—
5	·45	- -	47·5	—
6	·3	- -	45·	—
7	·25	- -	44·	—
8	S. L.	S. L.	45·	—
9	·2	- -	47·5	·18
10	·3	- -	43·	—
11	·2	- -	43·5	—
12	·3	- -	43·	·02
13	·3	- -	43·	—
14	·2	- -	40·	·04
15	·1	- -	39·	—
16	·2	- -	38·5	·02
17	- -	·1	39·	—
18	S. L.	S. L.	38·	·06
19	·2	- -	42·	·10
20	·2	- -	43·	·01
21	·2	- -	43·	·05
22	·1	- -	43·	—
23	·1	- -	41·	—
24	·2	- -	41·5	—
25	·2	- -	43·	—
26	·3	- -	42·5	·48
27	·4	- -	41·5	·03
28	·1	- -	41·5	·05
29	·4	- -	39·5	—
30	·4	- -	37·5	—
				1·04
December 1	·2	- -	35·	—
2	S. L.	S. L.	34·5	—
3	- -	·15	35·	·21
4	- -	·2	34·	·05
5	·2	- -	36·	·19
6	1·2	- -	41·	·06
7	1·9	- -	46·	·06
8	2·2	- -	47·	·02
9	1·95	- -	49·5	·09
10	1·8	- -	49·5	·17
11	2·3	- -	49·	·27
12	2·65	- -	48·	·28
13	3·5	- -	46·	·51
14	4·5	- -	44·	·01
15	4·6	- -	42·	—
16	3·2	- -	40·	—
17	2·6	- -	38·	—
18	2·6	- -	39·	·01
19	1·8	- -	39·	·04
20	1·5	- -	39·	—
21	1·25	- -	40·	—
22	1·2	- -	41·	—
23	·8	- -	42·	—
24	·75	- -	41·	·09
25	1·	- -	40·	—
26	1·05	- -	39·	—
27	·8	- -	38·	—
28	·8	- -	36·	—
29	·75	- -	33·	—
30	·4	- -	35·	·03
31	·1	- -	37·	—
				2·09

161 W. B. Hack, Engineer. 20 Engine runs and pumps that the engine only worked that portion of the hour. 1861

1857:		Level of Water in the River. Above Summer Level.	Level of Water in the River. Below Summer Level.	Temperature of River Water	Fall of Rain.
		Feet	Feet.	°	Inches.
January	1	·7	- -	40·	—
	2	·7	- -	41·5	·10
	3	·9	- -	41·5	·14
	4	1·4	- -	41·	·03
	5	1·8	- -	41·	·19
	6	1 8	- -	37·	·02
	7	1·7	- -	36·	—
	8	1·4	- -	36·	—
	9	1·2	- -	37·	·10
	10	1·9	- -	40·	·77
	11	3·8	- -	41·	·27
	12	5·4	- -	40·	·05
	13	5·6	- -	39·	—
	14	4·75	- -	37·	—
	15	4·3	- -	35·	—
	16	4·2	- -	34·	·13
	17	3·95	- -	35·	—
	18	3·2	- -	36·5	—
	19	2·7	- -	39·	·02
	20	2·3	- -	39·	·01
	21	2·5	- -	39·	·25
	22	2·95	- -	39·	—
	23	2·9	- -	38·5	·04
	24	2·75	- -	37·5	·05
	25	2·55	- -	38·	·14
	26	2·85	- -	37·	·09
	27	3·15	- -	36·5	·09
	28	2·95	- -	35·5	—
	29	2·4	- -	34·	—
	30	2·	- -	33·	—
	31	1·2	- -	34·	·27
					2·76
February	1	1·75	- -	33·	—
	2	1·4	- -	34·	—
	3	1·5	- -	34·	—
	4	1·45	- -	33·	—
	5	1·15	- -	33·	—
	6	·9	- -	36·	—
	7	1·2	- -	38·	—
	8	1·9	- -	37·	—
	9	2·3	- -	39·	—
	10	2·3	- -	40·	·10
	11	2·55	- -	40·	—
	12	2·4	- -	41·	—
	13	2·1	- -	40·	—
	14	1·7	- -	40·	—
	15	1·65	- -	40·	—
	16	1·7	- -	39·	—
	17	1·4	- -	39·5	—
	18	1·35	—	—	—
	19	1·2	- -	42·	—
	20	1·2	- -	42·5	—
	21	1·	- -	43·	—
	22	1·	- -	45·	—
	23	·95	- -	44·5	—
	24	·85	- -	44·	—
	25	·9	- -	43·	—
	26	·65	- -	42·	·03
	27	·7	- -	42·	—
	28	·65	- -	42·5	—
					·13

1857:		Level of Water in the River. Above Summer Level.	Level of Water in the River. Below Summer Level.	Temperature of River Water.	Fall of Rain.
		Feet.	Feet.	°	Inches.
March	1	·6	- -	43·	—
	2	·5	- -	44·	—
	3	·45	- -	44·	—
	4	·5	- -	44·	—
	5	·6	- -	43·	—
	6	·5	- -	44·	—
	7	·5	- -	45·	—
	8	·4	- -	44·	—
	9	·6	- -	41·	·09
	10	·4	- -	40·	·04
	11	·35	- -	40·	—
	12	·3	- -	39·	—
	13	·35	- -	39·5	·05
	14	·3	- -	41·5	·26
	15	·75	- -	44·	·10
	16	1·5	- -	43·	·02
	17	·9	- -	43·	—
	18	·8	- -	44·5	—
	19	·6	- -	47·	·10
	20	·5	- -	47·5	·04
	21	·5	- -	44·	·19
	22	·45	- -	42·	—
	23	·7	- -	43·	—
	24	·3	- -	42·	—
	25	·25	- -	43·	—
	26	·15	- -	42·	—
	27	·3	- -	44·	·01
	28	·2	- -	45·	—
	29	·15	- -	45·5	·05
	30	·4	- -	46·	·07
	31	·35	- -	47·	·12
					1·14
April	1	1·	- -	48·	—
	2	1·	- -	48·	·06
	3	1·15	- -	49·	·08
	4	1·15	- -	49·	·09
	5	1·3	- -	50·	·45
	6	2·3	- -	52·	·03
	7	2·45	- -	55·	—
	8	2·4	- -	53·	·17
	9	2·4	- -	52·5	·04
	10	2·15	- -	52·5	·01
	11	1·85	- -	54·	—
	12	1·7	- -	51·	·11
	13	1·1	- -	49·	·03
	14	1·15	- -	47·	·15
	15	1·35	- -	47·	—
	16	1·5	- -	47·	·12
	17	1·4	- -	47·	·10
	18	1·3	- -	48·	—
	19	·8	- -	51·	—
	20	·7	- -	53·	—
	21	·15	- -	54·	—
	22	·25	- -	54·	—
	23	·5	- -	52·	·12
	24	·5	- -	20·	—
	25	·5	- -	20·	—
	26	·5	- -	48·	—
	27	·5	- -	45·5	—
	28	·15	- -	45·	—
	29	·4	- -	45·	—
	30	S. L.	S. L.	46·5	·04
					1·60

1857:		Level of Water in the River. Above Summer Level.	Level of Water in the River. Below Summer Level.	Temperature of River Water.	Fall of Rain.
		Feet.	Feet.	°	Inches.
May	1	·3	- -	46·5	—
	2	·2	- -	48·	—
	3	S. L.	S. L.	48·5	—
	4	·3	- -	48·	—
	5	- -	·1	48·	—
	6	·25	- -	49·	—
	7	S. L.	S. L.	48·	—
	8	·1	- -	48·	—
	9	S. L.	S. L.	50·	—
	10	·1	- -	52·	—
	11	·1	- -	52·5	—
	12	S. L.	S. L.	54·	—
	13	·1	- -	56·	·02
	14	·05	- -	58·	—
	15	S. L.	S. L.	60·	—
	16	- -	·1	62·	—
	17	·2	- -	63·	—
	18	- -	·3	63·5	—
	19	- -	·1	65·	—
	20	- -	·4	64·	—
	21	- -	·3	64·	—
	22	- -	·3	62·	·03
	23	- -	·2	59·5	·38
	24	- -	·05	60·5	·05
	25	- -	·2	62·	—
	26	- -	·1	61·5	·10
	27	- -	·1	61·5	—
	28	- -	·2	62·	—
	29	- -	·2	62·	—
	30	- -	·2	61·	·01
	31	- -	·2	61·	—
					·59
June	1	- -	·25	61·5	—
	2	- -	·4	61·	—
	3	- -	·3	61·5	—
	4	- -	·35	62·	·07
	5	- -	·4	65·	—
	6	- -	·2	67·	—
	7	- -	·1	68·	·32
	8	- -	·2	65·	·05
	9	- -	·1	63·	·55
	10	- -	·05	61·5	·22
	11	·1	- -	62·	·01

1857:		Level of Water in the River. Above Summer Level.	Level of Water in the River. Below Summer Level.	Temperature of River Water.	Fall of Rain.
		Feet.	Feet.	°	Inches.
June	12	S. L.	S. L.	62·5	·02
	13	S. L.	S. L.	62·	—
	14	S. L.	S. L.	62·5	—
	15	- -	·2	63·	—
	16	- -	·2	62·	—
	17	- -	·2	61·5	—
	18	- -	·1	62·	—
	19	- -	·2	63·5	—
	20	- -	·2	66·5	·52
	21	S. L.	S. L.	69·	·50
	22	·3	- -	68·5	—
	23	·4	- -	68·5	—
	24	·25	- -	70·	—
	25	·1	- -	71·5	—
	26	S. L.	S. L.	71·5	—
	27	S. L.	S. L.	72·5	—
	28	S. L.	S. L.	74·	—
	29	- -	·4	73·	—
	30	- -	·3	70·	·14
					2·40
July	1	- -	·35	69·	—
	2	- -	·2	66·5	·25
	3	- -	·1	66·	—
	4	- -	·1	65·	·08
	5	S. L.	S. L.	65·	·08
	6	- -	·1	65·	·10
	7	·1	- -	64·	·09
	8	·1	- -	63·	—
	9	S. L.	S. L.	62·5	—
	10	S. L.	S. L.	64·	—
	11	- -	·2	65·5	·01
	12	- -	·1	66·	—
	13	- -	·1	68·5	—
	14	- -	·3	71·	—
	15	- -	·3	72·	—
	16	- -	·4	72·	—
	17	- -	·3	70·	·14
	18	- -	·4	70·5	—
	19	- -	·5	70·5	—

No. of Engine-repairs that the engine only worked that portion of the hour. W. B. Hach, Engineer.

Ordered by the House of Commons to be Printed, 1st July 1858.

Appendix III.—*continued.*

12.—TABLE showing the Districts and Sub-Districts into which the Metropolis is divided, the Area in Acres, the Population in 1851, the Number per Acre and the Number per Square Mile, together with the Assumed Number to which the Population will increase.

NAME of SUB-DISTRICT.	Area in Acres.	POPULATION in 1851.				Assumed Number to which the Population will increase.			
		Number per Acre.	Number per Square Mile.	Actual Number.	TOTAL.	Number per Acre.	Number per Square Mile.	Actual Number.	TOTAL.
LONDON:									
1— 6 West Districts	10,387	36·	23,040	376,427		45·	28,800	469,674	
7—11 North Districts	13,533	36·	23,040	490,396		63·	40,320	871,385	
12—19 Central Districts	1,839	214·	136,960	393,256		217·	138,880	399,256	
20—25 East Districts	5,797	84·	53,760	485,522		106·	67,840	614,910	
26—36 South Districts	43,695	14·	8,960	616,635		28·	17,920	1,222,864	
Total	75,251	31·	19,840	- -	2,362,236	47.	30,080	- -	3,578,089
NORTH SIDE OF THAMES.									
1. Kensington:									
1. Paddington, St. Mary	827	21·	13,351·0	17,252	- -	46·8	30,000	38,765	
2. Paddington, St. John	450	65·	41,600·	29,053	- -	65·	41,600	29,053	
3. Kensington Town	1,244	23·	15,013·7	29,183	- -	31·2	20,000	38,875	
4. Brompton	698	21·	13,634·4	14,870	- -	46·8	30,000	32,727	
5. Hammersmith, St. Peter	189	23·6	15,126·	4,467	- -	34·4	22,011	6,500	
6. Hammersmith, St. Paul	2,103	6·	4,045·4	13,293	- -	9·5	6,080	20,000	
7. Fulham	1,684	7·	4,517·2	11,886	- -	17·8	11,401	30,000	
2. Chelsea:									
8. Chelsea, South	303	62·2	30,808·	19,050	- -	62·2	39,808	19,050	
9. Chelsea, North-west	213	83·	53,090·0	17,669	- -	117·3	74,880	25,000	
10. Chelsea, North-east	284	70·	44,662·5	19,819	- -	87·4	55,955	24,819	
3. St. George, Hanover-square:									
11. Hanover-square	445	45·	28,800·	20,216	- -	45·	28,800	20,216	
12. Mayfair	136	95·	60,800·	12,980	- -	95·	60,800	12,980	
13. Belgrave	525	76·	48,803·3	40,034	- -	85·7	54,848	45,034	
4. Westminster:									
14. St. John	210	163·	104,320·	34,295	- -	163·	104,320	34,295	
15. St. Margaret	629	49·7	31,808·	31,314	- -	49·7	31,808	31,314	
5. St. Martin-in-the-Fields:									
16. Charing-Cross	241	52·	33,280·	12,587	- -	52·	33,280	12,587	
17. Long Acre	42	287·	183,680·	12,053	- -	287·	183,680	12,053	
6. St. James, Westminster:									
18. Berwick-street	25	432·	276,480·	10,798	- -	432·	276,480	10,798	
19. St. James-square	85	135·	86,400·	11,469	- -	135·	86,400	11,469	
20. Golden-square	54	262·	167,680·	14,139	- -	262·	167,680	14,139	
7. Marylebone:									
21. All Souls	112	258·	165,120·	28,841	- -	258·	165,120	28,841	
22. Cavendish-square	113	130·	83,206·	14,687	- -	130·	83,200	14,687	
23. Rectory	116	238·	152,320·	27,633	- -	238·	152,320	27,633	
24. St. Mary	108	211·	135,040·	22,814	- -	211·	135,040	22,814	
25. Christ Church	518	65·	41,600·	33,895	- -	65·	41,600	33,895	
26. St. John	542	55·	35,?18·9	29,826	- -	62·5	40,000	33,875	
8. Hampstead:									
27. Hampstead	2,252	5·	3,406·3	11,986	- -	44·4	28,416	100,000	
9. Pancras:									
28. Regent's Park	427	75·	48,000·	31,918	- -	75·	48,000	31,918	
29. Tottenham Court	145	196·	125,440·	28,433	- -	196·	125,440	28,433	
30. Grays-Inn-lane	155	171·	109,440·	26,523	- -	171·	109,440	26,523	
31. Somers Town	184	194·	124,160·	35,641	- -	194·	124,160	35,641	
32. Camden Town	171	123·	78,720·	21,115	- -	123·	78,720	21,115	
33. Kentish Town	1,634	14·	9,136·2	23,326	- -	61·2	39,168	100,000	
10. Islington:									
34. Islington, West	1,228	39·	24,954·2	47,881	- -	78·1	50,000	95,931	
35. Islington, East	1,899	25·	15,990·9	47,448	- -	78·1	50,000	148,349	

NAME of SUB-DISTRICT.	Area in Acres.	POPULATION in 1851.				Assumed Number to which the Population will increase.			
		Number per Acre.	Number per Square Mile.	Actual Number.	TOTAL.	Number per Acre.	Number per Square Mile.	Actual Number.	TOTAL.
North Side of Thames—*continued.*									
11. Hackney:									
36. Stoke Newington	639	8·	4,847·5	4,840	- -	23·4	15,000	14,978	
37. Stamford Hall	615	9·	5,774·5	5,549	- -	23·4	15,000	14,415	
38. West Hackney	472	40·	25,399·3	18,732	- -	46·8	30,000	22,122	
39. Hackney	1,731	12·	7,708·8	20,850	- -	31·2	20,000	54,093	
40. South Hackney	472	18·	11,468·4	8,458	- -	46·8	30,000	22,122	
12. St. Giles:									
41. St. George, Bloomsbury	122	138·	88,320·	16,807	- -	138·	88,320	16,807	
42. St. Giles, South	63	317·	202,880·	19,951	- -	317·	202,880	19,951	
43. St. Giles, North	60	291·	186,240·	17,456	- -	291·	186,240	17,456	
13. Strand:									
44. St. Anne, Soho	53	327·	209,280·	17,335	- -	327·	209,280	17,335	
45. St. Mary-le-Strand	53	219·	140,160·	11,615	- -	219·	140,160	11,615	
46. St. Clement Danes	36	430·8	275,712·	15,510	- -	430·8	275,712	15,510	
14. Holborn:									
47. St. George-the-Martyr	103	183·	117,120·	18,813	- -	183·	117,120	18,813	
48. St. Andrew, Eastern	33	423·	270,720·	13,971	- -	423·	270,720	13,971	
49. Saffron Hill	60	231·	147,840·	13,837	- -	231·	147,840	13,837	
15. Clerkenwell:									
50. St. James	74	291·	186,240·	21,529	- -	291·	186,240	21,529	
51. Amwell	82	192·	122,880·	15,720	- -	192·	122,880	15,720	
52. Pentonville	134	89·	56,960·	11,904	- -	89·	56,960	11,904	
53. Goswell-street	90	174·	111,360·	15,625	- -	174·	111,360	15,625	
16. St. Luke:									
54. Old street	52	204·	130,560·	10,617	- -	204·	130,560	10,617	
55. City-road	77	219·	140,160·	16,840	- -	219·	140,160	16,840	
56. Whitecross-street	33	414·	264,960·	13,657	- -	414·	264,960	13,657	
57. Finsbury	58	223·	142,720·	12,941	- -	223·	142,720	12,941	
17. East London:									
58. St. Botolph	85	280·	179,200·	23,824	- -	280·	179,200	23,824	
59. Cripplegate	68	303·	193,920	20,582	- -	303·	193,920	20,582	
18. West London:									
60. West London, North	47	275·	176,000·	12,946	- -	275·	176,000	12,946	
61. West London, South	77	205·7	131,648·	15,844	- -	205·7	131,648	15,844	
19. City of London:									
62. City of London, South-west	49	187·8	120,192·	9,204	- -	187·8	120,192	9,204	
63. City of London, North-west	72	165·	105,600·	11,847	- -	165·	105,600	11,847	
64. City of London, South	82	139·7	89,408·	11,461	- -	139·7	89,408	11,461	
65. City of London, South-east	84	126·	80,640·	10,594	- -	126·	80,640	10,594	
66. City of London, North-east	92	139·	88,960·	12,826	- -	139·	88,960	12,826	
20. Shoreditch:									
67. Holywell	68	254·	162,560·	17,245	- -	254·	162,560	17,245	
68. St. Leonard	75	259·	165,760·	19,449	- -	259·	165,760	19,449	
69. Hoxton New Town	130	181·	115,840·	23,505	- -	181·	115,840	23,505	
70. Hoxton Old Town	116	150·	96,000·	17,431	- -	150·	96,000	17,431	
71. Haggerston, West	132	154·	98,560·	20,276	- -	154·	98,560	20,276	
72. Haggerston, East	125	91·	58,117·1	11,351	- -	101·5	65,000	12,695	
21. Bethnal Green:									
73. Hackney-road	141	170·	108,800·	23,910	- -	170·	108,800	23,910	
74. Green	391	60·	38,555·5	23,555	- -	85·8	54,924	33,555	
75. Church	132	165·	105,600·	21,787	- -	165·	105,600	21,787	
76. Town	96	218·	139,520·	20,941	- -	218·	139,520	20,941	
22. Whitechapel:									
77. Artillery	25	271·	173,440·	6,769	- -	271·	173,440	6,769	
78. Spitalfields	53	289·	184,960·	15,336	- -	289·	184,960	15,336	
79. Mile End New Town	64	227·	145,280·	14,543	- -	227·	145,280	14,543	
80. Whitechapel, North	58	216·	138,240·	12,530	- -	216·	138,240	12,530	
81. Whitechapel Church	47	166·	10,624·	7,818	- -	166·	106,240	7,818	
82. Goodman's Fields	51	237·	151,680·	12,069	- -	237·	151,680	12,069	
83. Aldgate	85	125·8	80,512·	10,694	- -	125·8	80,512	10,694	

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W. B. Hoath, Engineer.
Engine represents that the engine only worked that portion of the hour.
21 May 1857.

NAME of SUB-DISTRICT.	Area in Acres.	POPULATION in 1851. Number per Acre.	Number per Square Mile.	Actual Number.	TOTAL.	Assumed Number to which the Population will increase. Number per Acre.	Number per Square Mile.	Actual Number.	TOTAL.
NORTH SIDE OF THAMES—*continued.*									
23. ST. GEORGE-IN-THE-EAST:									
84. St. Mary	62	291·	186,240·	18,067	- -	291·	186,240	18,067	
85. St. Paul	84	242·	154,880·	20,319	- -	242·	154,880	20,319	
86. St. John	97	103·	65,920·	9,990	- -	103·	65,920	9,990	
24. STEPNEY:									
87. Shadwell	109	148·	94,720·	16,179	- -	148·	94,720	16,179	
88. Ratcliff	113	134·	5,760·	15,212	- -	134·	85,760	15,212	
89. Mile End Old Town, Upper	191	155·	99,200·	29,582	- -	155·	99,200	29,582	
90. Mile End Old Town, Lower	490	55·	35,290·9	27,020	- -	101·5	65,600	49,735	
91. Limehouse	249	91·	58,556·1	22,782	- -	101·5	65,000	25,273	
25. POPLAR:									
92. Bow	1,428	13·	8,415·8	18,778	- -	52·5	33,600	75,000	
93. Poplar	1,185	24·	15,329.7	28,384	- -	54·8	35,072	65,000	
TOTAL on North Side	31,556	55·4	35,520·	- -	1,745,601	75·	48,000	- -	2,355,225
AREA, TERMED PROSPECTIVE, BY MR. BAZALGETTE.									
Chiswick	1,311	4·8	3,072·	6,303					
Brentford, Ealing	4,034	2·9	1,856·	11,891	- -	–	- -	60,000	
Acton	3,626	1·1	732·	4,150					
ADDITIONAL AREA PROVIDED FOR:									
Willesden	4,190	–	- -	2,939					
East Ham	2,455	–	- -	1,550	- -	–	- -	36,000	
Barking	6,000	–	- -	4,930					
Valley of the Lea	74,598	–	- -	59,432	- -	–	- -	100,000	
					91,195				196,000
TOTAL on North Side, including Prospective Area	96,216	19·	12,160·	- -	1,836,796	–	- -	- -	2,551,225
SOUTH SIDE OF THAMES:									
26. ST. SAVIOUR'S, SOUTHWARK:									
94. Christchurch	74	216·	138,240·	16,022	- -	216·	138,240	16,022	
95. St. Saviour's	126	156·	99,840·	19,709	- -	156·	99,840	19,709	
27. ST. OLAVE, SOUTHWARK:									
96. St. Olave	56	143·	91,520·	8,015	- -	143·	91,520	8,015	
97. St. John, Horsleydown	69	164·6	105,344·	11,360	- -	164·6	105,344	11,360	
28. BERMONDSEY:									
98. St. James	427	44·	28,326·3	18,899	- -	101·5	65,000	43,340	
99. St. Mary Magdalen	142	98·	62,801·0	13,934	- -	101·5	65,000	14,421	
100. Leather Market	92	166·	106,240·	15,295	- -	166·	106,240	15,295	
29. ST. GEORGE, SOUTHWARK:									
101. Kent-road	105	173·	110,720·	18,126	- -	173·	110,720	18,126	
102. Borough-road	65	244·	156,160·	15,862	- -	244·	156,160	15,862	
103. London-road	112	159·	101,760·	17,836	- -	159·	101,760	17,836	
30. NEWINGTON:									
104. Trinity	142	147·	94,922·	20,922	- -	147·	94,080	20,922	
105. St. Peter, Walworth	321	93·	59,535·8	29,861	- -	109·4	70,000	35,117	
106. St. Mary	161	87·	55,783·3	14,033	- -	108·3	69,299	17,433	
31. LAMBETH:									
107. Waterloo-road, 1st	68	207·	132,480·	14,088	- -	207·	132,480	14,088	
108. Waterloo-road, 2d	99	185·	118,400·	18,348	- -	185·	118,400	18,348	
109. Lambeth Church, 1st	154	119·	76,160·	18,409	- -	119·	76,160	18,409	
110. Lambeth Church, 2d	186	144·	92,160·0	26,784	- -	144·	92,160	26,784	
111. Kennington, 1st	452	53·	34,351·8	24,261	- -	79·8	50,615	35,847	
112. Kennington, 2d	510	57·	23,652·4	18,848	- -	62·5	40,000	31,875	
113. Brixton	1,445	10·	6,470·8	14,610	- -	34·6	22,144	50,000	
114. Norwood	976	4·	2,607·8	3,977	- -	30·7	19,648	30,000	

NAME of SUB-DISTRICT.	Area in Acres.	POPULATION in 1851. Number per Acre.	Number per Square Mile.	Actual Number.	TOTAL.	Assumed Number to which the Population will increase. Number per Acre.	Number per Square Mile.	Actual Number.	TOTAL.
SOUTH SIDE OF THAMES—*continued.*									
32. WANDSWORTH:									
115. Clapham	1,233	13·	8,455·4	16,290	- -	23·4	15,000	28,852	
116. Battersea	2,177	5·	3,097·3	10,560	- -	31·2	20,000	67,922	
117. Wandsworth	2,432	4·	2,529·2	9,611	- -	20·5	13,120	50,000	
118. Putney	2,136	2·	1,582·0	5,280	- -	11·	7,021	24,991	
119. Streatham	3,465	3·	1,666·5	9,023	- -	7·8	5,000	27,027	
33. CAMBERWELL:									
120. Dulwich	1,423	1·1	704·	1,632	- -	10·5	6,720	15,000	
121. Camberwell	1,339	13·	8,480·1	17,742	- -	29·8	19,072	40,000	
122. Peckham	1,146	17·	10,858·7	19,444	- -	31·2	20,000	35,755	
123. St. George	434	37·	23,371·8	15,849	- -	46·8	30,000	20,311	
34. ROTHERHITHE:									
124. Rotherhithe	749	23·7	15,210·7	17,805	- -	46·8	30,000	35,053	
35. GREENWICH:									
125. St. Paul, Deptford	1,587	15·7	10,041·8	24,899	- -	31·2	20,000	49,514	
126. St. Nicholas, Deptford	110	64·3	41,152·	7,071	- -	64·3	41,152	7,071	
127. Greenwich, West	301	62·5	40,000·	18,800	- -	62·5	40,000	18,812	
128. Greenwich, East	1,425	11·	7,288·3	16,228	- -	31·2	20,000	44,460	
129. Woolwich Dockyard	411	41·7	26,690·0	17,140	- -	62·5	40,000	25,687	
130. Woolwich Arsenal	756	20·	12,890·5	15,227	- -	62·5	40,000	47,093	
36. LEWISHAM:									
131. Plumstead	4,622	2·8	1,826·5	13,191	- -	21·9	14,016	101,634	
132. Eltham	4,350	·7	377·8	2,568	- -	2·3	1,472	10,000	
133. Lee	2,399	4·	2,261·7	8,478	- -	6·2	4,000	14,873	
134. Lewisham Village, Sydenham	5,418	2·	1,251·9	6,097 / 4,501	- -	14·7	9,408	80,000	
TOTAL on South Side	43,695	14·	8,960·	- -	616,635	28·	17,920	- -	1,222,864
AREA, TERMED PROSPECTIVE, BY MR. BAZALGETTE.									
Richmond	1,230	7·5	4,800·	9,255					
Mortlake (including East Sheen)	1,168	2·6	1,664·	3,110					
Barnes	936	1·7	1,088·	1,879					
Kew	230	4·3	2,752·	1,009	17,946	–	- -		65,000
ADDITIONAL AREA PROVIDED FOR:									
Wimbledon	3,700	·7	467·	2,693					
	7,264	2·4	1,536·						
Valley of the Wandle and of the Baveley Brook:									
Beddington, Wallington	3,909	–	- -	522 / 881					
Carshalton	2,904	–	- -	2,411					
Mitcham	2,893	–	- -	4,641	13,477	–	- -		40,000
Cheam	1,894	–	- -	1,137					
Sutton	1,803	–	- -	1,387					
Mordon	1,422	–	- -	628					
Merton	1,780	–	- -	1,870					
	16,605								
Valley of the Ravensbourne:									
Addington	3,900	–	- -	615					
Beckenham	3,875	–	- -	1,688					
Bromley	4,646	–	- -	4,127					
Chiselhurst	2,738	–	- -	2,088					
Farnborough	1,412	–	- -	920	31,458	–	- -		100,000
Hayes	1,272	–	- -	552					
Keston	1,474	–	- -	644					
Wickambreaux	2,310	–	- -	481					
Croydon	9,821	–	- -	20,343					
	31,448								

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W. B. Hack, Engineer.
No. of Engine represents that the engine only worked that portion of the hour, 4, 4½ and 4 placed over the No. of Engines which worked.
21 May 1857.

13.—TABLE, showing the Amount of POPULATION, Present and Prospective, for which provision will be made by the several High Level and Low Level Intercepting Sewers.

	Point of Accumulation of Sewage.	DISTRICT. No.	DISTRICT. Name.	Population in 1851.	Accumulated Population in 1851.	Number of Acres in District.	ASSUMED POPULATION. No. Per Acre.	ASSUMED POPULATION. Actual Number.	ASSUMED POPULATION. Accumulated Total.	PROSPECTIVE. Sewage in Eight Hours Flow.	PROSPECTIVE. Rainfall in Eight Hours.	PROSPECTIVE. Total.	Accumulated Total of Eight Hours Sewage and Rainfall in the London Districts only.
										Cubic feet.	*Cubic feet.*	*Cubic feet.*	
North Side of the Thames.													
High Level.	Stamford Brook Sewer.	6	Hammersmith, St. Paul's (part of).	2,215	2,215	350	9·5	3,333	3,333	11,666	58,328	69,994	69,994
	Counters Creek Sewer.	8	Kensington Town (one-half)	14,592	- -	622	31	19,488	- -	68,033	340,165	408,198	
		10	Chelsea N. E. (one fourth) -	4,954	- -	71	87	6,205	- -	21,718	103,092	124,810	
		14	Westminster, St. John (one-twentieth).	1,715	- -	10	163	1,715	- -	6,002	14,520	20,522	
				21,262	23,477	703	- -	27,358	30,691	96,753	457,777	553,530	623,524
	Ranelagh Sewer.	1	Paddington, St. Mary - -	17,252	- -	827	47	38,765	- -	135,678	678,387	814,065	
		2	Ditto St. John - -	29,053	- -	450	65	29,053	- -	101,685	508,427	610,112	
		26	St. John, Marylebone (two-thirds).	19,884	- -	361	63	22,583	- -	79,040	395,200	474,240	
		27	Hampstead (one-half) - -	5,993	- -	1,126	44	50,000	- -	175,000	875,000	1,050,000	
		25	Christchurch (one-third) -	11,298	- -	172	65	11,298	- -	39,543	197,715	237,258	
				83,480	106,957	2,936	- -	151,699	182,390	530,946	2,654,729	3,185,675	3,809,199
	King's Scholars' Pond Sewer.	11	Hanover-square - - -	20,216	- -	445	45	20,216	- -	70,756	353,780	424,536	
		12	May Fair - - - -	12,980	- -	136	95	12,980	- -	45,430	197,472	242,902	
		19	St. James's-square (one-half)	5,734	- -	42	135	5,734	- -	20,069	60,984	81,053	
		20	Golden-square (one-fourth) -	3,535	- -	13	262	3,535	- -	12,372	18,876	31,248	
		22	Cavendish-square (nine-tenths).	13,218	- -	102	130	13,218	- -	46,263	148,104	194,367	
		23	Rectory - - - -	27,633	- -	116	238	27,633	- -	96,716	168,432	265,148	
		24	St. Mary, Marylebone - -	22,814	- -	108	211	22,814	- -	79,849	156,816	236,665	
		25	Christchurch (one-third) -	11,298	- -	173	65	11,298	- -	39,543	197,715	237,258	
		26	St. John, Marylebone (one-third).	9,942	- -	181	63	11,292	- -	39,522	197,610	237,132	
		27	Hampstead (one-sixth) -	1,998	- -	375	44	16,667	- -	58,335	291,672	350,007	
				129,368	236,325	1,691	- -	145,387	327,777	508,855	1,791,461	2,300,316	6,109,515
	Regent-street Sewer.	19	St. James's-square (one-third)	3,823	- -	28	135	3,823	- -	13,381	40,656	54,037	
		20	Golden-square (one-third) -	4,713	- -	18	262	4,713	- -	16,495	26,136	42,031	
		21	All Souls (one-tenth) - -	2,884	- -	11	258	2,884	- -	10,094	15,972	26,066	
		22	Cavendish-square (one-tenth)	1,469	- -	11	130	1,469	- -	5,142	15,972	21,114	
		25	Christchurch (one-third) -	11,299	- -	173	65	11,299	- -	39,546	197,733	237,279	
		28	Regent's Park (one-half) -	15,959	- -	214	75	15,959	- -	55,857	279,282	335,139	
				40,147	276,472	455	- -	40,147	367,924	140,515	575,751	716,266	6,825,781
	Northumberland-street Sewer.	16	Charing Cross (one-third) -	4,196	- -	80	52	4,196	- -	14,686	73,430	88,116	
		17	Long Acre (one-half) - -	6,026	- -	21	287	6,026	- -	21,091	30,492	51,583	
		18	Berwick-street - - -	10,798	- -	25	432	10,798	- -	37,793	36,300	74,093	
		44	St. Anne, Soho - - -	17,335	- -	53	327	17,335	- -	60,673	76,956	137,629	
		20	Golden-square (part of) -	5,801	- -	23	262	5,801	- -	20,617	33,396	54,013	
		21	All Souls (nine-tenths) -	25,957	- -	101	258	25,957	- -	90,850	146,652	237,502	
		29	Tottenham Court (one-half)	14,217	- -	73	196	14,217	- -	49,761	105,996	155,757	
		43	St. Giles, North (two thirds)	11,637	- -	40	291	11,637	- -	40,729	58,080	98,809	
				96,057	372,529	416	- -	96,057	463,981	336,200	561,302	897,502	7,723,283
	Savoy-street Sewer.	17	Long Acre (one-half) -	6,027	- -	21	287	6,027	- -	21,094	30,492	51,586	
		28	Regent's Park (one-sixth) -	5,320	- -	71	75	5,320	- -	18,620	93,100	111,720	
		29	Tottenham Court (one-half)	14,216	- -	72	196	14,216	- -	49,756	104,544	154,300	
		41	St. George's, Bloomsbury -	16,807	- -	122	138	16,807	- -	58,825	177,144	235,969	
		42	St. Giles, South - - -	19,951	- -	63	317	19,951	- -	69,828	91,476	161,304	
		43	Ditto, North (one-third) -	5,819	- -	20	291	5,819	- -	20,366	29,040	49,406	
		45	St. Mary-le-Strand (two-thirds).	7,743	- -	35	219	7,743	- -	27,101	50,820	77,921	
				75,883	448,412	404	- -	75,883	539,864	265,590	576,616	842,206	8,565,489
	Norfolk-street Sewer.	46	St. Clement Danes (part) -	3,447	451,859	8	431	3,447	543,311	12,064	11,616	23,680	8,589,169
	Essex-street Sewer	46	St. Clement Danes (part) - five eighteenths.	4,308	456,167	10	431	4,308	547,619	15,078	14,520	29,598	8,618,767
	Fleet Sewer -	27	Hampstead (one-third) -	3,995	- -	751	44·4	33,333	- -	116,665	583,327	699,992	
		28	Regent's Park (part of) -	10,039	- -	142	75	10,039	- -	37,237	186,183	223,420	
		30	Gray's Inn-lane - - -	26,523	- -	155	171	26,523	- -	92,830	225,060	317,890	
		31	Somers-town - - -	35,641	- -	184	104	35,641	- -	124,744	267,168	391,912	
		32	Camden-town - -	21,115	- -	171	123	21,115	- -	73,902	248,292	322,194	

(continued)

Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine represents that the engine only worked that portion of the hour.

W. B. Hack, Engineer.

13.—TABLE, showing the Amount of Population, Present and Prospective, for which provision will be made by the several High Level and Low Level Intercepting Sewers—*continued.*

	Point of Accumulation of Sewage.	DISTRICT. No.	DISTRICT. Name.	Population in 1851.	Accumulated Population in 1851.	Number of Acres in District.	ASSUMED POPULATION. Number Per Acre.	ASSUMED POPULATION. Actual Number.	ASSUMED POPULATION. Accumulated Total.	PROSPECTIVE. Sewage in Eight Hours Flow.	PROSPECTIVE. Rainfall in Eight Hours.	PROSPECTIVE. Total.	Accumulated Total of Eight Hours Sewage and Rainfall in the London Districts only.
North Side of the Thames—*continued.*										*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	
High Level—*continued.*		33	Kentish-town	23,326	- -	1,634	61	100,000	- -	350,000	1,750,000	2,100,000	
		34	Islington, West (one-half)	23,040	- -	614	78	47,965	- -	167,878	839,387	1,007,265	
		47	St. George-the-Martyr	18,813	- -	103	183	18,813	- -	65,846	149,556	215,402	
		48	St. Andrew, Eastern	13,971	- -	33	423	13,971	- -	48,899	47,916	96,815	
		49	Saffron-hill	13,837	- -	60	231	13,837	- -	48,429	87,120	135,549	
		50	St. James, Clerkenwell	21,529	- -	74	291	21,529	- -	75,351	107,448	182,799	
		51	Amwell	15,720	- -	82	192	15,720	- -	55,020	119,064	174,084	
		52	Pentonville	11,904	- -	134	89	11,904	- -	41,664	194,568	236,232	
		53	Goswell-street	15,625	- -	90	174	15,625	- -	54,688	130,680	185,368	
		60	West London, North (nine-tenths).	11,051	- -	42	275	11,051	- -	40,778	60,984	101,762	
		61	Ditto - South (one-third).	5,281	- -	26	206	5,281	- -	18,484	37,752	56,236	
		62	City of London, South-West (one-half).	4,602	- -	25	188	4,602	- -	16,107	36,300	52,407	
				278,112	734,279	4,320	- -	408,149	955,768	1,428,522	5,070,805	6,499,327	15,118,094
	London Bridge Sewer.	35	Islington, East	23,724	- -	949	78	74,174	- -	259,609	1,298,045	1,557,654	
		38	West Hackney	9,366	- -	236	47	11,061	- -	38,714	193,568	232,282	
		54	Old-street	10,617	- -	52	204	10,617	- -	37,159	75,504	112,663	
		55	City-road	16,840	- -	77	219	16,840	- -	58,940	111,804	170,744	
		56	Whitecross-street	13,657	- -	33	414	13,657	- -	47,800	47,916	95,716	
		57	Finsbury	12,041	- -	58	223	12,041	- -	45,203	84,216	129,509	
		58	St. Botolph	28,824	- -	85	280	23,824	- -	83,384	123,420	206,804	
		59	Cripplegate	20,582	- -	68	303	20,582	- -	72,037	98,736	170,773	
		63	City of London, North-West	11,847	- -	72	165	11,847	- -	41,465	104,544	146,009	
		64	Ditto - - South (two-thirds).	7,641	- -	55	140	7,641	- -	26,743	79,860	106,603	
		65	Ditto - - South-East (three-fourths).	7,946	- -	63	126	7,946	- -	27,811	91,476	119,287	
		66	Ditto - - North-East	12,826	- -	92	139	12,826	- -	44,891	133,584	178,475	
		67	Holywell	17,245	- -	68	254	17,245	- -	60,358	98,736	159,094	
		68	St. Leonard	19,449	- -	75	259	19,449	- -	68,071	108,900	176,971	
		69	Hoxton, New Town	23,505	- -	130	181	23,505	- -	82,268	188,760	271,028	
		70	Hoxton, Old Town	17,431	- -	116	150	17,431	- -	61,008	168,432	229,440	
		71	Haggerstone, West	20,276	- -	132	154	20,276	- -	70,966	191,664	262,630	
		72	Ditto - East	11,351	- -	125	102	12,695	- -	44,433	181,500	225,933	
		73	Hackney-road (one-half)	11,955	- -	70	170	11,955	- -	41,842	101,640	143,482	
		77	Artillery	6,769	- -	25	271	6,769	- -	23,692	36,300	59,992	
		78	Spitalfields	15,336	- -	53	289	15,336	- -	53,676	76,956	130,632	
				315,128	1,049,407	2,634	- -	368,017	1,324,385	1,290,160	3,595,561	4,885,721	20,003,815
	Ratcliffe Cross Sewer.	40	South Hackney (one-third)	2,819	- -	157	47	7,374	- -	25,809	129,045	154,854	
		73	Hackney road (one-half)	11,955	- -	71	170	11,955	- -	41,842	103,092	144,934	
		75	Church, Bethnal Green	21,787	- -	132	165	21,787	- -	76,255	191,664	267,919	
		76	Town, - - ditto	20,941	- -	96	218	20,941	- -	73,293	139,392	212,685	
		79	Mile End New Town	14,543	- -	64	227	14,543	- -	50,901	92,928	143,829	
		80	Whitechapel, North	12,530	- -	58	216	12,530	- -	43,855	84,216	128,071	
		81	Ditto, Church	7,818	- -	47	166	7,818	- -	27,363	68,244	95,607	
		82	Goodman's Fields	12,069	- -	51	237	12,069	- -	42,241	74,052	116,293	
		83	Aldgate (one-third)	3,565	- -	28	126	3,565	- -	12,478	40,656	53,134	
		84	St. Mary-in-the-East (one-half).	9,034	- -	31	291	9,034	- -	31,619	45,012	76,631	
		85	St. Paul-in-the East	20,319	- -	84	242	20,319	- -	71,116	121,068	193,084	
		88	Ratcliffe (one-half)	7,006	- -	57	134	7,006	- -	26,021	82,764	109,385	
		89	Mile End, Old Town, Upper	20,582	- -	101	155	20,582	- -	103,537	277,332	380,869	
				174,568	1,223,975	1,007	- -	179,123	1,503,508	626,930	1,450,365	2,077,295	22,081,110
	Limekiln Dock Sewer.	74	Green (Bethnal Green)	23,555	- -	391	86	33,555	- -	117,443	567,732	685,175	
		90	Mile End, Old Town, Lower	27,020	- -	490	102	49,735	- -	174,072	711,480	885,552	
		91	Limehouse (one-quarter)	5,605	- -	62	102	6,318	- -	22,113	90,024	112,137	
		92	Bow (one-third)	6,250	- -	476	53	25,000	- -	87,500	437,500	525,000	
				62,529	1,286,504	1,419	- -	114,608	1,618,116	401,128	1,806,736	2,207,864	24,288,974
	Hackney Brook Sewer.	34	Islington, West (one-half)	23,941	- -	614	78	47,966	- -	167,881	839,405	1,007,286	
		35	Ditto, East (one-half)	23,724	- -	950	78	74,175	- -	259,613	1,298,062	1,557,675	
		36	Stoke Newington	4,840	- -	639	23	14,978	- -	52,423	262,115	314,538	
		37	Stamford-hill	5,549	- -	615	23	14,415	- -	50,452	252,263	302,715	
		38	West Hackney (one-half)	9,366	- -	236	47	11,061	- -	38,714	193,567	232,281	
		39	Hackney (part of)	10,850	- -	901	31	27,950	- -	96,800	484,033	580,833	
		40	South Hackney (two-thirds)	5,639	- -	315	47	14,748	- -	51,618	258,090	309,708	
		92	Bow (one-third)	6,250	- -	476	53	25,000	- -	87,500	437,500	525,000	
				90,108	1,376,672	4,746	- -	230,002	1,848,118	805,007	4,025,035	4,830,042	29,119,016

(*continued*)

Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine represents that the engine only worked that portion of the hour.

21 May 1857.

W. B. Hach, Engineer.

13.—TABLE, showing the Amount of Population, Present and Prospective, for which provision will be made by the several High Level and Low Level Intercepting Sewers—*continued.*

	Point of Accumulation of Sewage.	DISTRICT. No.	DISTRICT. Name.	Population in 1851.	Accumulated Population in 1851.	Number of Acres in District.	ASSUMED POPULATION. No. Per Acre.	ASSUMED POPULATION. Actual Number.	ASSUMED POPULATION. Accumulated Total.	PROSPECTIVE. Sewage in Eight Hours Flow.	PROSPECTIVE. Rainfall in Eight Hours.	PROSPECTIVE. Total.	Accumulated Total of Eight Hours Sewage and Rainfall in the London Districts only.
										Cubic feet.	*Cubic feet.*	*Cubic feet.*	
North Side of the Thames—*continued.*													
Low Level -	Wellington-street to Bridge-street, Blackfriars.	45	St. Mary-le-Strand (one-fourth).	3,879	- -	18	219	3,872	- -	13,552	26,136	39,688	
		46	St. Clement Danes (one-half)	7,755	- -	153	431	7,755	- -	27,142	26,136	53,278	
		00	West London, North (one-tenth).	1,205	- -		275	1,205	- -	4,532	7,200	11,702	
		01	West London, South (two-thirds).	10,503	- -	51	206	10,503	- -	36,070	74,052	111,022	
				23,485	1,400,157	92	- -	23,485	1,871,603	82,196	133,584	215,780	29,334,796
	Bridge-street, Blackfriars, to London Bridge.	02	City of London, South-west (one-half).	4,602	- -	24	188	4,602	- -	16,107	34,848	50,955	
		04	City of London, South (one-third).	3,820	- -	27	140	3,820	- -	13,370	39,204	52,574	
				8,422	1,408,579	51	- -	8,422	1,880,025	29,477	74,052	103,529	29,438,325
	London Bridge to Hermitage Dock.	05	City of London, South-east (one-fourth).	2,648	- -	21	126	2,648	- -	9,268	30,492	39,760	
		83	Aldgate (two-thirds) - -	7,129	- -	57	126	7,129	- -	24,951	82,764	107,716	
				9,777	1,418,356	78	- -	9,777	1,889,802	34,219	113,256	147,475	29,585,800
	Hermitage Dock to Limekiln Dock.	87	Shadwell - - - -	16,179	- -	109	148	16,179	- -	56,626	158,268	214,894	
		86	St. John-in-the-East - -	9,990	- -	97	103	9,990	- -	34,965	140,844	175,809	
		84	St. Mary-in-the-East (one-half).	9,033	- -	31	291	9,033	- -	31,615	45,012	76,627	
		88	Ratcliffe (one-half) - -	7,666	- -	56	134	7,666	- -	26,821	81,312	107,933	
		91	Limehouse (three-fourths) -	17,087	- -	187	102	18,955	- -	66,243	271,524	337,807	
				59,895	1,478,251	480	- -	61,763	1,951,565	216,170	696,960	913,130	30,498,930
	Poplar and Isle of Dogs.	02	Bow (one-third) - - -	6,200	- -	476	53	25,000	- -	87,500	437,500	525,000	
		93	Poplar - - - -	28,384	- -	1,185	55	65,000	- -	227,500	1,137,500	1,365,000	
				34,644	1,512,895	1,661	- -	90,000	2,041,565	315,000	1,575,000	1,890,000	32,388,930
	Hackney - -	39	Hackney (part of) - -	10,000	1,522,895	830	-	26,434	2,067,999	92,519	462,595	555,114	32,944,044
	Taken to the south side of the river.	3	Kensington Town (half) -	14,591	- -	622	11	19,437	- -	68,030	340,147	408,177	
		4	Brompton - - - -	14,870	- -	698	47	32,727	- -	114,544	572,723	687,267	
		5	Hammersmith, St. Peter -	4,467	- -	189	34	6,500	- -	22,750	113,750	136,500	
		6	Ditto - St. Paul -	11,078	- -	1,753	95	16,667	- -	58,335	291,672	350,007	
		7	Fulham - - - -	11,886	- -	1,084	18	30,000	- -	105,000	525,000	630,000	
		8	Chelsea, South - - -	19,050	- -	303	62	19,050	- -	66,675	333,375	400,050	
		9	Ditto North-west - -	17,669	- -	213	117	25,000	- -	87,500	309,276	396,776	
		10	Ditto North-east - -	14,864	- -	213	87	18,614	- -	65,149	309,276	374,425	
		13	Belgrave - - - -	40,034	- -	525	86	45,034	- -	157,619	762,300	919,919	
		14	St. John, Westminster -	32,580	- -	200	163	32,580	- -	114,030	290,400	404,430	
		15	St. Margaret, Westminster -	31,314	- -	629	50	31,314	- -	109,599	547,995	657,594	
		16	Charing-cross (two-thirds) -	8,391	- -	161	52	8,391	- -	29,369	146,842	176,211	
		19	St. James's-square (one-sixth)	1,012	- -	15	135	1,012	- -	3,692	21,780	28,472	
				222,706	1,745,601	7,205	- -	287,226	2,355,225	1,005,292	4,564,536	5,569,828	38,513,872
South Side of the Thames:													
High Level -	Beyond the Wandle.	118	Putney (part of) - -	1,000	1,000	405	15	6,000	6,000	21,000	105,000	126,000	126,000
	Wandsworth to Streatham.	117	Wandsworth (one-fifth) -	1,922	- -	486	21	10,000	- -	35,000	175,000	210,000	
		115	Clapham - - - -	16,290	- -	1,233	23	28,852	- -	100,982	504,910	605,892	
		110	Streatham - - - -	9,023	- -	3,465	7·8	27,027	- -	94,595	472,962	567,557	
				27,235	28,235	5,184	- -	65,879	71,879	230,577	1,152,872	1,383,449	

(*continued*)

Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine represents that the engine only worked that portion of the hour.

21 May 1857.

W. B. Hach, Engineer.

13.—TABLE, showing the Amount of Population, Present and Prospective, for which provision will be made by the several High Level and Low Level Intercepting Sewers—*continued.*

	Point of Accumulation of Sewage.	DISTRICT. No	DISTRICT. Name.	Population in 1851.	Accumulated Population in 1851.	Number of Acres in District	ASSUMED POPULATION. No. Per Acre.	ASSUMED POPULATION. Actual Number.	ASSUMED POPULATION. Accumulated Total.	PROSPECTIVE. Sewage in Eight Hours Flow.	PROSPECTIVE. Rainfall in Eight Hours.	PROSPECTIVE. Total.	Accumulated Total of Eight Hours Sewage and Rainfall in the London Districts only.
South Side of the Thames—*continued.*										*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	
Low Level -	In the Metropolitan boundary.	118	Putney (part of) - - -	4,280	- -	1,731	11	18,991	- -	66,469	332,343	398,712	
		117	Wandsworth (four-fifths) -	7,689	- -	1,946	21	40,000	- -	140,000	700,000	840,000	
				11,969	40,204	3,677	- -	58,991	130,879	206,469	1,032,343	1,238,812	2,748,261
	Reversed drainage from Effra.	116	Battersea - - - -	10,500	- -	2,177	31	67,922	- -	237,727	1,188,635	1,426,362	
		112	Kennington, 2nd - -	18,848	- -	510	63	31,875	- -	111,562	557,812	669,374	
		111	Ditto 1st - - -	24,261	- -	452	80	35,847	- -	125,465	627,323	752,788	
				53,609	93,873	3,139	- -	135,644	266,514	474,754	2,373,770	2,848,524	5,596,785
High Level -	Upper Effra -	113	Brixton - - - -	14,610	- -	1,145	35	50,000	- -	175,000	875,000	1,050,000	
		114	Norwood - - - -	3,977	- -	1,276	31	30,000	- -	105,000	525,000	630,000	
				18,587	112,460	2,421	- -	80,000	346,514	280,000	1,400,000	1,680,000	7,276,785
	Earl Sewer -	121	Camberwell (half) - -	8,871	- -	669	30	20,000	- -	70,000	350,000	420,000	
		122	Peckham (half) - - -	9,722	- -	573	31	17,878	- -	62,573	312,865	375,438	
		120	Dulwich - - - -	1,632	- -	1,423	11	15,000	- -	52,500	262,500	315,000	
				20,225	132,685	2,665	- -	52,878	399,392	185,073	925,365	1,110,438	8,387,223
	St. Paul's, Deptford.	125	St. Paul's, Deptford (half) -	12,449	145,134	793	31	24,757	424,149	86,649	433,247	519,896	8,907,119

	Eltham, Lee, &c.	132	Eltham - - - -	2,568	- -	4,350	2·3	10,000	- -	35,000	175,000	210,000	
		133	Lee - - - - -	8,478	- -	2,390	6·2	14,873	- -	52,055	260,278	312,333	
				11,046	156,180	6,740	- -	24,873	449,022	87,055	435,278	522,333	9,429,452
	Lewisham, &c. -	134	Lewisham Village & Sydenham.	10,598	166,778	5,418	15	80,000	529,022	280,000	1,400,000	1,680,000	11,109,452
Low Level -	Lambeth, &c. -	94	Christchurch - - -	16,022	- -	74	216	16,022	- -	56,077	107,448	163,525	
		95	St. Saviour's - - -	19,709	- -	126	156	19,709	- -	68,982	182,052	251,034	
		101	Kent-road - - - -	18,126	- -	105	173	18,126	- -	63,441	152,460	215,901	
		102	Borough-road - - -	15,862	- -	65	244	15,862	- -	55,517	94,380	149,897	
		103	London-road - - -	17,836	- -	112	159	17,836	- -	62,426	162,624	225,050	
		104	Trinity - - - -	20,022	- -	142	147	20,022	- -	73,227	206,184	279,411	
		105	St. Peter, Walworth - -	29,861	- -	321	109	35,117	- -	122,909	466,092	589,001	
		106	St. Mary - ditto - -	14,033	- -	161	108	17,433	- -	61,016	233,772	294,788	
		107	Waterloo-road, 1st - -	14,088	- -	68	207	14,088	- -	49,308	98,736	148,044	
		108	Ditto - - 2d - -	18,348	- -	99	185	18,348	- -	64,218	143,748	207,966	
		109	Lambeth Church, 1st - -	18,409	- -	154	119	18,409	- -	64,431	223,608	288,039	
		110	Ditto - - - 2d - -	26,784	- -	186	144	26,784	- -	93,744	270,072	363,816	
				230,000	396,778	1,615	- -	238,056	767,078	835,296	2,342,076	3,177,372	14,286,824
	Camberwell, &c. -	121	Camberwell (one-half) -	8,871	- -	670	30	20,000	- -	70,000	350,000	420,000	
		122	Peckham (one-half) - -	9,722	- -	573	31	17,877	- -	62,570	312,847	375,417	
		123	St. George, Camberwell -	15,849	- -	434	47	20,311	- -	71,088	355,443	426,531	
				34,442	431,220	1,077	- -	58,188	825,866	203,658	1,018,290	1,221,948	15,508,772
	Bermondsey, Rotherhithe, &c.	96	St. Olave - - - -	8,015	- -	56	143	8,015	- -	28,053	81,312	109,365	
		97	St. John, Horsleydown -	11,360	- -	60	185	11,360	- -	39,760	100,188	139,948	
		98	St. James, Bermondsey -	18,899	- -	427	102	43,340	- -	151,690	620,004	771,694	
		99	St. Mary, ditto -	13,934	- -	142	102	14,421	- -	50,473	206,184	256,657	

(*continued*)

13.—TABLE, showing the Amount of Population Present, and Prospective, for which provision will be made by the several High Level and Low Level Intercepting Sewers—*continued.*

	Point of Accumulation of Sewage.	DISTRICT. No.	DISTRICT. Name.	Population in 1851.	Accumulated Population in 1851.	Number of Acres in District.	ASSUMED POPULATION. No. Per Acre.	ASSUMED POPULATION. Actual Number.	ASSUMED POPULATION. Accumulated Total.	PROSPECTIVE. Sewage in Eight Hours Flow.	PROSPECTIVE. Rainfall in Eight Hours.	PROSPECTIVE. Total.	Accumulated Total of Eight Hours Sewage and Rainfall in the London Districts only.
South Side of the Thames—*continued.*										*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	
Low Level—*continued.*	Bermondsey, Rotherithe, &c.—*continued.*	100	Leather Market	15,295	- -	92	166	15,295	- -	53,533	133,584	187,117	
		124	Rotherhithe	17,805	- -	749	47	35,053	- -	122,685	613,427	736,112	
		125	St. Paul's, Deptford (half)	12,450	- -	794	31	24,757	- -	86,650	433,248	519,898	
		126	St. Nicholas, ditto	7,071	- -	110	64	7,071	- -	24,748	123,742	148,490	
				104,829	536,049	2,439	- -	159,312	985,178	557,592	2,311,080	2,869,281	18,378,053
	London Districts beyond the Ravensbourne.	127	Greenwich, West	18,800	- -	301	62	18,812	- -	65,842	320,210	395,052	
		128	Ditto East	16,228	- -	1,425	31	44,460	- -	155,610	778,050	933,660	
		129	Woolwich Dock Yard	17,140	- -	411	63	25,687	- -	89,905	449,523	539,428	
		130	Ditto Arsenal	15,227	- -	756	62	47,093	- -	164,825	824,127	988,952	
		131	Plumstead	13,191	- -	4,022	22	101,634	- -	355,710	1,778,595	2,134,314	
				80,586	616,635	7,515	- -	237,686	1,222,864	831,901	4,159,505	4,991,406	23,369,459
Area, termed prospective by Mr. Bazalgette, North Side.	Outside Metropolitan Boundary taken to South Side.	- -	Ealing	3,771	- -	1,279	6·1	30,000	- -	105,000	525,000	630,000	
			Acton, &c.	4,150	- -	3,628							
			Brentford, &c.	8,120	- -	2,755	7·4	30,000	- -	105,000	525,000	630,000	
			Chiswick, &c.	6,303	- -	1,311							
				22,344	- -	8,973	- -	60,000	- -	210,000	1,050,000	1,260,000	
South Side	At Wandle	- -	Richmond	9,255	- -	1,230	14	50,000	- -	165,000	825,000	990,000	
			Mortlake and East Sheen	3,110	- -	1,168							
			Barnes	1,879	- -	936							
			Kew	1,009	- -	230							
				15,253	- -	3,564							
Additional area, provided for North Side.		- -	Willesden	2,030	- -	4,190	1·4	6,000	- -	21,000	105,000	126,000	
			East Ham	1,550	- -	2,455	3·5	30,000	- -	105,000	525,000	630,000	
			Barking	4,030	- -	6,000							
			Valley of the Lea	59,432	- -	74,598	1·3	100,000	- -	350,000	1,750,000	2,100,000	
				68,851	- -	87,243	- -	136,000	- -	476,000	2,380,000	2,856,000	
South Side	Valley of the Wandle and Baveley Brook.	- -	Wimbledon	2,693	- -	3,700	4·1	15,000	- -	52,500	262,500	315,000	
			Beddington	522	- -	3,900	2·4	40,000	- -	140,000	700,000	840,000	
			Wallington	881									
			Carshalton	2,411	- -	2,004							
			Mitcham	4,041	- -	2,893							
			Cheam	1,137	- -	1,894							
			Sutton	1,387	- -	1,803							
			Mordon	628	- -	1,422							
			Merton	1,870	- -	1,780							
				13,477	- -	16,605							
	Valley of the Ravensbourne.	- -	Addington	615	- -	3,900	3·2	100,000	- -	350,000	1,750,000	2,100,000	
			Beckingham	1,088	- -	3,875							
			Bromley	4,127	- -	4,046							
			Chiselhurst	2,088	- -	2,738							
			Farnborough	920	- -	1,412							
			Hayes	522	- -	1,272							
			Keston	644	- -	1,474							
			Wickhambreux	481	- -	2,310							
			Croydon	20,343	- -	9,821							
				31,458	- -	31,448	- -	- -	- -	542,500	2,712,500	3,255,000	

21 May 1857.

Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine represents that the engine only worked that portion of the hour.

W. B. Hach, Engineer.

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

14.—INFORMATION OBTAINED FROM THE WATER COMPANIES.

(1.)—TABLE showing Average Daily Water Supply (Sundays excluded).

	CUBIC FEET (Per Diem).	GALLONS (Per Diem).
North Side:		
1. Chelsea Water Company - - -	934,467	5,840,419
2. East London „ - - -	2,380,876	14,880,475
3. Grand Junction „ - - -	1,009,982	6,312,383
4. Hampstead „ - - -	203,087	1,269,296
5. New River „ - - -	3,204,636	20,028,979
6. West Middlesex „ - - -	1,074,456	6,715,350
	8,807,504	55,046,902
South Side:		
1. Kent Water Company - - -	466,218	2,913,862
2. Lambeth „ - - -	958,566	5,991,036
3. Plumstead, Lewisham, &c. Company -	89,600	560,000
4. Southwark and Vauxhall „ -	1,694,960	10,593,500
	3,209,344	20,058,398
North Side - - - -	8,807,504	55,046,902
South Side - - - -	3,209,344	20,058,398
	12,016,848	75,105,300*

(2.)—Table showing Unusually Large Supplies of Water.

	Average Daily Supply.	Day of Large Supply, April 28.	Largest Supply in any One Day.	Day on which Largest Supply occurred.
North Side:	*Gallons.*	*Gallons.*	*Gallons.*	
1. Chelsea Water Company -	5,840,419	5,910,921	7,315,800	April 7; Tuesday.
2. East London „ -	14,880,475	15,009,662	15,915,175	„ 13; Monday.
3. Grand Junction „ -	6,312,383	6,611,805	7,084,575	„ 20 „
4. Hampstead „ -	—	—	—	—
5. New River „ -	—	—	—	—
6. West Middlesex „ -	6,715,350	7,380,675	7,785,675	„ 27; Monday.
	33,748,627	34,913,063	38,101,225	
Deduct Average - -	33,748,627	33,748,627	33,748,627	
In excess of Average -	1,164,436	4,352,598		
Per-centage of Excess -	3·45	12·89		
South Side:				
1. Kent Water Company - -	2,913,862	3,024,410	3,497,662	April 16; Wednesday.
2. Lambeth „ - -	5,991,036	6,177,600	7,426,651	„ 20; Monday.
3. Plumstead, Lewisham, &c. Co.	—	—	—	—
4. Southwark and Vauxhall „	10,593,500	11,557,000	11,557,000	„ 28; Tuesday.
	19,498,398	20,759,010	22,491,313	
Deduct Average - -	19,498,398	19,498,398	19,498,398	
In excess of Average -	1,260,612	2,992,915		
Per-centage of Excess -	6·46	15·34		
North Side - -	33,748,627	34,913,063	38,101,225	
South Side - - -	19,498,398	20,759,010	22,491,313	
Grand Total - -	53,247,025	55,672,073	60,592,538	
Deduct Average - -	53,247,025	53,247,025	53,247,025	
In excess of Average -	2,425,048	7,345,513		
Per-centage of Excess -	4·55	13·79		

* In addition, the Orange-street Waterworks pump daily about 500,000 gallons.

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

(3.)—TABLE* showing Per-centage of Summer Increase, and Number of Houses Supplied by the Companies.

NAME OF COMPANY.	Number of Houses Supplied by the Company.	Actual Increase on Former Returns of Water Supply.	Expected further Increase during Summer.	TOTAL INCREASE.
North Side:		*Per cent.*	*Per cent.*	*Per cent.*
1. Chelsea - - - - - -	25,313	15	2½	17½
2. East London - - - - -	70,876	—	—	—
3. Grand Junction - - - - -	17,716	5	2½	7½
4. Hampstead - - - - - -	6,708	5	—	5
5. New River - - - - - -	96,992	5	5	10
6. West Middlesex - - - - -	28,409†	15	7	22
	246,014			
South Side:				
1. Kent - - - - - - -	17,150	No increase.	—	—
2. Lambeth - - - - - -	29,308	15	3	18
3. Plumstead - - - - - -	3,150	—	—	—
4. Southwark and Vauxhall - - -	44,529	7⅓	8	15⅓
	94,137			
North Side - - - -	246,014			
South Side - - - -	94,137			
	340,151			

† This Return is divided thus - - - { Houses - - - 26,100 ; Stables - - - 2,309 ; 28,409

(4.)—COPIES of Letters sent by order of the Referees to the Water Companies.

(1.)

29, Great George Street, Westminster, S.W.,
6 May 1857.

Sir.

I am directed by the Referees on the above question, appointed by the First Commissioner of Her Majesty's Works, &c., to request the Directors of the ———— Waterworks Company to oblige them with a return of the quantity of water supplied in their district *daily*, from March 29th last, to May 2d, both inclusive; and I am also to ask the favour of your furnishing them with the approximate quantity delivered from the works *hourly* throughout each day (24 hours) in the week ending Saturday the 11th April (Sunday the 5th included).

I have, &c.
Herbert C. Saunders.

To the Secretary of the ————
Waterworks Company.

(2.)

29, Great George Street, Westminster, S.W.,
16 June 1857.

Sir,

I am desired by the Referees to request you will have the goodness, with reference to the return of the quantity of water supplied by the ———— Water Company, to inform them *the per-centage of increase which has already been experienced*, and *what will probably be the maximum increase during the present summer.*

The Referees would also feel obliged by your informing them the *number of houses* supplied by the ———— Company at Lady-day last. I am directed to request the favour of a reply on or before the 24th instant.

I am, &c.
Herbert C. Saunders.

To the Secretary of the ————
Company.

* This and the two preceding Tables are extracted from the Returns on pages 154 to 165.

161
W. B. Hack. Engineer
Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine re
engine represents that the engine only worked that portion of the hour.
21 May 1857.

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

(5.)—REPLIES to the LETTERS sent by the Referees to the WATER COMPANIES.

NORTH OF RIVER.

1.—CHELSEA WATERWORKS.

RETURN to CIRCULAR 1.

(A.) RETURN of the Quantity of WATER supplied in the District Daily, from 29th March to 2d May 1857, inclusive.

DATE.	DAILY, 24 HOURS.	WEEKLY.
1857:	*Gallons.*	*Gallons.*
Sunday, March 29	[1,354,001]	
„ 30	5,459,303	
„ 31	5,855,248	
April 1	4,722,995	
„ 2	4,737,878	
„ 3	5,752,122	
„ 4	6,955,625	
		34,837,172
Sunday, April 5	[1,801,100]	
„ 6	5,822,000	
„ 7	7,315,800	
„ 8	6,198,280	
„ 9	5,363,050	
„ 10	4,925,550	
„ 11	5,900,200	
		37,325,980
Sunday, April 12	[2,045,431]	
„ 13	5,528,860	
„ 14	6,064,352	
„ 15	5,466,098	
„ 16	5,424,096	
„ 17	4,897,341	
„ 18	6,190,161	
		35,616,339
Sunday, April 19	[1,733,790]	
„ 20	6,575,074	
„ 21	6,099,730	
„ 22	5,999,282	
„ 23	5,287,859	
„ 24	6,491,702	
„ 25	6,207,055	
		38,394,492
Sunday, April 26	[1,359,575]	
„ 27	5,907,242	
„ 28	5,910,921	
„ 29	5,608,115	
„ 30	5,632,542	
May 1	6,133,210	
„ 2	6,780,899	
		37,332,504
TOTAL for 5 Weeks		183,506,487

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

1.—CHELSEA WATERWORKS—*continued.*

(B.) RETURN of the Quantity of WATER supplied in the District Hourly, from 5th April to 11th April 1857 inclusive.

From 6 P.M.	Sunday, 5th April.	Monday, 6th April.	Tuesday, 7th April.	Wednesday, 8th April.	Thursday, 9th April.	Friday, 10th April.	Saturday, 11th April.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
7 P.M. -	98,400	40,200	179,200	155,400	57,000	77,000	33,600
8 „ -	112,000	40,200	219,200	99,400	46,200	67,900	81,200
9 „ -	125,600	19,800	137,600	71,400	65,400	67,200	93,800
10 „ -	83,200	40,200	94,400	98,000	45,600	56,700	105,000
11 „ -	40,000	75,000	94,400	67,200	34,800	37,100	39,900
12 „ -	40,000	55,200	134,400	37,800	44,400	56,000	51,800
1 A.M. -	52,000	13,800	92,800	155,400	43,800	56,000	51,100
2 „ -	48,800	55,200	169,600	92,400	43,200	65,100	51,100
3 „ -	48,800	55,200	91,200	121,800	63,000	54,600	34,300
4 „ -	60,000	75,000	89,600	119,000	42,600	54,600	42,000
5 „ -	60,000	34,200	169,600	205,800	52,200	44,100	58,100
6 „ -	32,000	96,000	128,400	176,400	61,800	63,700	58,100
Galls.	800,800	600,000	1,600,400	1,400,000	600,000	700,000	700,000
7 A.M. -	221,000	573,000	687,000	590,000	574,000	566,000	660,000
8 „ -	203,000	543,000	642,000	550,000	550,000	526,000	630,000
9 „ -	130,000	552,000	630,000	550,000	540,000	502,000	570,000
10 „ -	110,000	573,000	630,000	490,000	535,000	502,000	600,000
11 „ -	110,000	410,000	527,000	470,000	440,000	447,000	530,000
12 „ -	37,000	421,000	458,000	344,000	392,000	388,000	300,000
1 P.M. -	55,000	389,000	367,000	329,000	263,000	297,000	210,000
2 „ -	37,000	421,000	430,000	367,000	260,000	340,000	550,000
3 „ -	20,000	494,000	504,000	410,000	450,000	187,000	530,000
4 „ -	20,000	421,000	430,000	348,000	390,000	234,000	300,000
5 „ -	20,000	250,000	210,000	230,000	230,000	108,500	160,000
6 „ -	37,300	175,000	200,400	120,280	139,050	128,050	160,200
Galls.	1,000,300	5,222,000	5,715,400	4,798,280	4,763,050	4,225,550	5,200,200
24 Hours -	1,801,100	5,822,000	7,315,800	6,198,280	5,363,050	4,925,550	5,900,200

RETURN to CIRCULAR 2.

Office of Chelsea Waterworks, Great Queen-street,
Westminster, S. W., 14 July 1857.

Sir,

IN compliance with the desire of the Referees to whom the question of the main drainage of the metropolis is entrusted, I forward the returns of the quantity of water supplied by this Company; and I am to state that the quantity delivered in the district during the last five weeks, has been nearly 15 per cent. in excess of the Return, and it is anticipated that this excess will amount to 17½ per cent. during the summer.

The number of houses supplied at Lady-day last, was - - 25,313.

I am, &c.
Albert Gill,
Secretary.

H. C. Saunders, Esq.,
29, Great George-street.

29,644.0

W. B. Hack, Engineer.

Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine represents that the engine only worked that portion of the hour.

21 May 1857.

2.—EAST LONDON WATERWORKS.

RETURN to CIRCULAR 1.

(A.) TOTAL Quantity of WATER Pumped Daily, from 28 March to 1 May inclusive, in Cubic Feet.

March	28	-	-	-	2,502,400	April	15	-	-	-	2,304,262
„	29	-	-	S.	[1,105,582]	„	16	-	-	-	2,332,494
„	30	-	-	-	2,306,518	„	17	-	-	-	2,366,289
„	31	-	-	-	2,398,288	„	18	-	-	-	2,398,913
April	1	-	-	-	2,364,845	„	19	-	-	S.	[1,175,188]
„	2	-	-	-	2,377,192	„	20	-	-	-	2,350,852
„	3	-	-	-	2,396,823	„	21	-	-	-	2,455,246
„	4	-	-	-	2,347,790	„	22	-	-	-	2,410,359
„	5	-	-	S.	[1,189,140]	„	23	-	-	-	2,351,552
„	6	-	-	-	2,396,579	„	24	-	-	-	2,402,504
„	7	-	-	-	2,397,066	„	25	-	-	-	2,463,571
„	8	-	-	-	2,372,675	„	26	-	-	S.	[1,147,409]
„	9	-	-	-	2,378,413	„	27	-	-	-	2,390,949
„	10	-	-	-	2,122,854	„	28	-	-	-	2,401,546
„	11	-	-	-	2,262,558	„	29	-	-	-	2,401,108
„	12	-	-	S.	[878,480]	„	30	-	-	-	2,458,482
„	13	-	-	-	2,546,428	May	1	-	-	-	2,472,254
„	14	-	-	-	2,212,995	„	2	-	-	-	2,463,354

(B.) The hourly quantities from 5 April to 11 April will probably be as follows:
April 5—Sunday.—On this day the supply may be taken as uniform throughout the 24 hours.

„ 6
„ 7
„ 8
„ 9
„ 10
„ 11

} The first four days the supply was at average rate, but the 10th, being Good Friday, was a low day, and the 11th was also unusually low for a Saturday.

The latest observations which I made with any pretensions to strict accuracy gave the following proportions per cent. of the whole, as delivered hourly; the figures in *italics* give what was probably the actual proportion on the first four days of the week in question:

P.M.	6 to 7	-	-	3·41		A.M.	7	-	-	4·19	*4·69*
„	8	-	-	3·07		„	8	-	-	6·25	*6·75*
„	9	-	-	2·54		„	9	-	-	6·37	*6·57*
„	10	-	-	2·45		„	10	-	-	6·53	*6·53*
„	11	-	-	2·33		„	11	-	-	6·40	*6·40*
Midnight	12	-	-	2·01		Noon	12	-	-	6·10	*6·10*
A.M.	1	-	-	2·15		P.M.	1	-	-	6·32	*6·32*
„	2	-	-	2·09		„	2	-	-	5·81	*5·81*
„	3	-	-	2·09		„	3	-	-	6·15	*5·95*
„	4	-	-	1·98		„	4	-	-	6·15	*5·65*
„	5	-	-	2·26		„	5	-	-	6·05	*5·55*
„	6	-	-	2·64		„	6	-	-	4·55	

Good Friday and the Saturday following were doubtless exceptional days.

(signed) *Charles Greaves*, Engineer.

RETURN to CIRCULAR 2.

East London Waterworks Company,
Office, 16, St. Helen's Place, 18 June 1857.

Sir,

THE Directors instruct me to inform you that the number of houses supplied by this Company at Christmas last was 70,876. Our account is not made up at Lady-day.

I am further instructed to send you a copy of our Engineer's Report, in reply to the Commissioners' inquiries, dated 16th instant.

I am, &c.
J. Cecil, Secretary.

H. C. Saunders, Esq., Secretary,
Main Drainage Commission.

2.—EAST LONDON WATERWORKS—*continued.*

Copy of Engineer's Report upon the Inquiries of Main Drainage Commissioners.

Gentlemen,

Old Ford, 18 June 1857.

IN reply to a letter from the Secretary, dated yesterday, stating that I am to report to day,—

1st.—"The percentage of increase of our supply of water already experienced, taken with reference to return of such supply already made to Main Drainage Commissioners."

2d.—"What will probably be the maximum during the summer?"

I have to report, that the annual increase in the supply has been one million gallons per day, for seven years.

The supply for - - - 1850, was 10 million gallons per day.
The average increase gives, 1851 - 11 „ „ „
„ „ 1852 - 12 „ „ „
„ „ 1853 - 13 „ „ „
„ „ 1854 - 14 „ „ „
„ „ 1855 - 15 „ „ „
And the supply for - - 1856 - 16 „ „ „
The maximum during the summer will probably be 18 millions of gallons.

To the Chairman, &c.,
East London Waterworks.

(signed) *Charles Greaves*, Engineer.

3.—GRAND JUNCTION WATERWORKS.

RETURN to CIRCULAR 1.

STATEMENT No. 1.—The Quantity of WATER supplied Daily by this Company from the 29th March to the 2d May 1857, both days inclusive.

DAY OF THE WEEK.	DATE.	GALLONS.	DAY OF THE WEEK.	DATE.	GALLONS.
	1857:			1857:	
Sunday - -	29 Mar. -	[2,432,330]	Thursday - -	16 April -	6,274,355
Monday - -	30 „ -	5,919,710	Friday - -	17 „ -	6,208,535
Tuesday - -	31 „ -	5,847,450	Saturday - -	18 „ -	6,488,435
Wednesday -	1 April -	5,990,420	Sunday - -	19 „ -	[3,064,700]
Thursday - -	2 „ -	6,046,980	Monday - -	20 „ -	7,084,575
Friday - -	3 „ -	5,983,800	Tuesday - -	21 „ -	6,833,655
Saturday - -	4 „ -	6,058,095	Wednesday -	22 „ -	6,485,930
Sunday - -	5 „ -	[2,405,780]	Thursday - -	23 „ -	6,373,370
Monday - -	6 „ -	6,170,520	Friday - -	24 „ -	6,434,115
Tuesday - -	7 „ -	6,024,040	Saturday - -	25 „ -	6,460,360
Wednesday -	8 „ -	5,928,000	Sunday - -	26 „ -	[2,533,080]
Thursday - -	9 „ -	6,025,230	Monday - -	27 „ -	6,960,915
Friday - -	10 „ -	4,847,920	Tuesday - -	28 „ -	6,611,805
Saturday - -	11 „ -	6,380,600	Wednesday -	29 „ -	6,531,975
Sunday - -	12 „ -	[2,486,720]	Thursday -	30 „ -	6,539,570
Monday - -	13 „ -	6,594,040	Friday - -	1 May -	6,746,650
Tuesday - -	14 „ -	6,065,510	Saturday - -	2 „ -	7,053,960
Wednesday -	15 „ -	6,315,450			

Office of Grand Junction Waterworks Company,
20 May 1857.

E. O. Coe, Secretary.

STATEMENT No. 2.—The approximate Quantity of WATER delivered from the Works Hourly throughout each day (24 hours), from the 5th to the 11th April 1857, both days inclusive.

		Gallons.
Sunday, 5th April 1857 -	from 12 p.m. to 6 a.m., the average per hour was,	75,493
	6 a.m. to 9 a.m. „ „	136,800
	9 a.m. to noon „ „	120,333
	noon to 6 p.m. „ „	112,163
	6 p.m. to 12 p.m. „ „	84,740

161

28,544·0

W. B. Hoch, Engineer.

21 May 1857.

Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine represent that the engine only worked that portion of the hour.

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

3.—Grand Junction Waterworks—*continued.*

			Gallons.
Monday, 6th April 1857 -	from 12 p.m. to 6 a.m., the average per hour was,		84,740
	6 a.m. to 2 p.m.	„ „	352,940
	2 p.m. to 4 p.m.	„ „	287,910
	4 p.m. to 8.30 p.m.	„ „	349,367
	8.30 p.m. to 11 p.m.	„ „	246,900
	11 p.m. to 12 p.m.	„ „	73,340
Tuesday, 7th April 1857 -	from 12 p.m. to 6 a.m.	„ „	73,530
	6 a.m. to 2 p.m.	„ „	341,765
	2 p.m. to 4 p.m.	„ „	249,600
	4 p.m. to 8.30 p.m.	„ „	364,200
	8.30 p.m. to 11 p.m.	„ „	247,776
	11 p.m. to 12 p.m.	„ „	91,200
Wednesday, 8th April 1857,	from 12 p.m. to 6 a.m.	„ „	91,643
	6 a.m. to 9 a.m.	„ „	250,233
	9 a.m. to 2 p.m.	„ „	364,525
	2 p.m. to 4 p.m.	„ „	272,400
	4 p.m. to 8.30 p.m.	„ „	346,903
	8.30 p.m. to 11 p.m.	„ „	246,540
	11 p.m. to 12 p.m.	„ „	83,600
Thursday, 9th April 1857 -	from 12 p.m. to 6 a.m.	„ „	84,106
	6 a.m. to 2 p.m.	„ „	348,937
	2 p.m. to 4 p.m.	„ „	241,780
	4 p.m. to 8.30 p.m.	„ „	340,529
	8.30 p.m. to 11 p.m.	„ „	245,100
	11 p.m. to 12 p.m.	„ „	100,700
Friday, 10th April 1857 -	from 12 p.m. to 4 a.m.	„ „	101,080
	4 a.m. to 1 p.m.	„ „	379,480
	1 p.m. to 12 p.m.	„ „	93,480
Saturday, 11th April 1857,	from 12 p.m. to 6 a.m.	„ „	93,797
	6 a.m. to 2 p.m.	„ „	367,050
	2 p.m. to 4 p.m.	„ „	293,545
	4 p.m. to 9 p.m.	„ „	346,650
	9 p.m. to 11 p.m.	„ „	236,460
	11 p.m. to 12 p.m.	„ „	88,160

Office of Grand Junction Waterworks Company, 20 May 1857. — *E. O. Coe*, Secretary.

Return to Circular 2.

Grand Junction Waterworks Company,
Office, Brook-street, Grosvenor-square, 23 June 1857.

Sir,

In reply to your communication of the 16th instant, I am instructed to acquaint you that the greatest quantity of water supplied during any one week to the present time has been 45,342,315 imperial gallons, which will be found to be an increase of about five per cent. upon the largest weekly quantity named in the return already sent. It is not anticipated that there will be any important increase on this amount during the remainder of the summer; it certainly will not exceed 2½ per cent.

I am, &c.
(signed) *E. O. Coe*, Secretary.

Herbert C. Saunders. Esq.

Grand Junction Waterworks Company,
Office, Brook-street, Grosvenor-square, 25 June 1857.

Sir,

In my desire that the information respecting supply should reach you in due time, I accidentally omitted to state the number of houses supplied by the Company; I now beg to acquaint you that the number of houses supplied by the Company at Lady-day last was 17,716.

I am, &c.
(signed) *E. O. Coe*, Secretary.

Herbert C. Saunders, Esq.

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

4.—HAMPSTEAD WATERWORKS.

Return to Circular 1.

Hampstead Waterworks Office,
Hardwick Place, Hampstead Road, 18 May 1857.

Sir,

In reply to the inquiries contained in your communication of the 6th instant, I beg to inform you that the daily quantity of water delivered in our district during the periods you mention, averaged 1,269,296 gallons, exclusive of Sundays, on which day there is no supply beyond that required by road watering. The hours of service are from 5 A.M. to 6 P.M. We have no means of determining the quantity supplied during each hour.

I am, &c.
(signed) *Thomas Hakewill*,
Secretary.

Herbert C. Saunders, Esq.,
29, Great George Street, Westminster.

Return to Circular 2.

Hampstead Waterworks Office,
1 July 1857.

Sir,

In reply to your communication of the 16th ultimo, I beg to inform you that the percentage of increase in the quantity of water supplied is about 5 per cent., so far as we have been enabled to estimate it to the present time.

The number of houses supplied by this Company at Lady-day last was 6,708.

I am, &c.
(signed) *H. P. Hakewill.*

Herbert C. Saunders, Esq.

5.—NEW RIVER COMPANY.

Return to Circular 1.

New River Office, 15 May 1857. E. C.

Sir,

In reply to your letter dated the 6th instant, I am instructed to acquaint you, for the information of the Referees on the main drainage of the metropolis, that the quantity of water delivered by the New River Company to the houses in their district, between the 29th March and the 2d instant, was 20,028,979 gallons, and that the general period of supply from the store covered reservoirs, which are always full in the morning, takes place between the hours of 5 o'clock in the morning and 9 o'clock at night, the greatest depression in these reservoirs being little more than four feet, and that at mid-day, from which period the water gradually resumes its elevation by the above-mentioned hour of 9 o'clock at night.

I am, &c.
(signed) *Frederick Inglis*,
Clerk.

Herbert C. Saunders, Esq.

Return to Circular 2.

New River Office, E. C., 23 June 1857.

Sir,

In reply to the inquiry contained in your communication of the 16th instant, on the subject of the recent return by the New River Company to the Referees, on the main drainage of the metropolis, I am instructed to acquaint you that the increase which has already taken place, beyond such return, is 5 per cent., and that the probable summer maximum will be a further 5 per cent.

That the houses supplied by this Company at Lady-day last amounted to 96,992.

I am, &c.
(signed) *Frederick Inglis*,
Clerk.

Herbert C. Saunders, Esq.

28,544·0
27,111·0
25,910·0
21 May 1857.

W. B. Hack, Engineer.

Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine represents that the engine only worked that portion of the hour.

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

6.—WEST MIDDLESEX WATERWORKS.

RETURN to CIRCULAR 1.

(A.) AN ACCOUNT of the Daily Quantity of WATER pumped from *Hammersmith*, from Saturday 28th March, to Friday 1st May 1857.

DATE.	TUNS DAILY.	TUNS WEEKLY.
1857:		
Saturday - March 28 - - -	28,340	
Sunday - „ 29 - - -	[9,432]	
Monday - „ 30 - - -	33,651	
Tuesday - „ 31 - - -	29,089	
Wednesday - April 1 - - -	28,820	
Thursday - „ 2 - - -	28,490	
Friday - „ 3 - - -	27,976	
		185,798
Saturday - April 4 - - -	29,186	
Sunday - „ 5 - - -	[9,245]	
Monday - „ 6 - - -	31,452	
Tuesday - „ 7 - - -	29,682	
Wednesday - „ 8 - - -	28,940	
Thursday - „ 9 - - -	28,652	
Friday - „ 10 - - -	27,111	
		184,380
Saturday - April 11 - - -	28,544	
Sunday - „ 12 - - -	[8,942]	
Monday - „ 13 - - -	33,143	
Tuesday - „ 14 - - -	28,071	
Wednesday - „ 15 - - -	29,036	
Thursday - „ 16 - - -	28,382	
Friday - „ 17 - - -	28,310	
		184,428
Saturday - April 18 - - -	29,069	
Sunday - „ 19 - - -	[8,450]	
Monday - „ 20 - - -	34,343	
Tuesday - „ 21 - - -	33,590	
Wednesday - „ 22 - - -	30,569	
Thursday - „ 23 - - -	29,612	
Friday - „ 24 - - -	29,972	
		195,605
Saturday - April 25 - - -	28,194	
Sunday - „ 26 - - -	[8,942]	
Monday - „ 27 - - -	34,603	
Tuesday - „ 28 - - -	32,803	
Wednesday - „ 29 - - -	28,278	
Thursday - „ 30 - - -	30,110	
Friday - May 1 - - -	27,285	
		190,215

21 May 1857.

W. B. Hack, Engineer.

6.—WEST MIDDLESEX WATERWORKS—*continued.*

(B.) AN ACCOUNT of the Hourly Quantity of WATER Pumped from *Hammersmith*, from Sunday, 5th April, to Saturday, 11th April 1857.

HOURS.	SUNDAY, 5th April.				MONDAY, 6th April.				TUESDAY, 7th April.				WEDNESDAY, 8th April.				THURSDAY, 9th April.				FRIDAY, 10th April.				SATURDAY, 11th April.			
	Engines.			Tuns of Water Pumped.	Engines.			Tuns of Water Pumped.	Engines.			Tuns of Water Pumped.	Engines.			Tuns of Water Pumped.	Engines.			Tuns of Water Pumped.	Engines.			Tuns of Water Pumped.	Engines.			Tuns of Water Pumped.
	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.
1 a.m.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	563·6	1	-	-	555·7	-	-	-	550·0	1	-	-	575·8
2 „	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	563·6	1	-	-	555·7	-	-	-	550·0	1	-	-	575·8
3 „	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	563·6	1	-	-	555·7	-	-	-	550·0	1	-	-	575·8
4 „	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	563·6	1	-	-	555·7	-	-	-	550·0	1	-	-	575·8
5 „	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	563·6	1	-	-	555·7	-	-	-	550·0	1	-	-	575·8
6 „	-	-	-	-	-	-	-	530·0	-	-	-	1008·8	1	-	-	1104·2	1	-	3	1008·0	1	-	-	1008·8	-	-	-	713·0
7 „	-	-	-	-	-	-	-	916·0	-	-	-	1741·0	-	-	-	1088·1	-	-	-	1044·4	-	-	-	1741·0	-	-	-	1805·3
8 „	-	-	-	-	-	-	-	1862·9	-	-	-	1741·0	-	-	-	1783·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
9 „	-	-	-	-	-	-	-	1862·9	-	-	-	1741·0	-	-	-	1783·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
10 „	-	-	-	-	-	-	-	1862·9	-	-	-	1741·0	-	-	-	1783·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
11 „	-	-	-	-	-	-	-	1862·9	-	-	-	1741·0	-	-	-	1783·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
12 „	-	-	-	-	-	-	-	1862·9	-	-	-	1741·0	-	-	-	1783·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
1 p.m.	-	-	-	-	-	-	-	1862·9	-	-	-	1741·0	-	-	-	1783·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
2 „	-	-	-	-	-	-	-	1862·9	-	-	-	1741·0	-	-	-	1783·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
3 „	-	-	-	-	-	-	-	1862·9	-	-	-	1741·0	-	-	-	1783·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
4 „	-	-	-	-	-	-	-	1862·9	-	-	-	1770·2	-	-	-	1788·2	-	-	-	1741·0	-	-	-	1741·0	-	-	-	1805·3
5 „	-	-	-	-	-	-	-	1862·9	-	-	-	1770·2	-	-	-	1788·2	-	-	-	1490·5	-	-	-	1741·0	-	-	-	1805·3
6 „	-	-	-	-	-	-	-	1862·9	-	-	-	1770·2	-	-	-	1788·2	-	-	-	1398·0	-	-	-	1741·0	-	-	-	1805·3
7 „	-	-	-	-	-	-	-	1862·9	-	-	-	1770·2	-	-	-	1402·2	-	-	-	1398·0	1	-	-	1741·0	-	-	-	1805·3
8 „	-	-	-	-	-	-	-	1401·6	-	-	-	1571·0	-	-	-	669·6	1	-	-	979·8	1	-	-	650·0	-	-	-	447·7
9 „	-	-	-	-	-	-	-	1100·3	-	-	-	1377·0	-	-	-	669·6	1	-	-	555·7	1	-	-	650·0	-	-	-	414·0
10 „	-	-	-	-	-	-	-	1100·3	-	-	-	1316·2	-	-	-	669·6	1	-	-	555·7	1	-	-	650·0	-	-	-	414·0
11 „	Engines not at work, the mains being charged from Barrow Hill - -			372·5	1	-	-	1100·3	1	-	-	550·0	1	-	-	669·6	1	-	-	555·7	1	-	-	650·0	-	-	-	414·0
12 „				372·5	1	-	-	1100·3	1	-	-	550·0	1	-	-	669·6	1	-	-	555·7	1	-	-	650·0	-	-	-	414·0
				9,246·0				31,452·0				29,082·0				28,910·0				28,652·0				27,111·0				29,544·0

Note.—The fractions ¼, ½, and ¾ placed over the No. of Engine represents that the engine only worked that portion of the hour.

21 May 1857.

W. B. Hack, Engineer.

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

6.—West Middlesex Waterworks—*continued.*

Return to Circular 2.

Office of West Middlesex Waterworks,
New Road, St. Marylebone, W., 23 June 1857.

Sir,

In answer to your letter of the 16th instant, I beg to state that the increase already experienced in the quantity of water supplied over and above the former return, is equal to 15 per cent.; and that a further increase equal to 7 per cent. more, making together an increase of 22 per cent. on the return made on the 22d May, will probably be the maximum during the summer.

The number of houses supplied at Lady-day last was	26,100
Stables	2,309
Total tenements	28,409

I believe that a majority of the stables in this Company's district have separate supplies laid on; the others are supplied through the houses to which they belong; many stables also are not occupied as such, but have persons residing in the rooms above the coach-house, &c.

I am, &c.

H. C. Saunders, Esq. *W. H. Whiffin*, Secretary.

SOUTH OF RIVER.

1.—KENT WATERWORKS.

Return to Circular 1.

RETURN of Water pumped Daily from 29th March to 2d May 1857, both days inclusive.

	Gallons.		Gallons.
Sunday, March 29	none.	April 16	3,497,662
„ 30	3,155,706	„ 17	2,407,364
„ 31	3,116,518	„ 18	2,911,144
April 1	2,666,698		
„ 2	2,730,414	Sunday, April 19	none.
„ 3	2,611,464	„ 20	3,267,982
„ 4	2,956,902	„ 21	3,173,490
		„ 22	3,010,050
Sunday, April 5	none.	„ 23	2,812,626
„ 6	3,073,788	„ 24	2,389,444
„ 7	3,019,744	„ 25	2,852,084
„ 8	3,053,370		
„ 9	2,982,534	Sunday, April 26	none.
„ 10	2,073,928	„ 27	3,148,746
„ 11	3,136,702	„ 28	3,024,410
		„ 29	2,809,470
Sunday April 12	none.	„ 30	2,835,702
„ 13	3,374,576	May 1	3,020,864
„ 14	2,964,762	„ 2	3,267,124
„ 15	2,070,616		

Deptford, 13 May 1857.

W. R. Morris,
Engineer to the Company.

Return to Circular 2.

Kent Waterworks, Mill-lane, Deptford,
18 June 1857.

Sir,

The supply of water appears to be stationary as to quantity at these works.
The greatest day's demand for the current year has not exceeded 3,750,000 gallons.
The number of houses in supply at Lady-day last was 17,150.

I am, &c.

— Saunders, Esq. (signed) *W. R. Morris.*

Appendix III.

Sewage, Rainfall and Population.

Information as to Water Supply.

2.—LAMBETH WATERWORKS.

Return to Circular 1.

(A.) RETURN of the Quantity of Water supplied in the District Daily, from 29th March to 2d May 1857, inclusive.

Date.	Daily, 24 hours.	Weekly.
1857:	*Gallons.*	*Gallons.*
Sunday, March 29	[2,739,875]	
„ 30	6,778,159	
„ 31	6,778,159	
April 1	6,405,824	
„ 2	5,735,805	
„ 3	5,372,250	
„ 4	5,616,272	
Sunday „ 5	[2,643,013]	39,426,344
„ 6	6,216,433	
„ 7	6,268,432	
„ 8	5,235,095	
„ 9	6,381,012	
„ 10	5,717,918	
„ 11	4,565,790	
Sunday „ 12	[2,756,637]	37,027,693
„ 13	6,920,568	
„ 14	5,920,200	
„ 15	5,996,750	
„ 16	5,844,311	
„ 17	5,539,566	
„ 18	5,091,450	
Sunday „ 19	[3,732,721]	38,069,482
„ 20	7,436,651	
„ 21	5,529,017	
„ 22	6,421,350	
„ 23	6,026,834	
„ 24	5,612,492	
„ 25	5,411,148	
Sunday „ 26	[900,905]	40,170,213
„ 27	6,584,103	
„ 28	6,177,600	
„ 29	6,387,868	
„ 30	6,039,284	
May 1	6,025,665	
„ 2	5,695,095	
		37,810,520
Total for 5 Weeks		192,504,252

Note.—The daily supply to the districts outside the metropolitan boundary is about 250,000 gallons.

(B.) RETURN of the Quantity of Water supplied in the District Hourly, from 5th April to 11th April 1857, inclusive.

From 6 P.M.	Sunday, 5th April.	Monday, 6th April.	Tuesday, 7th April.	Wednesday, 8th April.	Thursday, 9th April.	Friday, 10th April.	Saturday, 11th April.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
7 P.M.	151,116	104,612	265,736	216,333	274,034	224,474	182,618
8 „	107,664	160,611	265,736	259,954	274,034	224,474	182,618
9 „	64,212	104,143	102,155	129,066	218,295	177,139	182,618
10 „	64,186	103,861	156,441	128,969	162,462	177,112	152,347
11 „	64,163	47,702	156,409	128,871	162,339	129,671	111,221
12 „	64,139	109,217	211,026	129,307	162,214	131,299	109,935
1 A.M.	20,540	167,288	158,227	131,128	154,935	178,715	37,610
2 „	20,445	169,883	160,593	174,458	61,896	179,110	140,171
3 „	20,347	172,511	163,354	134,427	162,743	179,851	74,471

2.—Lambeth Waterworks—*continued.*

From 6 P.M.	Sunday, 5th April.	Monday, 6th April.	Tuesday, 7th April.	Wednesday, 8th April.	Thursday, 9th April.	Friday, 10th April.	Saturday, 11th April.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
4 A.M. -	- -	223,783	116,883	136,436	125,773	180,368	147,418
5 „ -	- -	273,083	169,681	177,147	169,219	180,843	147,722
6 „ -	24,596	322,383	265,736	216,333	227,124	181,472	217,514
7 „ -	118,731	373,653	361,791	216,333	368,347	267,477	253,442
8 „ -	149,903	376,283	314,718	255,519	370,922	312,133	255,140
9 „ -	193,671	325,671	315,354	296,230	323,453	314,465	219,070
10 „ -	195,174	326,290	315,990	298,239	324,105	270,234	219,050
11 „ -	195,077	327,172	316,628	258,208	324,754	270,786	219,029
12 „ -	151,334	382,860	317,137	258,573	325,404	271,338	255,381
1 P.M. -	151,310	328,958	370,880	302,341	378,691	271,890	218,969
2 „ -	151,285	386,128	373,246	260,101	381,513	319,225	255,260
3 „ -	194,835	385,991	375,125	303,795	383,932	319,119	255,140
4 „ -	194,738	385,867	375,003	303,697	385,853	366,245	255,099
5 „ -	151,164	329,427	320,324	259,980	329,897	318,858	255,017
6 „ -	194,593	329,396	320,294	259,954	329,865	271,626	218,788
Gallons -	2,643,223	6,216,773	6,268,467	5,235,399	6,381,704	5,717,924	4,565,648

Note.—The daily supply to the districts outside the metropolitan boundary is about 250,000 gallons.

Return to Circular 2.

Office of Lambeth Waterworks,
55, Newington Place, Kennington, S., 15 July 1857.

Sir,

I am desired by the Directors of the Lambeth Waterworks to transmit herewith for the information of the Referees on the main drainage of the Metropolis, the returns requested in your letters of 6th May and 16th June last.

The increase of the supply to this day has been about 15 per cent. beyond the quantity of water in the return, and it is estimated a further increase will be experienced during the summer of about 3 per cent.

The number of houses supplied in April last was 29,308.

I am, &c.
W. S. Phipps, Secretary.

H. C. Saunders, Esq.

3.—PLUMSTEAD, WOOLWICH, AND CHARLTON WATERWORKS.

Return to Circular 1.

Plumstead, Woolwich, and Charlton,
Consumers Pure Water Company (Limited),
9 June 1857.

Sir,

Your letter of the 16th May has remained unanswered, in consequence of a change of officers in the Company, and a consequent impediment to business; I have, however, instituted inquiries, and have much pleasure in forwarding the information you require.

The average daily supply between March 29th and May 2d was 560,000 gallons, or 3,920,000 per week of seven days.

The average hourly supply in the week ending April 11th, during the 12 hours the water is supplied (from 7 A.M. to 7 P.M.), was 47,000 gallons.

Any further information I shall be happy to afford, if possible.

I am, &c.
E. C. Ashdown, Secretary.

H. C. Saunders, Esq.

Return to Circular 2.

Plumstead, Woolwich, and Charlton
Consumers Pure Water Company (Limited),
23 June 1857.

Sir,

In reply to yours of the 16th ult., I beg to inform you that we now average an addition of 10 houses per week attached to our mains, which will probably continue during the next 12 months.

The number of houses supplied by the Company at Lady-day last was 3,150.

I am, &c.
E. C. Ashdown, Secretary.

H. C. Saunders, Esq.

4.—SOUTHWARK AND VAUXHALL WATERWORKS.

Return to Circular 1.

(A.) Quantity of Water pumped Daily into the District supplied by the Southwark and Vauxhall Water Company, from 29th March to 2d May 1857 inclusive.

1857:	*Gallons.*		*Gallons.*
Sunday, March 29 - -	[4,414,000]	April 16 - -	10,027,000
„ 30 - -	10,979,000	„ 17 - -	10,250,000
„ 31 - -	11,192,000	„ 18 - -	10,750,000
April 1 - -	11,143,000	Sunday, April 19 - -	[3,566,000]
„ 2 - -	11,187,000	„ 20 - -	10,143,000
„ 3 - -	10,996,000	„ 21 - -	10,528,000
„ 4 - -	11,084,000	„ 22 - -	10,970,000
Sunday, April 5 - -	[3,636,000]	„ 23 - -	10,176,000
„ 6 - -	10,141,000	„ 24 - -	10,254,000
„ 7 - -	9,931,000	„ 25 - -	10,756,000
„ 8 - -	10,201,000	Sunday, April 26 - -	[4,640,000]
„ 9 - -	10,358,000	„ 27 - -	10,123,000
„ 10 - -	10,100,000	„ 28 - -	11,557,000
„ 11 - -	10,564,000	„ 29 - -	10,670,000
Sunday, April 12 - -	[4,971,850]	„ 30 - -	10,866,000
„ 13 - -	10,166,000	May 1 - -	10,643,000
„ 14 - -	10,265,000	„ 2 - -	10,983,000
„ 15 - -	10,786,000		

Joseph Quick, Engineer.

(B.) Quantity of Water pumped (each Hour) during the Day and Night into the District supplied by the Southwark and Vauxhall Water Company, from 5 April to 11 April 1857 (inclusive).

—	Sunday, 5th April.	Monday, 6th April.	Tuesday, 7th April.	Wednesday, 8th April.	Thursday, 9th April	Friday, 10th April.	Saturday, 11th April.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
1 A.M. -	70,000	86,000	87,000	86,000	93,000	86,000	97,000
2 „ -	86,000	92,000	91,000	88,000	96,000	93,000	101,000
3 „ -	101,000	109,000	111,000	107,000	163,000	108,000	188,000
4 „ -	125,000	296,000	301,000	298,000	303,000	297,000	352,000
5 „ -	162,000	504,000	502,000	506,000	498,000	512,000	553,000
6 „ -	231,000	606,000	601,000	604,000	647,000	598,000	657,000
7 „ -	238,500	680,000	664,000	678,000	682,000	678,000	681,000
8 „ -	274,000	679,000	681,000	683,000	679,000	682,000	698,000
9 „ -	358,000	666,000	682,000	660,000	658,000	667,000	689,000
10 „ -	421,000	594,000	592,000	596,000	602,000	597,000	596,000
11 „ -	256,000	566,000	580,000	567,000	579,000	563,000	598,000
12 „ -	212,000	582,000	568,000	582,000	601,000	597,000	603,000
1 P.M. -	166,000	598,000	601,000	597,000	602,000	603,000	602,000
2 „ -	122,000	556,000	549,000	488,000	552,000	582,000	578,000
3 „ -	106,000	489,000	486,000	550,000	492,000	496,000	506,000
4 „ -	100,000	462,000	458,000	466,000	460,000	463,000	481,000
5 „ -	92,000	461,000	432,000	458,000	502,000	453,000	462,000
6 „ -	87,000	445,000	429,000	506,000	438,000	438,000	508,000
7 „ -	80,000	436,000	408,000	470,000	496,000	412,000	412,000
8 „ -	75,000	383,000	322,000	385,000	361,000	387,000	379,000
9 „ -	70,000	317,000	306,000	282,000	329,000	293,000	314,000
10 „ -	69,000	228,000	222,000	237,000	217,000	219,000	237,000
11 „ -	68,000	184,000	159,000	159,000	201,000	171,000	160,000
12 „ -	67,000	122,000	125,000	168,000	107,000	105,690	112,000

Joseph Quick, Engineer.

Return to Circular 2.

Office of Southwark and Vauxhall Water Company,
Sumner-street, Southwark, 20 June 1857.

Sir,

In answer to your communication of the 16th instant, I am instructed to inform you that the progressive increase of 7½ per cent. has already occurred in the supply of water from this Company since the last detailed return; and Mr. Quick considers a further advance over that supply, to the amount of 7 or 8 per cent., may be looked for during the summer.

The number of houses supplied by the Company was 44,529 at Lady-day 1857.

I have, &c.
(signed) *James Rossiter*, Secretary.

Herbert C. Saunders, Esq.,
29, Great George-street.

LIST of PLATES to APPENDIX III.

Plate 1. Drawing of the Weirs used in Gauging the Sewers.

„ 2. Diagram showing the Mean Dry-Weather Discharge of the Principal Sewers, &c. on the North Side of the Thames, between February and June 1857.

„ 3. Diagram showing the Mean Dry-Weather Discharge of the Principal Sewers, &c. on the South Side of the Thames.

„ 4. Map showing the Lines of Main Sewers in the Metropolis, and the Ratio of the Mortality from Cholera in the several Districts.

„ 5. Map showing the Extent of Ground covered by the Metropolis in the years 1745, 1818, 1834 and 1857 respectively.

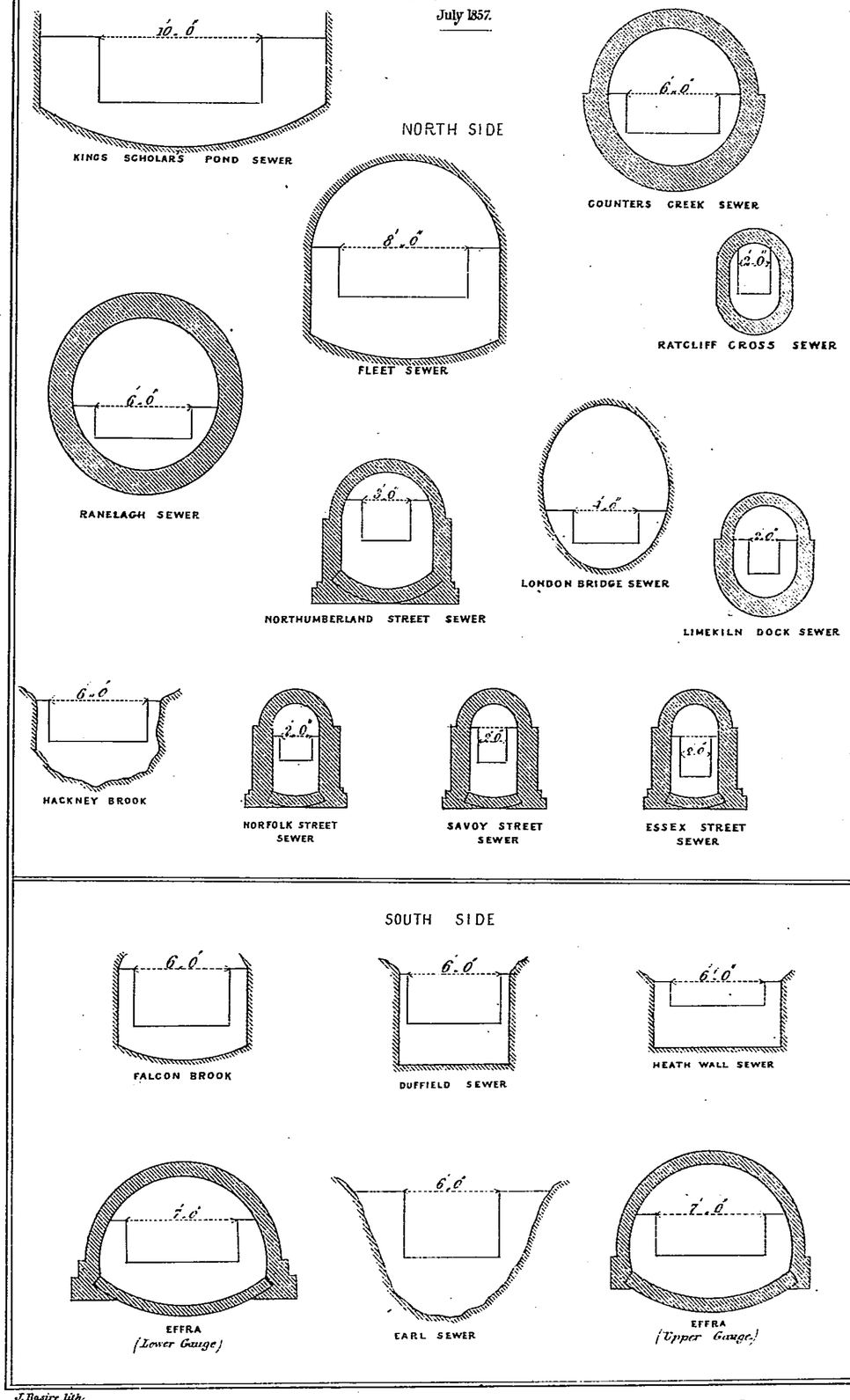
„ 6. Diagram to illustrate the Increase of Population in some of the Metropolitan Districts.

APPENDIX III.
(Plate I.)

WEIRS USED IN GAUGING FLOW OF SEWERS.

Scale 3/4th inch to a foot.

July 1857.



J. Basire, lith.

№ 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.
Henry Hansard, Printer.

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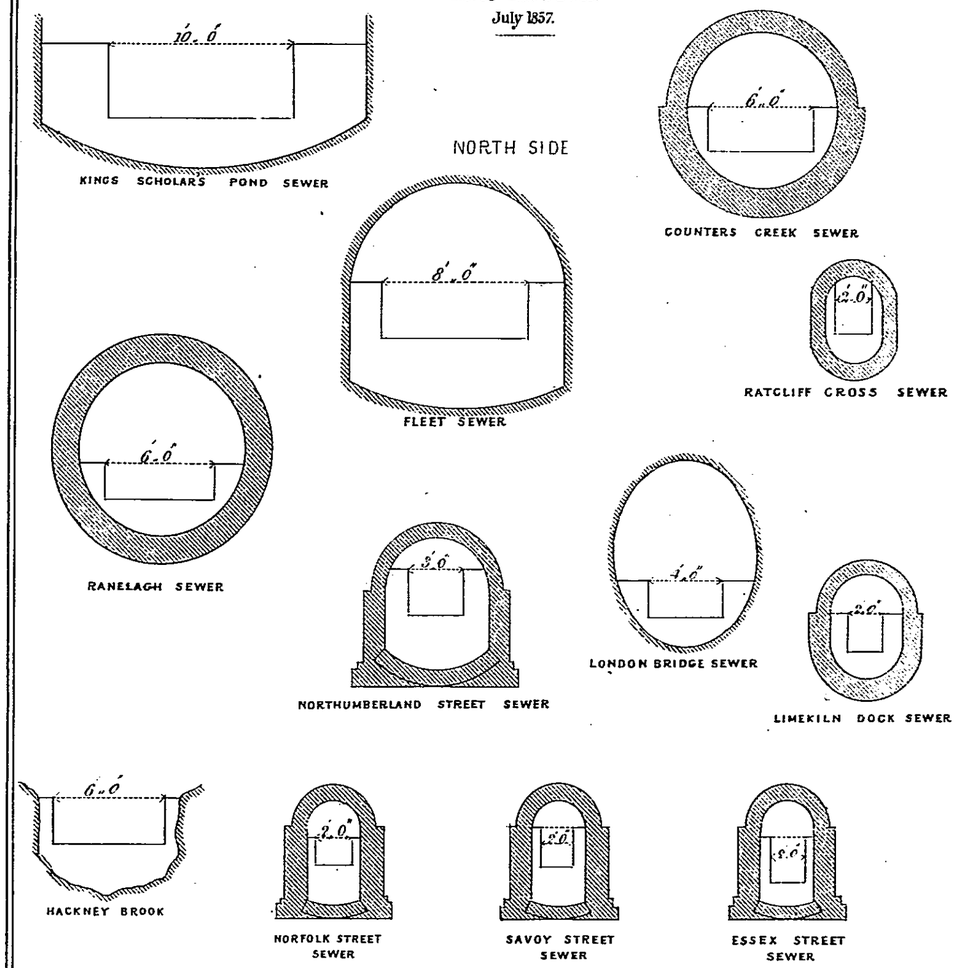
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(Plate I.)

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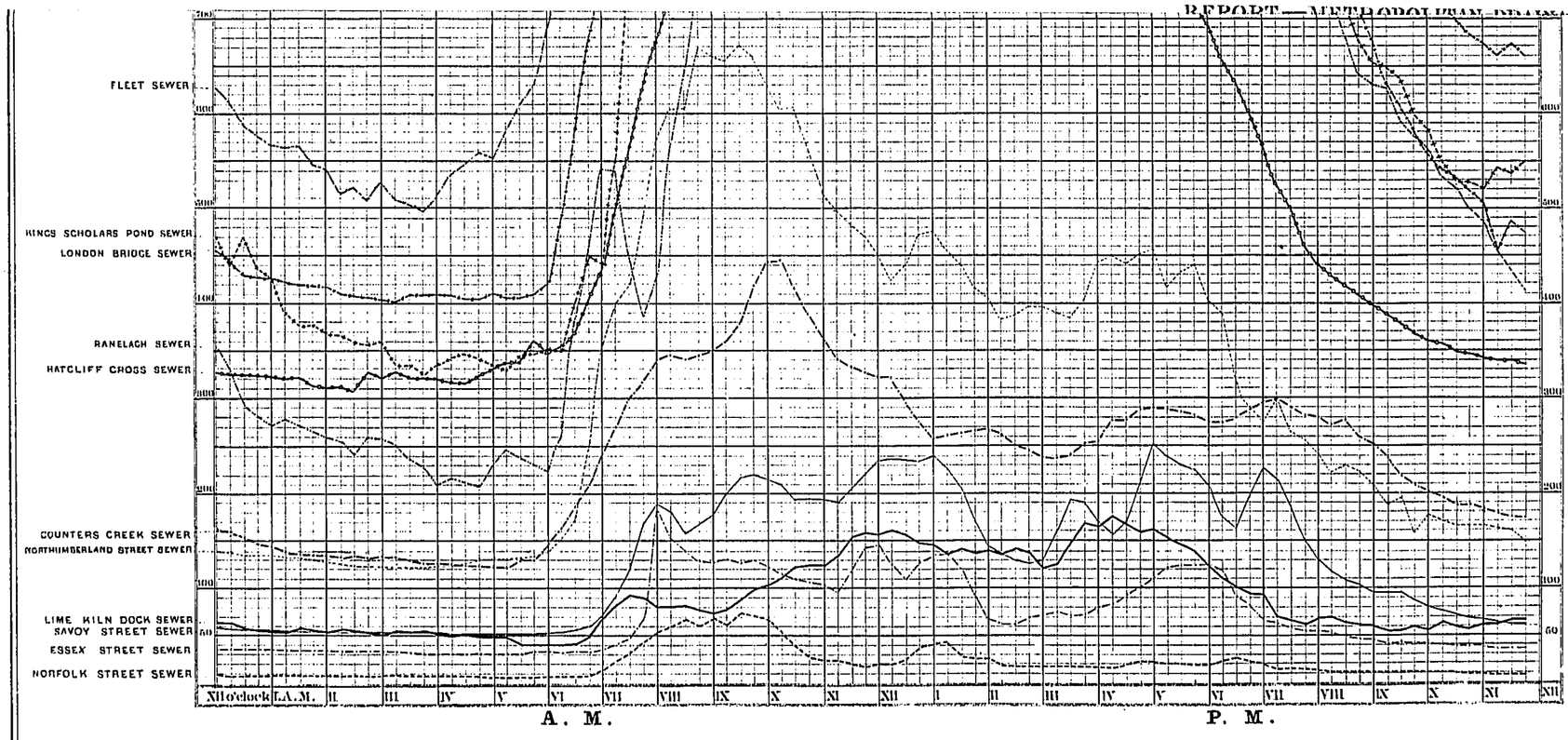
Scale 1/8th inch to a foot.

July 1857.



J. Basire, lith.

№ 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.
Henry Hansard, Printer.



Standidge & Co. Lith. Old Jewry, London.

No 233. Ordered, by The House of Commons, to be Printed 3rd August, 1857.

Henry Hansard, Printer.

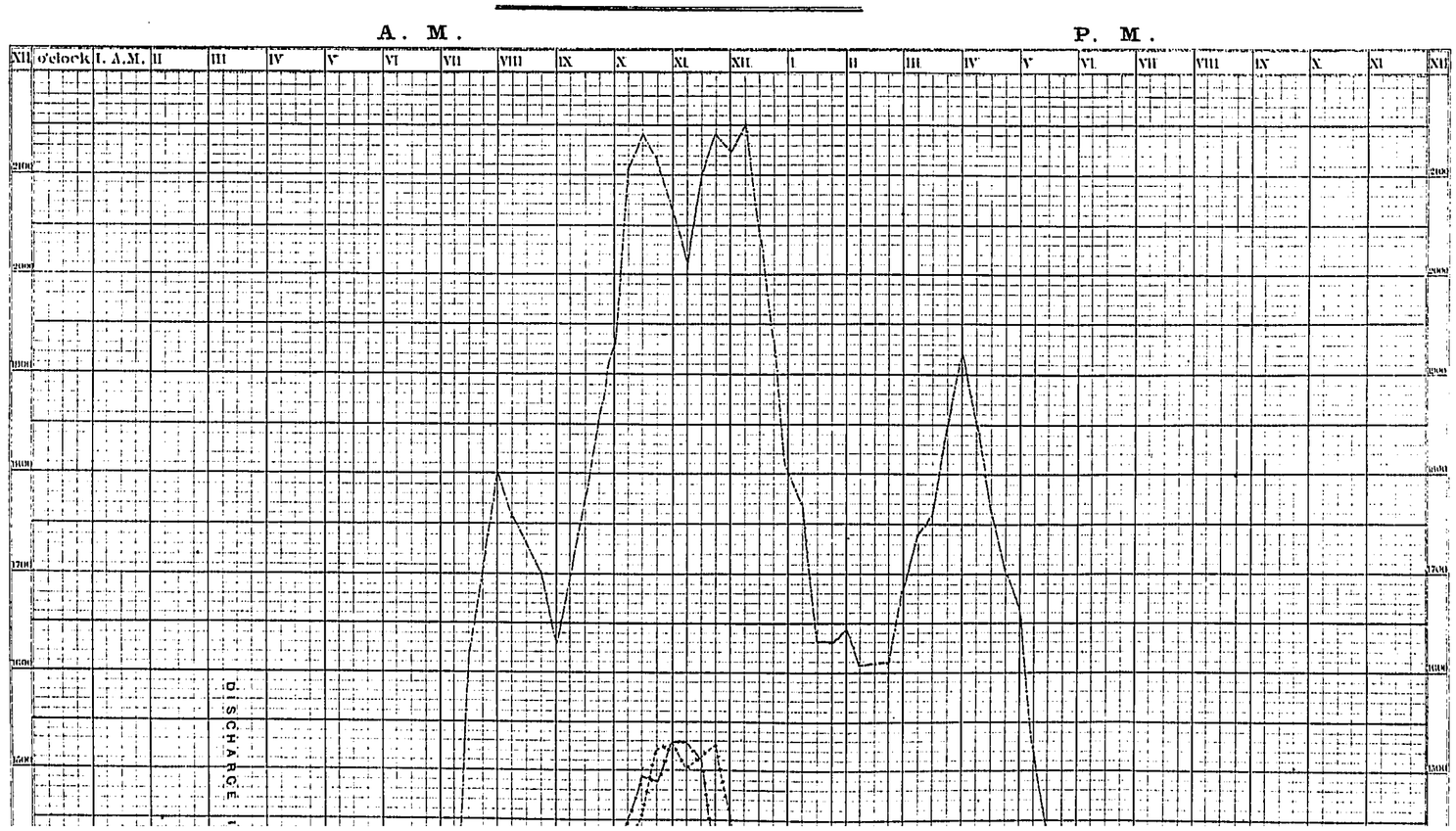
APPENDIX III.
(Place, 2)

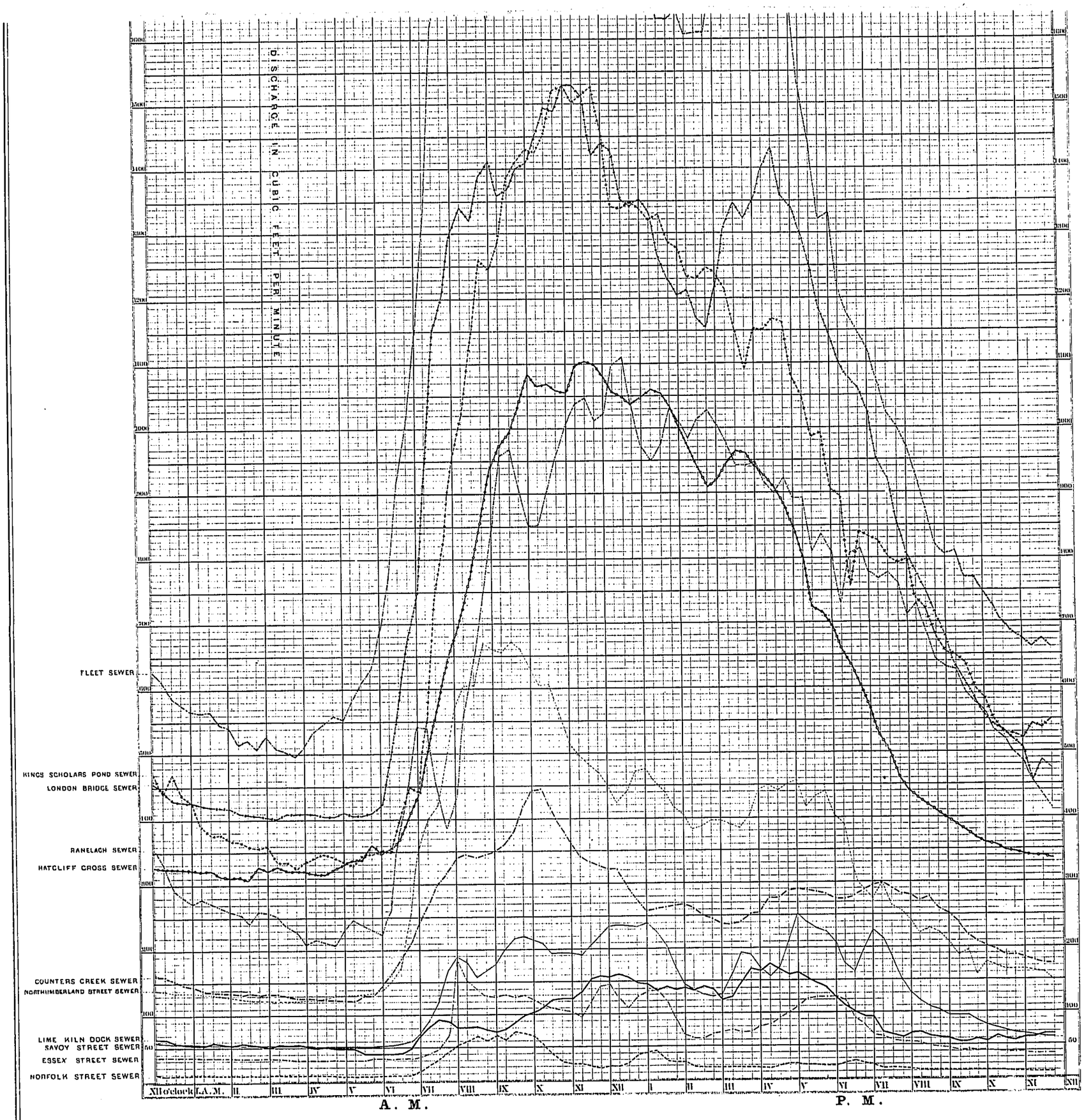
DIAGRAM

SHOWING THE MEAN DRY WEATHER DISCHARGE IN CUBIC FEET PER MINUTE OF THE

PRINCIPAL SEWERS ON THE NORTH SIDE OF THE THAMES,

BETWEEN THE MONTHS OF FEBRUARY AND JUNE 1857.

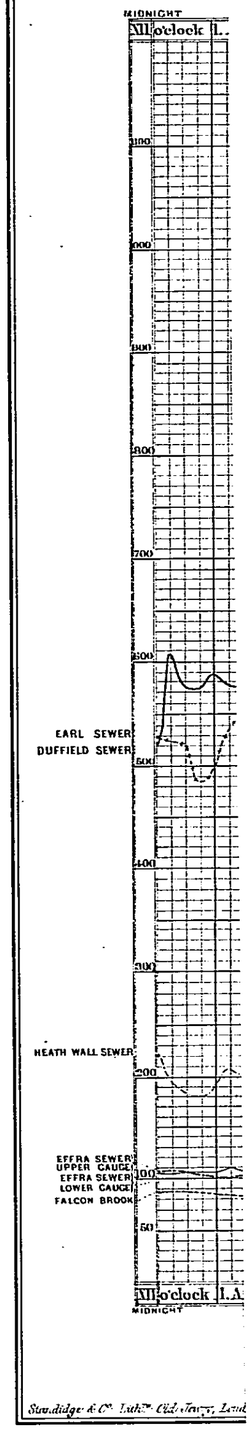




Standidge & Co. Lith. Ord Savoy, London.

Nº233. Ordered, by The House of Commons, to be Printed 3rd. August, 1857.

Henry Hansard, Printer.

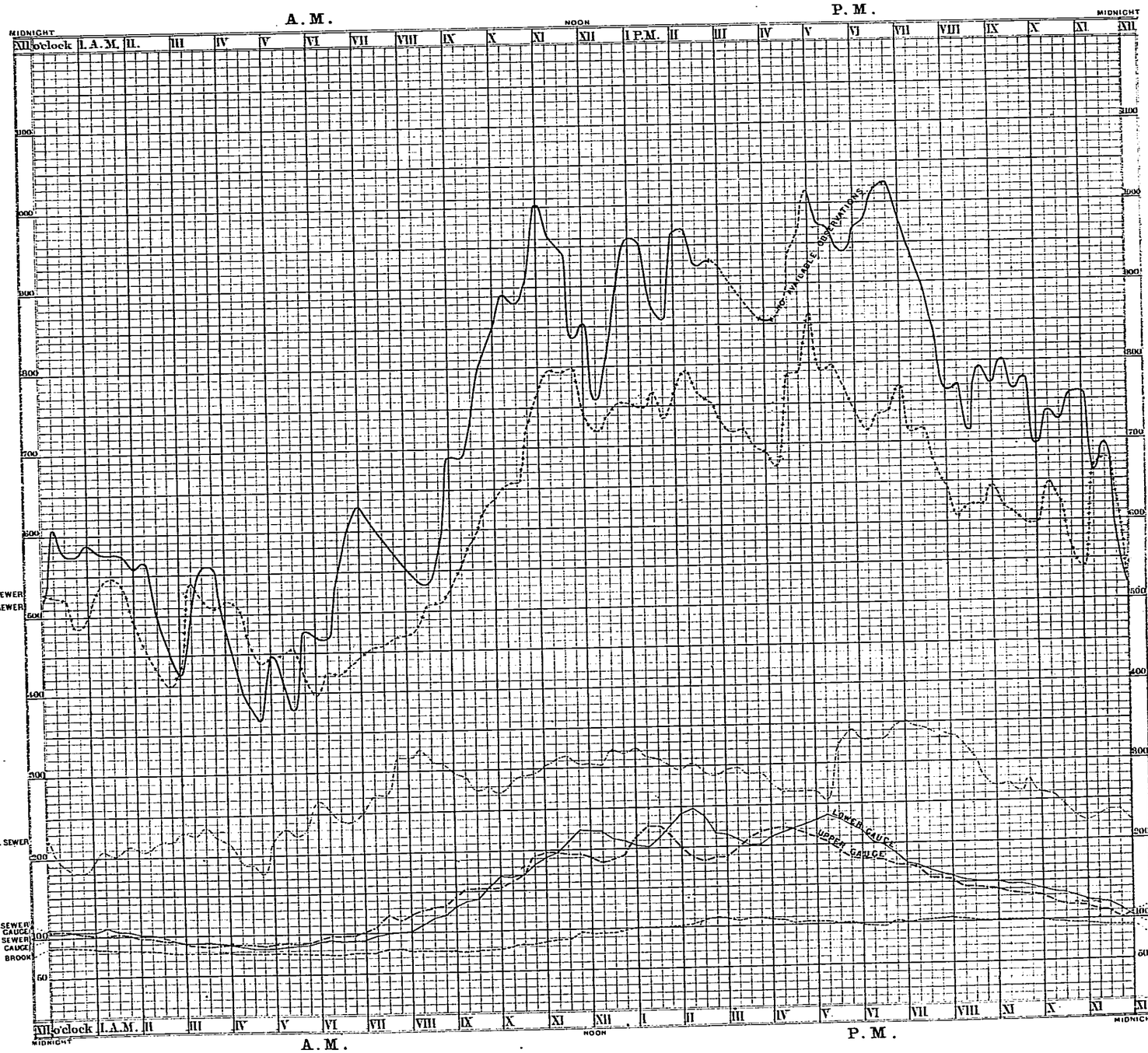


Standidge & Co. Lith.rs Old Jewry, Lond

APPENDIX III.
(Plate, 3.)

DIAGRAM

SHOWING THE MEAN DRY WEATHER DISCHARGE IN CUBIC FEET PER MINUTE OF THE
PRINCIPAL SEWERS ON THE SOUTH SIDE OF THE THAMES,
AS GAUGED FROM FEBRUARY TO APRIL, 1857.



Standidge & Co. Lith.rs Old Jewry, London.

N°233. Ordered by The House of Commons, to be Printed, 3rd August, 1857.

APPENDIX III.
(PLATE 4.)

MAP
OF THE
OPOLITAN DISTRICTS
Showing the course of the
OF MAIN SEWERS

REFERENCE TO SUB-DISTRICTS.

KENSINGTON.
1 Paddington St. Mary.
2 Paddington St. John.
3 Kensington Town.
4 Brompton.
5 Hammersmith St. Peter.
6 Hammersmith St. Paul
7 Fulham.

CHELSEA.
8 South.
9 North West.
10 North East.

ST. GEORGE'S HANOVER SQ.
11 Hanover Square.
12 May Fair.
13 Belgrave.

WESTMINSTER.
14 St. John.
15 St. Margaret.

ST. MARTIN IN THE FIELDS.
16 Charing Cross.
17 Long Acre.

ST. JAMES, WESTMINSTER.
18 Berwick Street.
19 St. James' Square.
20 Golden Square.

MARY-LE-BONE.
21 All Souls.
22 Cavendish Square.
23 Rectory.
24 St. Mary.
25 Christchurch.
26 St. John.

HAMPSTEAD.
27 Hampstead.

PANCRAS.
28 Regents Park.
29 Tottenham Court Road.
30 Grays Inn Lane.
31 Somerstown.
32 Camden Town.
33 Kentish Town.

ISLINGTON.
34 West.
35 East.

HACKNEY
36 Stoke Newington.
37 Stamford Hill.
38 West Hackney.
39 Hackney.
40 South Hackney.

ST. GILES.
41 St. Georges, Bloomsbury.
42 St. Giles, South.
43 St. Giles, North.

STRAND.
44 St. Anne, Soho.
45 St. Mary-le-Strand.
46 St. Clement Danes.

HOLBORN.
47 St. George the Martyr.
48 St. Andrew, Eastern.
49 Saffron Hill.

CLERKENWELL.
50 St. James'
51 Amwell.
52 Pentonville.
53 Goswell Street.

ST. LUKE
54 Old Street.
55 City Road.
56 Whitecross Street.
57 Finsbury.

EAST LONDON.
58 St. Botolph.
59 Cripplegate.

WEST LONDON.
60 North.
61 South.

CITY OF LONDON
62 South West.
63 North West.
64 South.
65 South East.
66 North East.

SHOREDITCH.
67 Holywell.
68 St. Leonard.
69 Hoxton New Town.
70 Hoxton Old Town.
71 Haggerstone West.
72 Haggerstone East.

BETHNAL GREEN.
73 Hackney Road.
74 Green.
75 Church.
76 Town.

WHITECHAPEL.
77 Artillery.
78 Spitalfields.
79 Mile End New Town.
80 Whitechapel North.
81 Whitechapel Church.
82 Goodman's Fields.
83 Aldgate.

ST. GEORGE'S IN THE EAST.
84 St. Mary.
85 St. Paul.
86 St. John.

STEPNEY.
87 Shadwell
88 Ratcliffe
89 Mile End Old Town Upper.
90 Mile End Old Town Lower.
91 Limehouse.

POPLAR.
92 Bow.
93 Poplar.

ST. SAVIOUR SOUTHWARK.
94 Christchurch.
95 St. Saviour.

ST. OLAVE, SOUTHWARK.
96 St. Olave.
97 St. John, Horseleydown.

BERMONDSEY.
98 St. James.
99 St. Mary Magdalene
100 Leather Market.

ST. GEORGE'S SOUTHWARK.
101 Kent Road.
102 Borough Road.
103 London Road.

NEWINGTON.
104 Trinity.
105 St. Peter, Walworth.
106 St. Mary.

LAMBETH.
107 Waterloo Road. 1st
108 Waterloo Road. 2nd
109 Lambeth Church 1st
110 Lambeth Church 2nd
111 Kennington, 1st
112 Kennington, 2nd
113 Brixton.
114 Norwood.

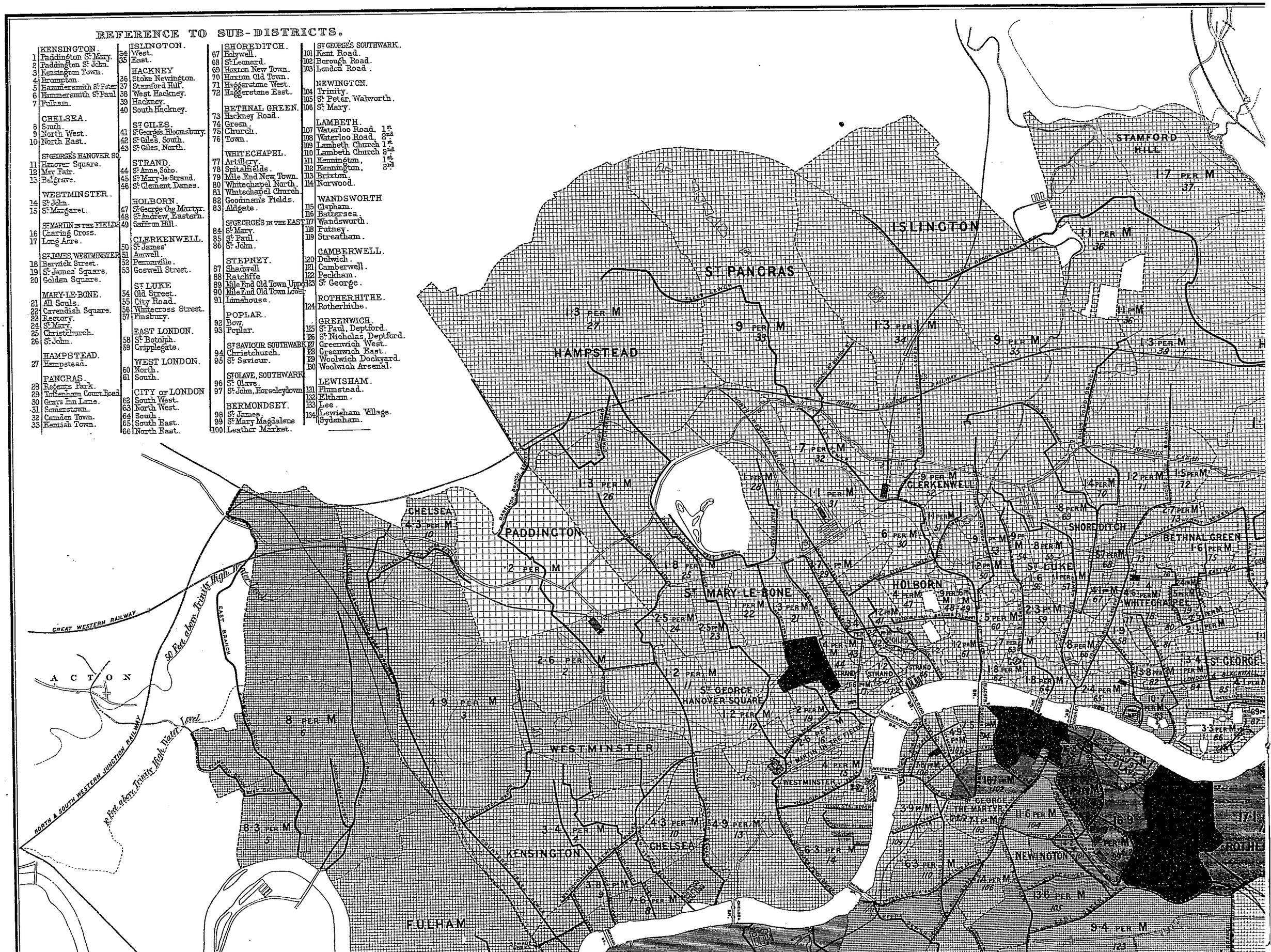
WANDSWORTH
115 Clapham.
116 Battersea.
117 Wandsworth.
118 Putney.
119 Streatham.

CAMBERWELL.
120 Dulwich.
121 Camberwell.
122 Peckham.
123 St. George.

ROTHERHITHE.
124 Rotherhithe.

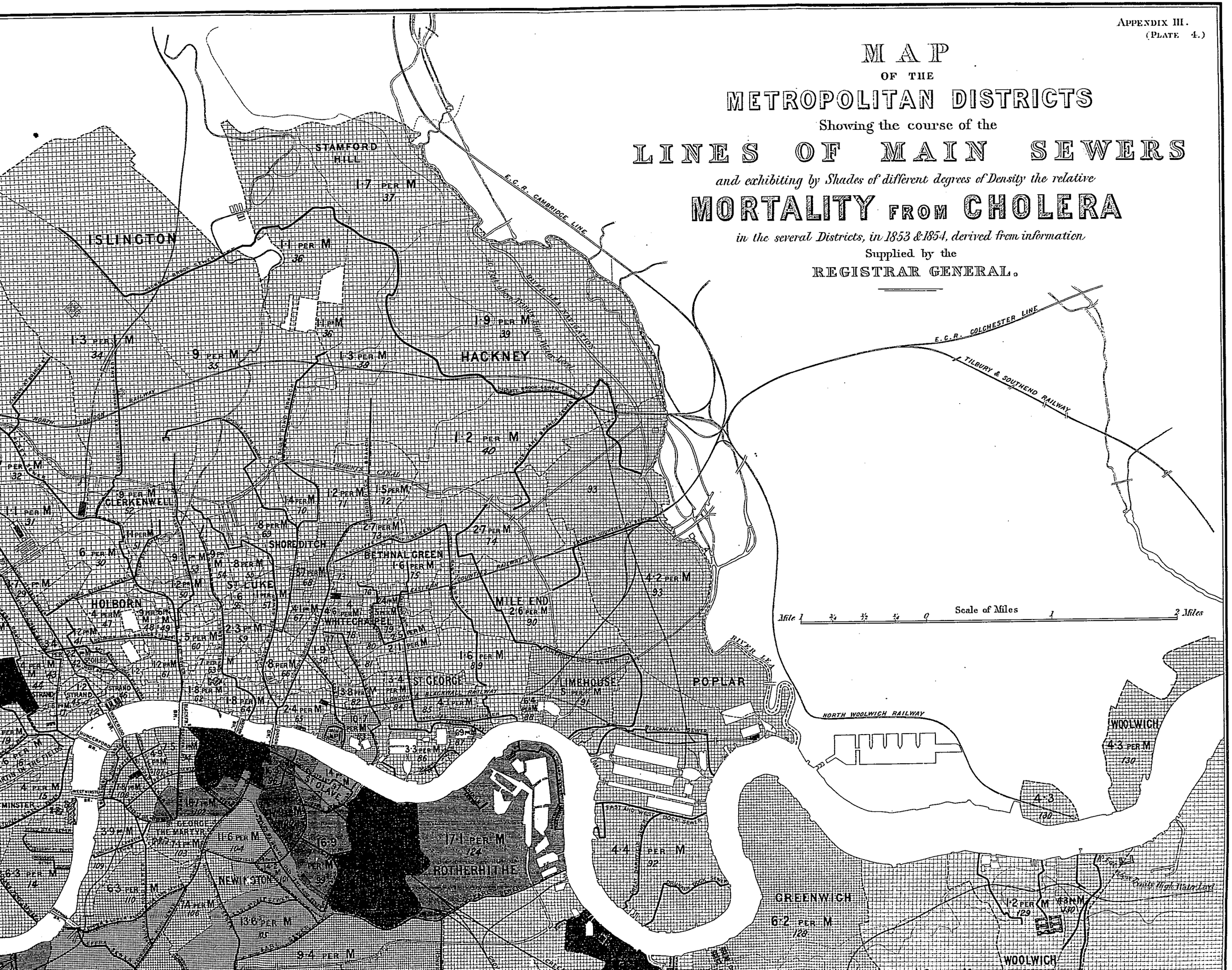
GREENWICH.
125 St. Paul, Deptford.
126 St. Nicholas, Deptford.
127 Greenwich West.
128 Greenwich East.
129 Woolwich Dockyard.
130 Woolwich Arsenal.

LEWISHAM.
131 Plumstead.
132 Eltham.
133 Lee.
134 Lewisham Village.
134 Sydenham.



APPENDIX III.
(PLATE 4.)

MAP
OF THE
METROPOLITAN DISTRICTS
Showing the course of the
LINES OF MAIN SEWERS
and exhibiting by Shades of different degrees of Density the relative
MORTALITY FROM CHOLERA
in the several Districts, in 1853 & 1854, derived from information
Supplied by the
REGISTRAR GENERAL.



ACTON

10 Feet above Trinity High Water Level

NORTH & SOUTH WESTERN JUNCTION RAILWAY

8 PER M 6

8·3 PER M 5

2·6 PER M 2

4·9 PER M 3

1·2 PER M 11

ST GEORGE HANOVER SQUARE 1·2 PER M 12

WESTMINSTER

3·4 PER M 4

4·3 PER M 10

4·9 PER M 13

KENSINGTON

CHELSEA

3·8 PER M 9

7·6 PER M 8

FULHAM

5·9 PER M 7

MORTLAKE

BEVERLEY BROOK

10 Feet above Trinity High Water Level

50 Feet above Trinity High Water Level

RICHMOND RAILWAY

1·8 PER M 118

7 PER M 117

WANDSWORTH

SOUTH WESTERN RAILWAY

LORD SPENCER'S SEWER

LONDON & SOUTH WESTERN RAILWAY

13·5 PER M 111

LAMBETH

15·2 PER M 116

10·9 PER M 115

1·9 PER M 119

1·2 (STRAND) 45

1·2 (STRAND) 15

1·8 PER M 62

2·4 PER M 65

3·8 PER M 82

10·7 PER M 83

3·4 ST GEORGE

4·1 PER M 84

3·3 PER M 86

4·3 PER M 106

7·5 PER M 87

4·9 PER M 107

2 PER M 19

2·6 PER M 16 THE FIELDS

2 PER M 15

WESTMINSTER

ST MARTIN IN THE FIELDS

ST GEORGE THE MARTYR

3·9 PER M 108

7·1 PER M 103

11·6 PER M 104

6·3 PER M 14

6·3 PER M 110

NEWINGTON

7·8 PER M 116

13·6 PER M 105

9·4 PER M 123

CAMBERWELL

8·1 PER M 118

10·1 PER M 122

12 PER M 121

3·9 PER M 113

WANDSWORTH 7 PER M 117

120

EFFRA SEWER (UPPER NORWOOD BRANCH)

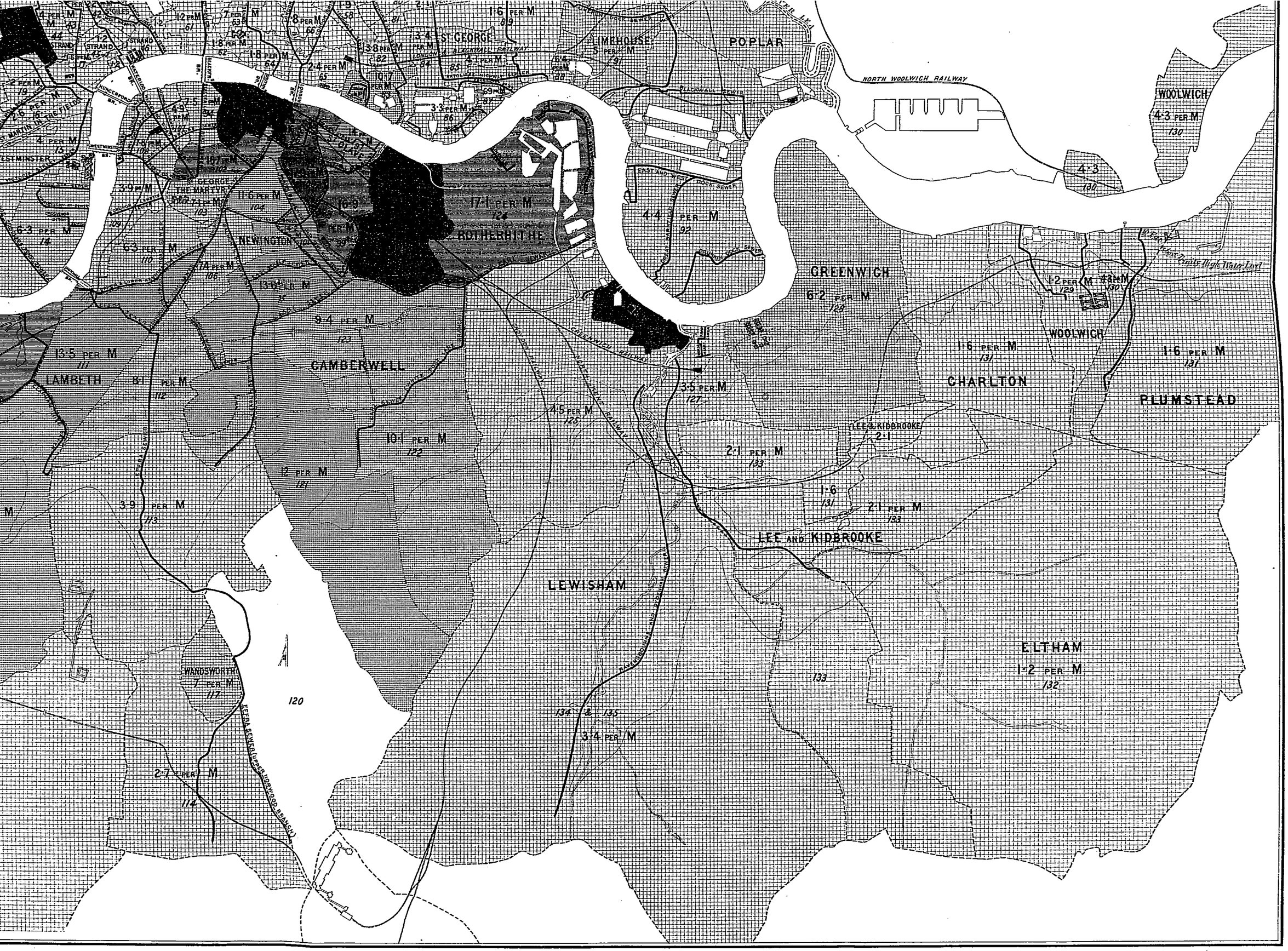
2·7 PER M 114

17·1 PER M 124

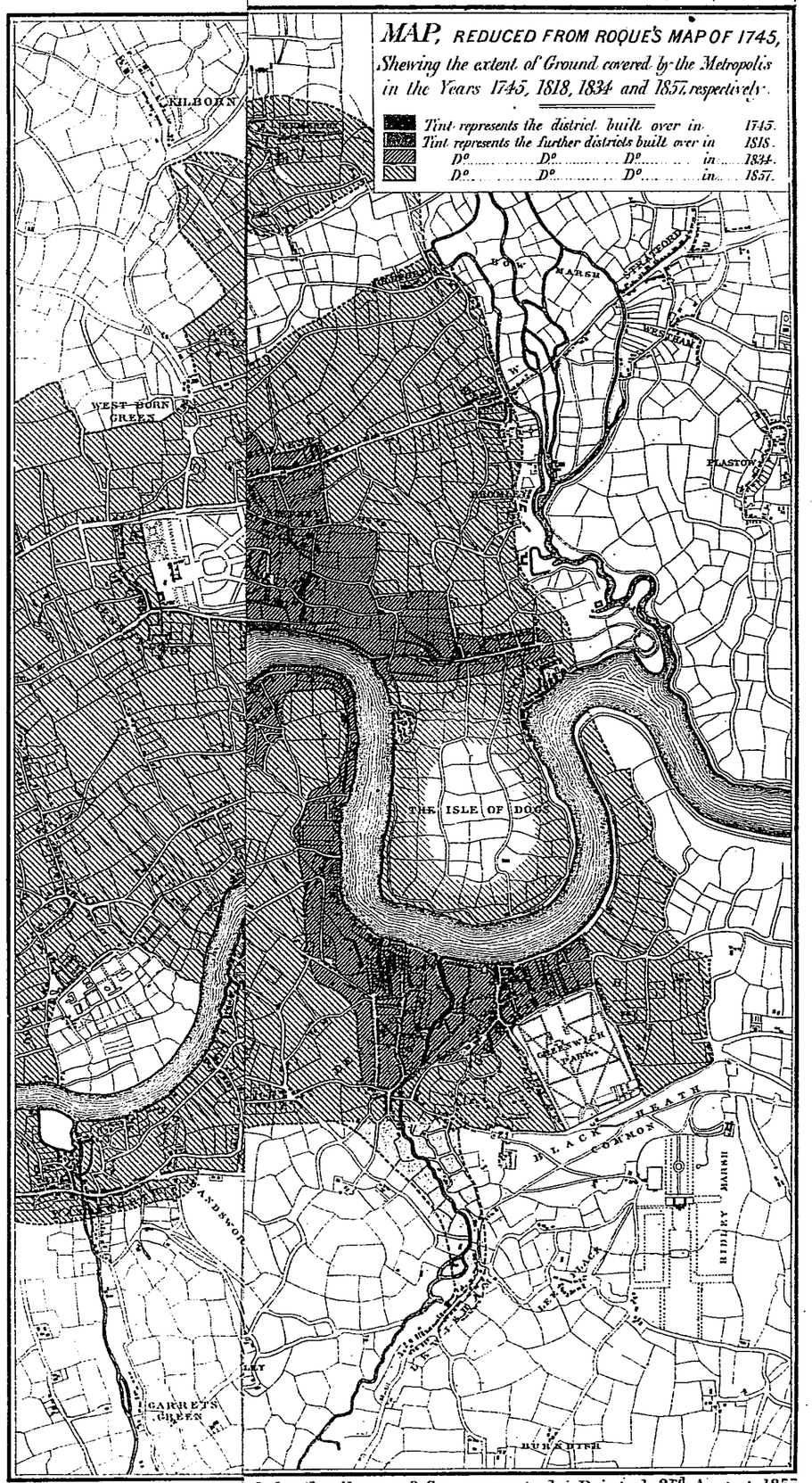
ROTHERHITHE

16·9 PER M 99

L



№ 233. Ordered, by the House of Commons, to be Printed 3rd August 1857.



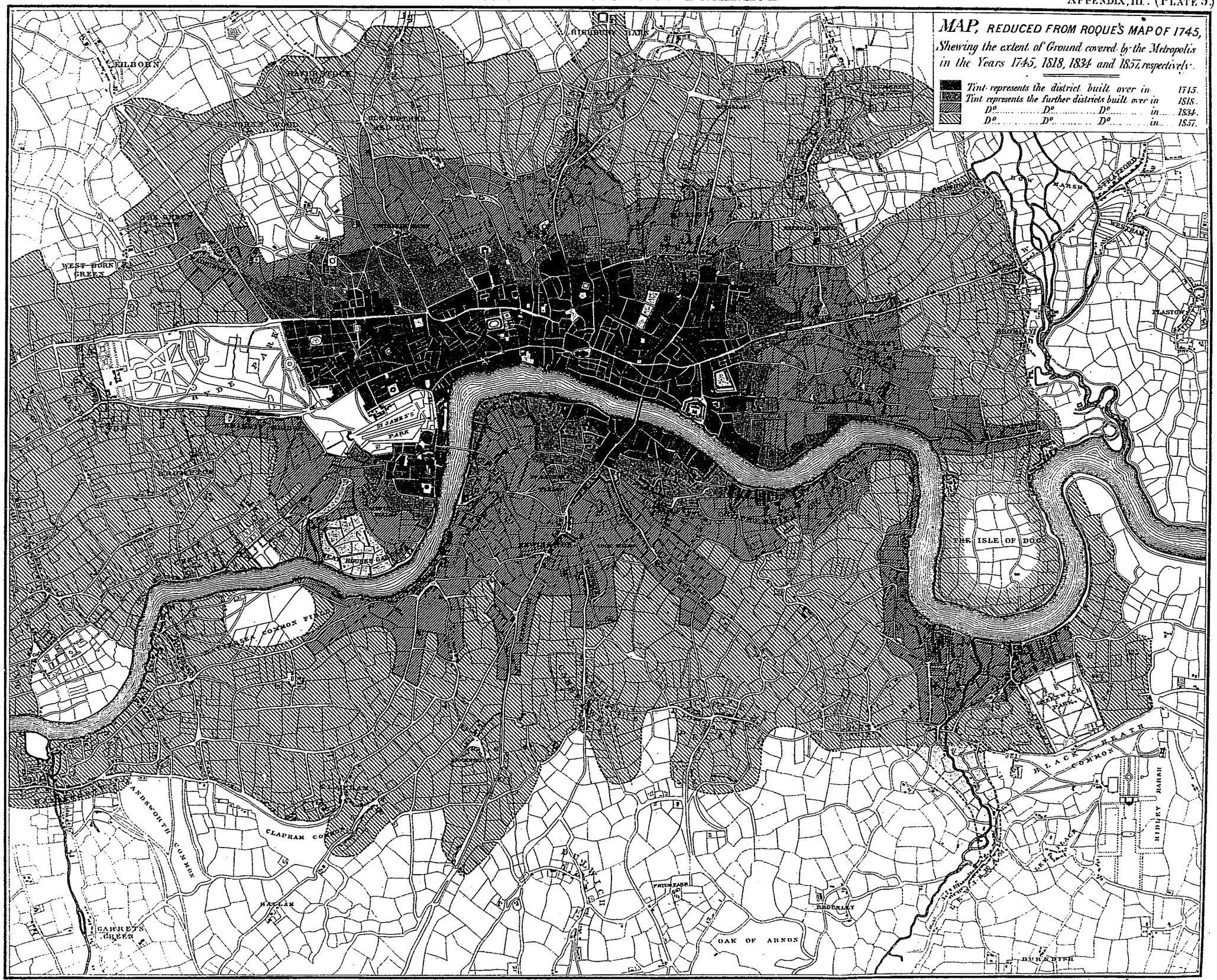
Day & Son, Lith^rs to the Queen.

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Henry Hansard, Printer.

MAP, REDUCED FROM ROQUE'S MAP OF 1745,

Shewing the extent of Ground covered by the Metropolis in the Years 1745, 1818, 1834 and 1857, respectively.

Tint represents the district built over in				*1745.*
Tint represents the further districts built over in				*1818.*
Dº	*Dº*	*Dº*	*in*	*1834.*
Dº	*Dº*	*Dº*	*in*	*1857.*



Day & Son, Lith^rs to the Queen.

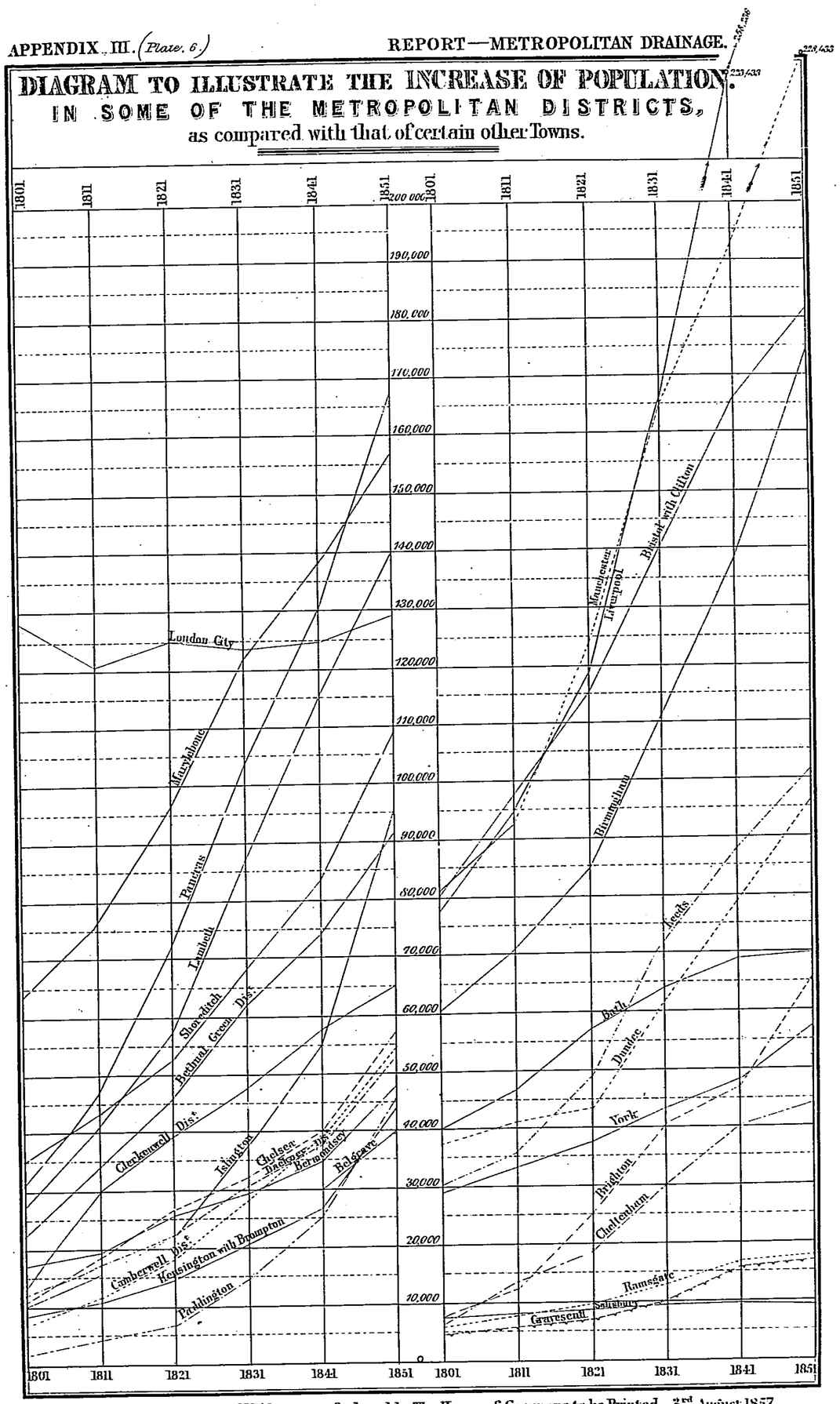
Nº 233. Ordered, by the House of Commons, to be Printed 3rd August 1857.

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DIAGRAM TO ILLUSTRATE THE INCREASE OF POPULATION.

IN SOME OF THE METROPOLITAN DISTRICTS,

as compared with that of certain other Towns.



No 233. Ordered, by The House of Commons, to be Printed, 3rd August 1857.

Henry Hansard, Printer.

APPENDIX IV.

Mr. Blackwell's Experiments on effect of Running Water.

Experiments by Mr. *Blackwell* on Effect of Running Water in moving various Substances.

The following experiments were undertaken by Mr. Blackwell in the early part of the present year, at Crofton, in Wiltshire, where the springs constituting the head of the Bedwyn Stream are collected in a 10-acre reservoir, the regular discharge of which admitted of an extensive range of experiments of this character.

The water here issues from numerous springs in the lower chalk, and the contiguous beds of the upper green sand formation, at a temperature which scarcely ever varies a degree from the average of 51 Fahrenheit, always remarkably clear, and its volume, the situation, and circumstances generally seemed to answer almost every reasonable requirement.

The experiments were suggested by a want, which has frequently been felt, of an exact record of facts bearing on this important branch of engineering knowledge, and at no time would the advantage of correct data be more useful than when so much of the engineer's attention is directed to the construction of sewers, an important branch of which Mr. Blackwell, as one of the referees, has had his attention particularly called to while investigating the subject of the main drainage of London. Having in view, therefore, the application of exact knowledge to this question, the experiments have been designed with, the following views:

1. To ascertain the velocity of the stream at which selected materials of a known quality size, form, and specific gravity,* will cease to move on a level plane forming the bottom of the watercourse.

2. To determine the ratio which exists between the velocity of the stream and the velocity of the materials moved, by increasing such velocities, and continuing the observations for such a period as would be calculated to afford good practical results.

3. To determine the effect of aggregation of well-known descriptions of materials, and the influence of such aggregation when exposed to certain velocities of the stream, observing the circumstances attendant on the removal of the materials forming the aggregated mass.

4. Finally, to secure such a record of the facts as could at any future time be referred to. channel was practically level from end to end. (*See* Plate 1.)

The arrangement of the apparatus used for the experiments will be best explained by reference to the sketch, which shows a rectangular channel, 60 feet long, having a transverse section of four feet wide and three feet deep. This channel, or watercourse, was made of planks of elm rough from the saw, painted on the inside, and rendered water-tight. The Certain distances were measured off, but the velocities, which were quite uniform in that part of it, were specially confined to a length of 30 feet.

The regulation of water could be easily effected by sluices at the head, or by depressing the tail water, which was a portion of the Kennet and Avon Canal, in length a quarter of a mile.

The velocity of the water was ascertained, instrumentally, by a tachometer, which could be accurately and instantly fixed in any part of the channel; and the instrument was frequently tested by reference to its indications in passing through a measured distance of perfectly still water, and by the surface velocities indicated by floats; indeed every reasonable means were taken to secure accuracy.

The weight of each of the objects tried was ascertained, first in air, and then in water, by means of which its cubic contents and specific gravity were ascertained.

The form and general dimensions of these materials are given by photography, on a board divided into inches, so that a clear idea may be gained of their form; and, finally, they are all preserved for future reference. (*See* Plates 2, 3, 4 and 5.)

The experiments, 412 in number, were made on different sizes of the same material, and several experiments were made on the same specimen. They would occupy too much space to be given in detail. A short statement, in the form of the annexed table, has therefore been drawn up, which shows the general results obtained.

The first vertical column contains a description of the objects, and a reference by which they can be distinguished in the plates.

The first horizontal column shows the velocity of the current in which the objects were experimented upon; and underneath this is shown the effect of such velocity, the object either starting or attaining the stated velocity. Thus, for example, Broken Granite, No. 1, started with a velocity of current between 2·00 and 2·25 per second, and moved at the rate of 1·00 per second, with a velocity of current of between 2·75 and 3·00 per second, &c. &c.

TABLE

* The materials selected are such as are met with in sewers and watercourses; or such as may be expected, from their presence, to interfere with their action.

TABLE showing the Effect of Running Water in moving various Substances.

DESCRIPTION OF OBJECT.		Weight in Oz. Avoirdupois.	Cubic Contents in Inches.	Specific Gravity.	VELOCITY OF CURRENT.															
					0 to 1·00.	1·00 to 1·25.	1·25 to 1·50.	1·50 to 1·75.	1·75 to 2·00.	2·00 to 2·25.	2·25 to 2·50.	2·50 to 2·75.	2·75 to 3·00.	3·00 to 3·25.	3·25 to 3·50.	3·50 to 3·75.	3·75 to 4·00.	4·00 to 4·25	4·25 to 4·50.	4·50 to 4·75.	4·75 to 5·00.
Brickbat	A. 1	22 00	18·5	2·05	–	–	–	–	–	–	–	–	Start	0·94	1·15	1·25	1·30	–	2·14	2·31	—
	„ 2	16·0	13·6	2·03	–	–	–	–	–	Start	–	–	1·15	–	–	1·50	–	–	–	2·31	—
	„ 3	9·0	7·33	2·12	–	–	–	–	–	Start	0·7	0·82	–	1·20	–	–	–	1·87	2·00	2·61	—
	„ 4	6·0	4·76	2·18	–	–	–	–	–	–	Start	–	–	0·42	–	1·2	–	2·00	2·14	—	
	„ 5	3·0	2·59	2·00	–	–	–	–	Start	–	–	1·00	–	–	1·50	—					
	B. 1.	16·0	12·98	2·13	–	–	–	–	–	–	Start	–	–	–	1·11	1·50	1·58	2·00	–	–	2·73
Building Stone (Oolite)	C. 1	22·0	17·08	2·15	–	–	–	–	–	–	–	–	Start	1·00	1·15	1·25	1·43	—			
	„ 2	9·0	6·70	2·32	–	–	–	–	–	–	–	Start	0·91	–	1·15	1·20	1·25	1·87	—		
	„ 3	3·0	2·39	2·17	–	–	–	–	–	Start	–	–	–	–	1·36	1·43	1·87	–	–	2·22	—
Chalk	D. 1	22·0	18·54	2·05	–	–	–	–	Start	–	0·60	0·67	–	1·20	1·30	–	1·07	–	1·76	—	
	„ 2	16·0	12·74	2·17	–	–	–	–	–	–	Start	–	1·00	1·11	1·50	–	1·87	—			
	„ 3	9·0	7·78	2·00	–	–	–	–	–	Start	–	0·03	–	1·36	–	1·87	—				
	„ 4	6·0	5·18	2·00	–	–	–	–	–	Start	–	0·92	–	1·15	1·58	–	1·67	2·14	—		
	„ 5	3·0	2·39	2·17	–	–	–	–	–	–	Start	0·75	0·94	1·03	–	1·77	—				
Flints	E. 1	16·0	10·37	2·67	–	–	–	–	–	–	–	–	–	Start	–	1·00	1·06	–	1·56	1·84	—
	„ 2	9·0	6·05	2·57	–	–	–	–	–	Start	0·70	–	–	–	1·30	1·50	—				
	„ 3	6·0	4·11	2·52	–	–	–	–	–	–	Start	–	0·87	–	–	–	–	1·46	1·58	–	2·00
	„ 4	3·0	1·95	2·66	–	–	–	–	–	–	–	Start	–	–	1·07	1·36	1·43	1·76	—		
Coal	F. 1	22·0	28·59	1·33	–	–	–	Start	–	–	–	0·91	–	–	1·50	1·76	1·87	—			
	„ 2	9·0	11·69	1·33	–	–	Start	0·54	–	–	1·11	–	–	1·67	–	–	2·07	—			
	„ 3	3·0	4·11	1·26	–	–	Start	0·45	–	–	1·11	–	–	1·87	2·00	—					
Clinkers	G. 1	16·0	11·67	2·37	–	–	–	–	–	Start	–	–	–	–	1·36	—					
	„ 2	9·0	6·05	2·57	–	–	–	–	–	–	–	–	Start	–	–	–	–	1·15	1·50	—	
	„ 3	3·0	2·39	2·17	–	–	–	–	–	Start	–	–	–	–	–	1·50	–	1·87	—		
Copper Slag	H. 1	6·0	3·46	3·00	–	–	–	–	–	–	–	–	–	–	Start	–	1·07	–	1·67	1·76	—
	„ 2	3·0	1·73	3·00	–	–	–	–	–	–	Start	–	–	–	–	–	1·21	1·76	2·00	—	
	„ 3	1·50	0·86	3·00	–	–	–	–	–	–	–	Start	0·79	–	1·11	–	1·76	–	2·00	—	
Limestone	I. 1	5·0	3·02	2·86	–	–	–	–	–	–	Start	–	–	–	0·94	1·11	–	1·58	1·67	—	
	„ 2	3·0	1·73	3·00	–	–	–	–	–	–	–	Start	–	–	0·90	–	–	1·25	–	1·43	2·00
	„ 3	1·5	0·86	3·00	–	–	–	–	–	–	–	Start	–	–	–	–	1·00	–	1·25	—	
Oyster shells	J. 1	2·87	2·60	1·91	–	–	–	–	Start	0·29	–	–	–	–	0·94	–	1·57	—			
	„ 2	1·12	0·86	2·24	–	–	–	–	–	–	Start	–	–	–	0·38	0·86	1·12	—			
	„ 3	0·50	0·33	2·63	–	–	Start	–	–	–	–	–	–	–	–	–	1·50	–	1·76	—	
Slates	K. 1	15·0	9·06	2·86	–	–	–	–	–	–	–	–	Start	–	–	–	2·00	–	–	2·14	—
	„ 2	9·0	5·4	2·88	–	–	–	–	–	–	–	–	–	Start	–	–	–	–	–	1·00	1·58
	„ 3	4·0	2·38	2·90	–	–	–	–	–	Start	–	–	0·68	–	–	–	–	1·43	2·00	—	
Nails	L. 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Start	—
Scraps of iron (small)	M. 1	–	–	–	–	–	–	–	–	–	–	Start	—								
Ginger beer bottle	N. 1	18·87	14·50	2·25	–	–	–	–	–	–	–	Start	1·87	–	–	–	2·14	—			
Glass bottle broken	O. 1	19·0	12·12	2,71	–	–	–	–	–	–	–	Start	–	–	–	1·11	1·58	—			
Brick on dab of clay	P. 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Start about 6·00		
Granite (broken)	R. 1	0·50	4·22	2·66	–	–	–	–	–	Start	–	0·65	1·00	–	1·15	1·25	–	1·76	—		
	R. 2	3·0	1·94	2·67	–	–	–	–	–	Start	–	–	–	–	–	–	1·00	1·44	–	1·87	—
	R. 3	1·50	0 97	2·66	–	–	–	–	–	–	–	–	Start	–	1·11	–	1·30	1 50	2·00	—	
Boulders	S. 1	11·87	–	–	–	–	–	–	Start	–	1·08	–	1·30	–	–	–	–	1·53	—		
	S. 2	5·87	–	–	–	–	–	–	–	–	Start	1·11	–	–	1·67	–	–	2·14	—		
	S. 3	3·31	–	–	–	–	–	–	–	–	–	Start	–	1·50	–	2·00	–	2·31	—		
Sewage deposit		–	–	1·30	–	–	Start	—													
Road scrapings		–	–	1·78	Start	—															
Gravel ¼ inch		–	–	1·41	–	–	Start	—													
Ditto ½ inch		–	–	1·46	–	–	–	–	–	–	Start	—									
Sand (yellow)		–	–	1·81	Start	—															
Ditto (green)		–	–	1·81	Start	—															

July 1857.

A. L. Trembicki.

Appendix IV.

Mr. Blackwell's Experiments on effect of Running Water.

These experiments allow the following inferences to be drawn: 1. For objects of the same character, the velocity required to start them increased with the mass of the object. 2. For different objects, the velocity required increased with the specific gravity. 3. That, according as the object assumed a form approaching a sphere, the less velocity it took to move it; whereas a flat object, like slate, required a considerable current before it became disturbed from its position. And, 4. As the velocity of current is increased after an object is in motion, the velocity of such object increases in a progressive ratio.

It is well to observe at once that a velocity which will start an object will (when constantly maintained, and no accidental circumstance occur to prevent it) never allow such object to deposit in the stream.

Layers of the different objects were submitted to the action of the current; and the general results prove that the velocity required to remove them was considerably above that which would have been efficient in the case of a single object.

As a general conclusion, it may be observed that a velocity of from 2 ft. to 2 ft. 6 in. per second will remove all objects of the nature and dimensions of those that are likely to be found in sewers.

LIST of PLATES to APPENDIX IV.

Plate 1. Sketch of Apparatus used in Mr. Blackwell's Experiments on the effect of Running Water in moving various Substances.

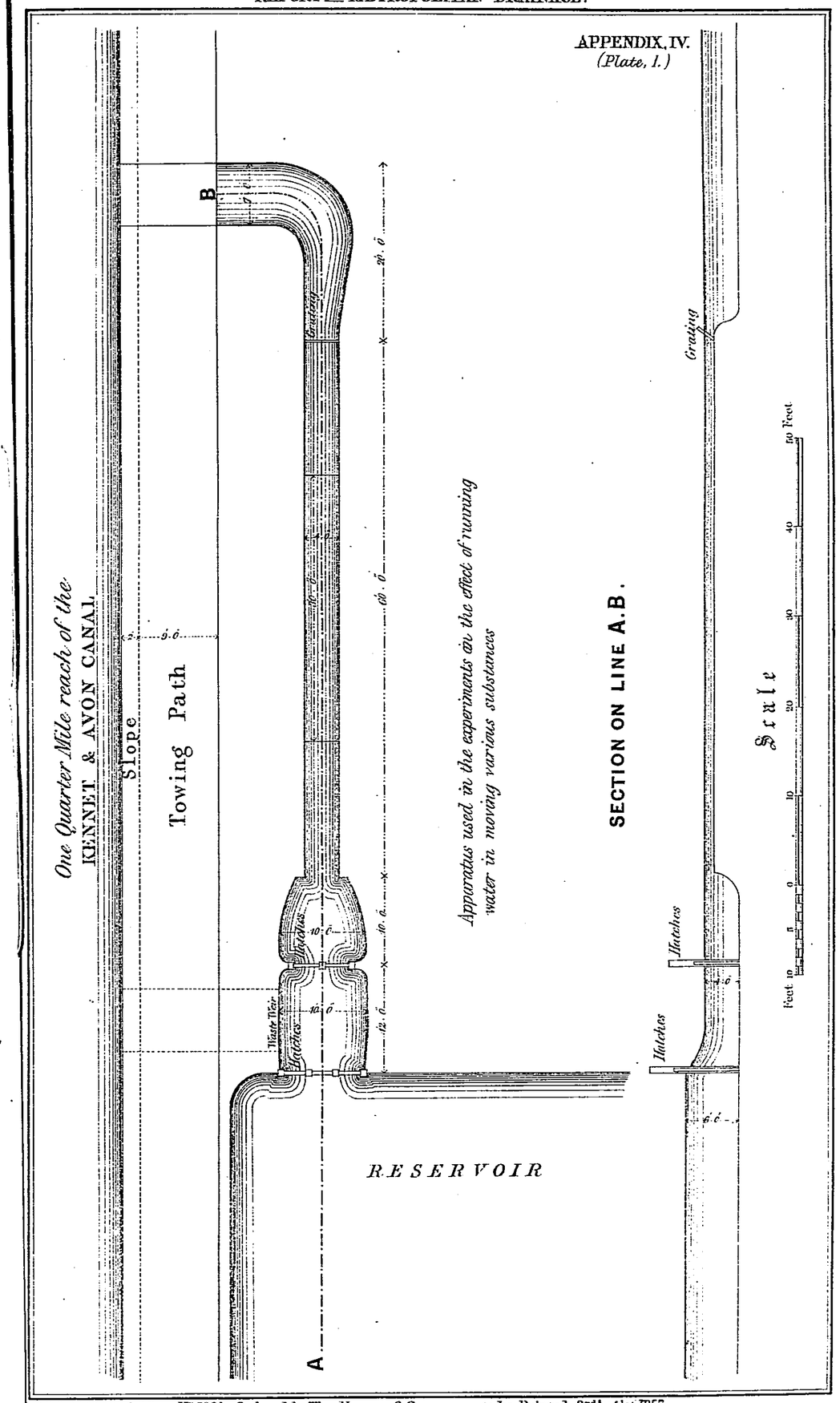
„ 2. Drawing from a Photograph of the Objects experimented upon.

„ 3. Ditto - - - - - - ditto.

„ 4. Ditto - - - - - - ditto.

„ 5. Ditto - - - - - - ditto.

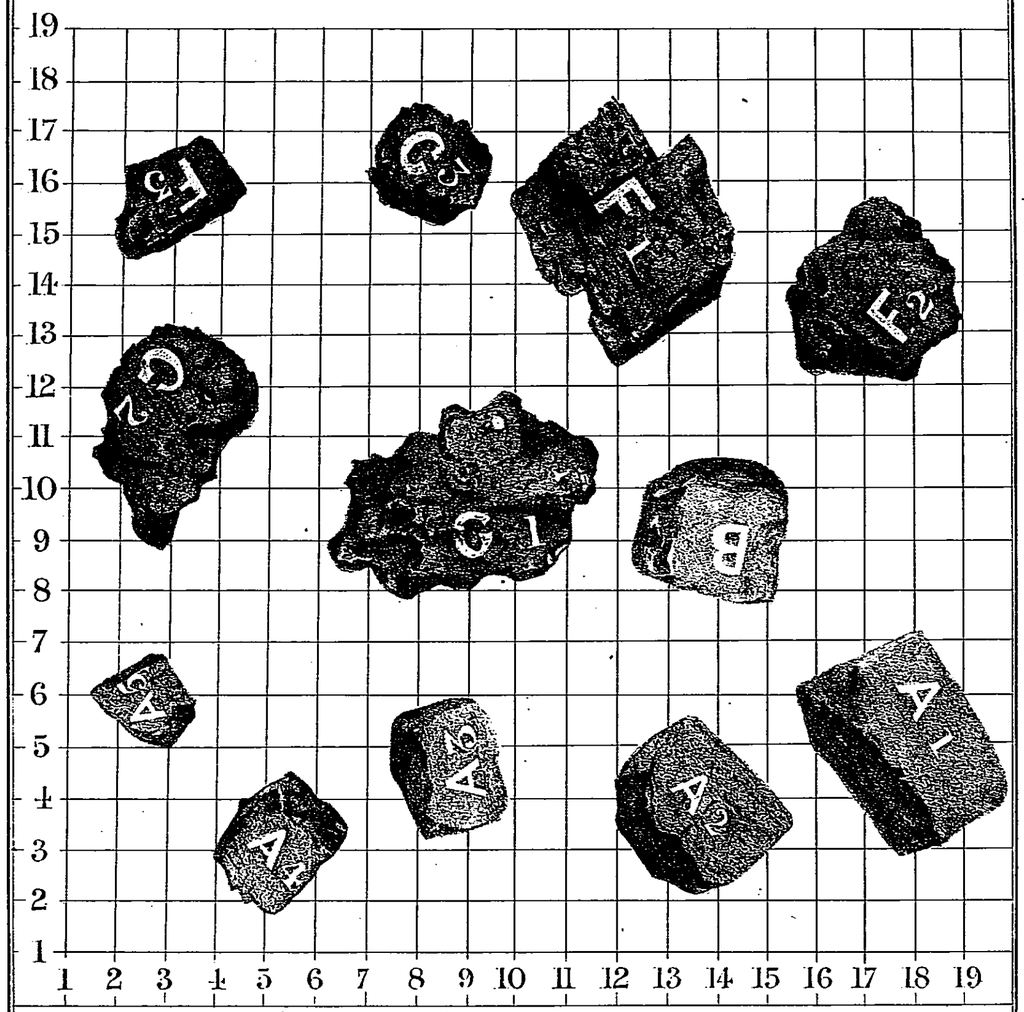
APPENDIX, IV.
(Plate, I.)



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APPENDIX. IV.
(Plate. 2.)

DRAWINGS FROM A PHOTOGRAPH OF THE OBJECTS REFERRED TO IN THE EXPERIMENTS MADE BY Mr BLACKWELL.



A! A² A³ A⁴ A⁵ B ..... BRICKS

C! C² C³ ..... SLAG

F! F² F³ ..... COAL

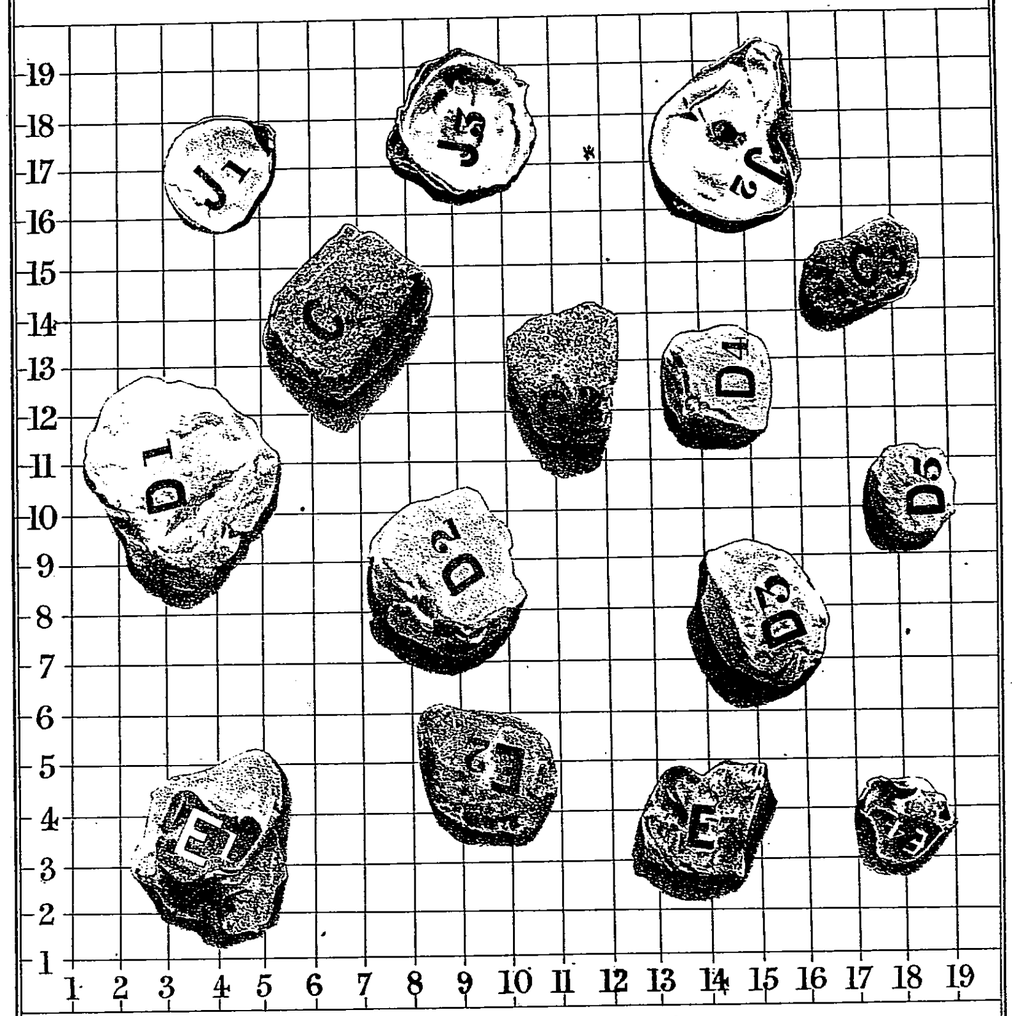
Photographed by Dr F. Britton

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APPENDIX, IV.
(Plate. 3.)

DRAWINGS FROM A PHOTOGRAPH OF THE OBJECTS REFERRED TO IN THE EXPERIMENTS MADE BY MR BLACKWELL.



E! E² E³ E⁴ FLINT GRAVEL.

D! D² D³ D⁴ D⁵ CHALK OF GREAT BEDWYN NORTH WILTS.

C! C² C³ UPPER OOLITE BRADFORD WILTS.

J! J² J³ OYSTER SHELLS.

Photographed by Dr F. Britton

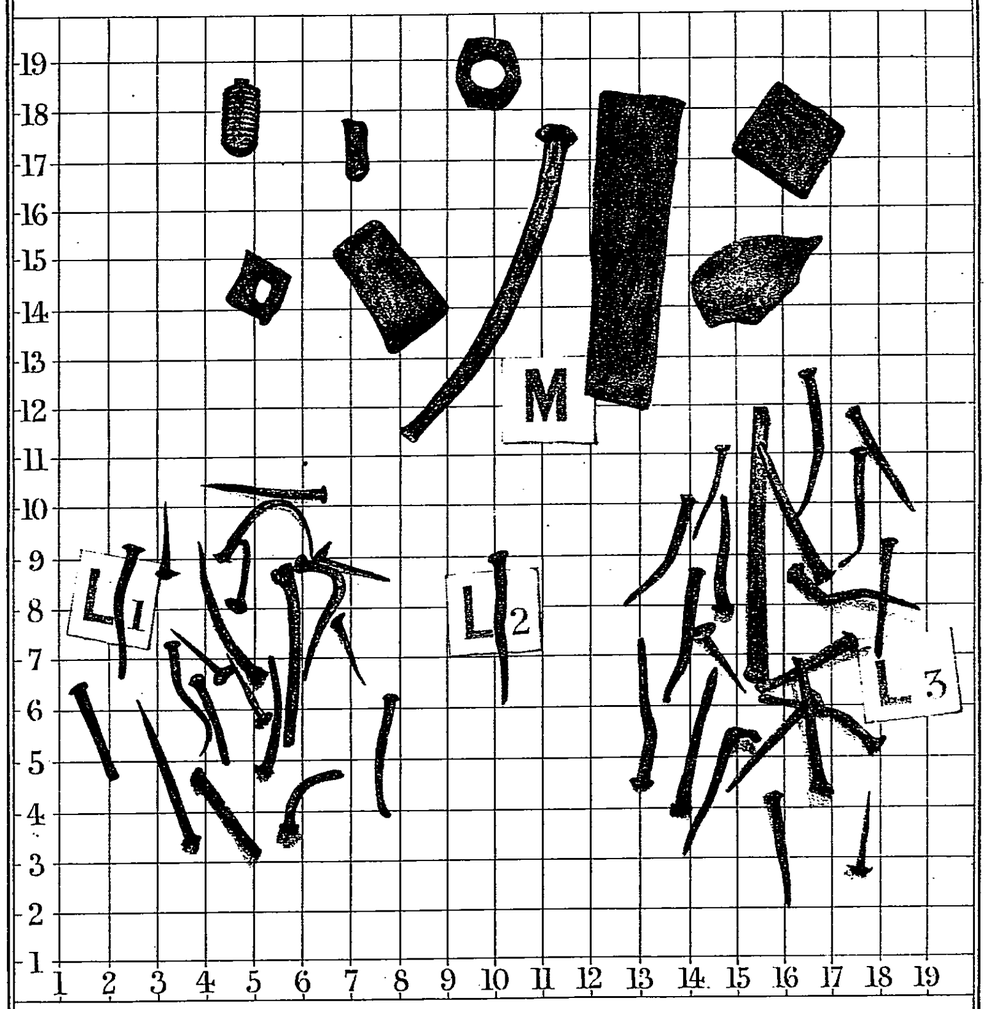
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APPENDIX, IV.
(Plate 4.)

DRAWINGS FROM A PHOTOGRAPH OF THE OBJECTS REFERRED TO IN THE EXPERIMENTS MADE BY Mr BLACKWELL.



L! L² L³ OLD IRON. (SEWER DEPOSIT)

M OLD IRON.

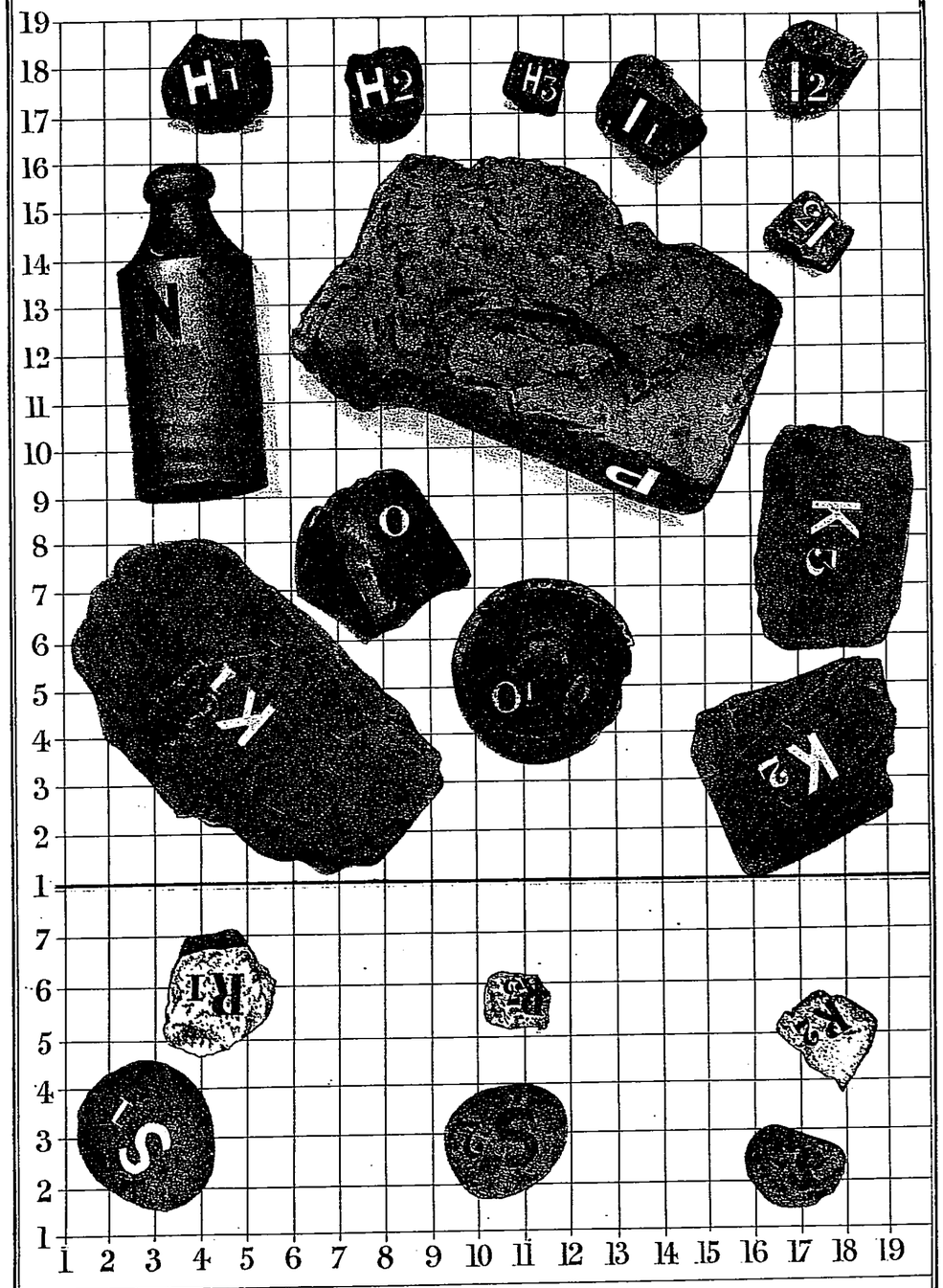
Photographed by Mr F. Bedford.

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APPENDIX. IV.
(Plate 5.)

DRAWINGS FROM A PHOTOGRAPH OF THE OBJECTS REFERRED TO IN THE EXPERIMENTS MADE BY Mr BLACKWELL.



H.¹ H.² H.³ COPPER SLAG. ROAD MATERIAL.
I.¹ I.² I.³ LIMESTONE. ROAD MATERIAL.
K.¹ K.² K.³ SLATE.
N. STONE WARE BOTTLE.

O. O.¹ BROKEN GLASS BOTTLE.
P. ENTIRE BRICK SET DOWN ON STIFF GAULT CLAY.

Photographed by Dr F. Boxall.
Day & Son, Lith.rs to the Queen.
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APPENDIX V.

General Information upon the River—and Tidal Experiments.

1.—Minutes of Evidence given by Captain *Bullock*, R.N.

(i.)

Meeting of Referees, 29, Great George-street, Friday, 1 May.

Captain *Bullock* attended by appointment.

Capt. Bullock, R.N.

In answer to a question, Captain Bullock said, that the inclosure of the Mucking Flats would be advantageous, and would in no way impede the action of the tidal wave. As a principle, Captain Bullock said, that whenever the river expanded to a greater breadth than that of any point in its course lower down, it would be desirable to inclose part of the side of the river, limiting the stream to the same width as that to which it was so contracted further down.

Captain Bullock considered any inclosures which would cause the ebb and the flood tide to flow in the same channel would be very advantageous.

Captain Bullock said that there was no doubt the fish were rapidly leaving the river.

In answer to a question, Captain Bullock said, that the transference of a large body of water, rainfall, &c., from London to a point 20 miles below it, would have no effect upon the river as a navigable stream, tidal water being sure to take its place.

Captain Bullock, in answer to a question, said, that fresh water was always to be found at Deptford, but not so at Woolwich; thus showing about the point to which the salt water penetrated.

Captain Bullock said, that one of his greatest objections to the outfall at Erith was, that there was a shoal there which would be greatly augmented by having the sewer constantly discharging itself opposite to it.

Captain Bullock considers Sea Reach a greatly superior place to Erith, as a river question for the outfall, the river being there very deep, and not likely to be impeded by shoals formed by the sewage matter discharging from the sewer. As a public question, Captain Bullock thought it very desirable that Sea Reach should be adopted for the outfall, as, if the discharge be made at Erith, in certain phases of wind and tide there is no doubt the sewage would penetrate as far as Woolwich, if not actually within the Metropolis.

Captain Bullock attributed the fact of the fish leaving the river or going further down it to the increased amount of fresh water, but had not entered sufficiently fully into the subject to know from what cause the additional land water came down.

Captain Bullock said that there was a great deal more mud held in suspension in the river now, than there was before the steam-boats plied, and believed that the banks were now much more thoroughly cleansed than they were in olden times.

With regard to Mr. M'Clean's plan, Captain Bullock said, in answer to a question, that there was no doubt the sewage discharged at the Swire Hole would be carried up by the young flood-tide as far as Burnham, and he considered that the effect of this sewage matter upon the oysters would be very injurious.

Captain Bullock thought, if the sewer were to be carried to the German Ocean, Shoebury Ness would be a better place to go to than the Swire Hole, as proposed by Mr. M'Clean.

Captain Bullock thought Mr. M'Clean's plan was undesirable, not only on account of the damage likely to be done to the oyster beds, but also on account of the great expense which it would entail.

Captain Bullock said, that the sewage, when thrown into the river, would continue to hug the shore, but would no doubt be eventually mixed with the river-water by the action of the steam-boats.

In answer to a question, Captain Bullock said, that it was well ascertained that sewage mixed with salt water emitted disagreeable smells, and alluded to the case of the Gambia and other African rivers, where the malaria on the coast was attributed to the organic matter brought down by the streams.

(ii.)

Copy of Letter addressed by Captain *Bullock*, R. N., to Sir *B. Hall*, Bart.
(Submitted by Captain *Bullock* to the Referees.)

Sir, 16, Richmond-terrace, Gravesend.

Upon a question of such vast importance as the perfect drainage of the City of London, it seems to me to be the duty of any one, so well acquainted as I ought to be with the present state of the Thames, to express his opinion, as well as endeavour to impress upon the minds of the accomplished engineers, to whom you have intrusted the solution of a difficult problem, the disadvantage of accepting any plan which does not embrace in its details the two national requirements, viz. "the healthful drainage of the Metropolis," and "the restoration of the Thames," to comparative purity, with a becoming deference to plans B. and B*., near Erith, the latter, as you aver, to be the least objectionable. I feel bound to state my conviction, based upon a long experience, that the discharge of the London sewage into the Thames at any part of it "short of Sea Reach," however economical it may appear at first sight, is sure to affect injuriously the river's bed, and in the end become a most expensive inconvenience to its navigation. I gladly refer you to Captain Burstal, my excellent assistant in the latest survey of the Thames, for the confirmation of a statement founded upon practice as well as theory, that the confluence of "two adverse streams" is always a prolific source of injury, causing eddies in their locality, in the centre of which there is always a tendency

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a tendency to deposit, and that therefore an outfall of sewage carrying in suspension an incalculable amount of sedimentary matter in suspension would unquestionably raise the bed of a river to a shoal, and in the course of time seriously affect, if it did not impede, the transit of merchandise to the seat of our active commerce, and hence my appeal to Her Majesty's Chief Commissioner's judgment, and to solicit his advocacy and approval only of such a comprehensive measure as would ensure the conservation of the Thames, as well as confer upon the population of London the blessing of an untainted atmosphere. If I had any pretension to the science of civil engineering, I might have suggested an elaborate and imposing scheme of drainage as would have suited the wants and resources of a great city, for I confess to the impression that it ought to be a scheme of such magnitude and excellence as to ensure to the Metropolis advantages commensurate with the outlay, satisfy the intelligence of the age, elicit the admiration of science, and, like the River Embankment, (the enterprising work of the twelfth century) become a lasting monument of the skill and energy of the present generation.

In conclusion, I have to beg of you, Sir Benjamin, the favour to peruse my Report upon the "Thames in 1846," in which I have endeavoured to define the injurious effects of any local disturbance in a "tideway," examples of which abound in the river.

I have, &c.

Fred. Bullock, Captain R. N.
Nautical Surveyor.

The Right Hon. Sir Benjamin Hall, Bart.
&c. &c. &c.

2.—Minutes of Evidence given by Captain *Edward Burstal*, R. N.

(i.)

Meeting of the Referees, 29 Great George-street, Wednesday, March 11.

Captain *Burstal* attended by appointment.

Capt. Burstal, R.N.

Relating to his observations on flow of stream, Captain Burstal said that the water which was opposite Point A. at Barking two hours before high tide, in springs reached canal at Blackwall, in neaps reached Hook Ness, at high water.

Captain Burstal took high water as found in the Admiralty tables. Mr. Bazalgette differed, and thought the time of slack water ought to be taken.

The highest tides in the Thames are produced by the north wind.

The difference of time between high tide at the Nore and London Bridge is about 1 hour 40 minutes.

At London, high water is two feet above what it is at Sheerness; but low water is one foot lower; striking a level between the two places.

Ordnance bench marks differ four inches at Greenwich from those of Mr. Macdougall Smith.

The fall of spring tides in the pool is 19 feet 9 inches, being 1 foot 11 inches more than the Trinity standard.

Mr. Bazalgette is wrong in saying that the same water that passes Barking two hours before high tide will return to the same spot at two hours after in its downward course, whereas it will not do so till 3 hours 22 minutes after.

A float experimented upon proved the above. It was also found to travel 12 miles on the ebb from the East India Docks.

Another float, put in at Barking two hours after high water, floated down to Long Reach in the ebb, and back as far as Charlton Pier with the flood.

Mr. Bazalgette was present at this experiment on the 19th June 1856, and expressed himself quite satisfied.

The extreme point to which sewage, ejected into the river at high water, would go, was found to be Pitcher's yard (near Rosherville), a distance of 14 miles. This happened in spring tide. The extreme flow in neap tides would be 11½ miles.

Mr. Foster's observations show that a float, put into water at Barking, advances five miles on its course towards the sea in 14 days, or one lunation.

Captain Burstal did not think that more tidal water would find its way up to London in consequence of 500,000,000 gallons of drainage, which at present flows in daily during wet weather, being abstracted. The above amount of drainage is equal to a reservoir of 15 acres, 25 feet in depth.

In answer to a question from Captain Galton, Captain Burstal said that he thought the forcing power of the ebb tide might be perceptibly diminished by the abstraction of so large a volume of drainage. The effect, however, might be considerably modified by the pouring in again at Barking the total amount of water abstracted before.

Captain Burstal said, that he had been engaged on the Thames first in 1832, and that the condition of the water was much less filthy then than now. Captain Burstal attributed the present dirty state of the river greatly to the agitation kept up by the paddle-wheels of steamers. The effect Captain Burstal considered advantageous; for by these means the deposit was prevented accumulating, being carried down by the ebb tide.

The bed of the river at London Bridge is 10 feet lower now than it was when surveyed by Mr. Telford in 1823.

In answer to a question, Captain Burstal said, that the first hour and a half of ebb and flood tide the stream runs along the two banks of the river, after which, in almost all reaches, it flows fairly and equally throughout the breadth of the river.

This hugging the banks is a general law, and would apply to the river even at Gravesend.

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Captain Burstal said that his report to Sir Benjamin Hall was only intended as recommending the point called B* to supersede point B, which did not meet with the requirements of the Act of Parliament; and not as being the best point to be found, but as the nearest which would comply with the Act of Parliament.

Captain Burstal thought that, wherever the sewage was discharged, there would be danger of a shoal being formed from the road drift finding its way into the river.

Captain Burstal thought that none of the sewage ejected during the two hours before high tide would affect Erith; but only that which was discharged during the hour following high water.

With regard to the enclosure of the Maplin Sands, Captain Burstal thought that their being reclaimed would not affect the tidal flow at the mouth of the Thames.

Captain Burstal stated that the double tides which occasionally occur at London, he attributed to electrical influences.

The increased waste of land in some parts of the river, Captain Burstal attributed to the agitation of water produced by the steamers; not at all to an increased tidal wave.

Captain Burstal did not think that the abstraction of the daily sewage would perceptibly diminish the stream in its course through London, or from above London.

The water into which it is proposed to discharge the sewage at Erith will be brackish.

(ii.)

Copy of Observations forwarded by Captain *Burstal* on day following the interview.

On a reconsideration of the subject under discussion yesterday, as to the effect on the stream and depth of the river, by abstracting 800,000,000 cubic feet of water (supposed to be the amount of sewage and land drainage in a wet season) from the metropolitan area; I am of opinion that the tidal wave would still flow to such a distance and height, as to make the high water the same as it is at present, but the depths at low water would undergo a diminution to a small extent, from such abstraction above the point of outfall from which such a quantity of water is started into the river. The effect below the point of outfall would be to increase the ebb stream, and slightly increase the low-water depths in the river.

With reference to the effect it would have on the oscillation of the tidal stream, it appears evident that the ebb stream having acquired an acceleration, the tendency would be to carry bodies held in suspension more quickly towards the sea or at a greater rate than five miles in 14 days, as shown in the experiments made in 1851.

Should this theory be correct, it would be desirable to have correct tidal observations in various parts of the river registered from one common datum, for the purpose of future comparisons.

3.—Minutes of Evidence given by *S. W. Leach*, Esq., Engineer to the Navigation Committee of the Corporation of London.

Meeting of the Referees, 29, Great George-street, Wednesday, April 1.

Mr. *Leach* attended by appointment.

S. W. Leach, Esq.

With regard to the proposed outfall at B*, Mr. Leach stated that he was inclined to fear from the shoaly nature of the Erith Reach, that there would be a serious accretion below the point where the whole sewage of London was to be discharged.

Mr. Leach also believed that it would be a nuisance to the crews of the collier vessels bringing to and anchoring near the proposed point of discharge, till there is room for them in the pool, as well as to the shipping passing up and down the river.

Mr. Leach related that he had lately had occasion to observe, while dredging opposite the St. Saviour's Dock, the immense deposit of light mud from the discharge of a sewer.

Mr. Leach considered the proposed point of outfall in Sea Reach, where there is 35 feet depth and more of water, very preferable to Erith (B*), where there is not more than 18 to 23 feet of water.

In answer to a question, Mr. Leach said that he did not think there was so much mud apparent in the river as there used to be. He attributed it partly to the deepening of the river, which rendered it less liable to deposit and remain on the shores; and partly to the wash of the steamers. (Mr. Leach promised a tracing of the river, showing the depths, shoals, &c.)

In answer to a question from Captain Galton, Mr. Leach said that he thought neither side of the river, at Sea Reach, had any particular recommendation over the other, in case it were determined to discharge the whole sewage of London at one point only.

He considered Sea Reach the best place, as the effect of the sewage water would be inappreciable in the large volume of river water there.

Mr. Leach did not think the abstraction of 500,000,000 gallons of water from the Thames at London would have any effect on the tidal flow, as the capacity of the river was constantly being increased, and the place of the water thus abstracted would be filled up by tidal water.

Mr. Leach observed upon the clear state of the Thames in London at the present moment, and attributed it to the sewers having been washed out last autumn by heavy rains.

In answer to a question, Mr. Leach believed the flow of landwater through Teddington Weir was now about 800,000,000 gallons.

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Mr. Leach thought measures ought to be taken to prevent privies, house drains, wharfs, ships, factories, &c., turning their refuse into the river. The police have power now, by Act of Parliament, to prevent any dirt being thrown into the river; but it is very difficult effectually to prevent its being done.

Mr. Leach alluded to the case of the London gas and other gas companies, who are believed to turn their refuse direct into the Thames, through pipes which they call suction pipes; and which are occasionally used as such.

Mr. Leach thought the docks ought to be restrained from turning large quantities of deposited mud, as they do now, by sluicing, into the river.

In answer to a question from Mr. Simpson, Mr. Leach described the effect of the removal of old London Bridge; which had been to discover shoals, by causing the tide to ebb out lower after the removal of old London Bridge, and its debris from the bed of the river; these shoals had, to a great extent, been removed from the bed of the river for building purposes.

In carrying out alterations in river lines, &c., Captain Bullock and Mr. Walker's plan of 1841 is always now adhered to.

The conservators of the Thames grant licences for dredging in the river westward of London Bridge.

Mr. Leach did not think there had been much difference in the Trinity high water-mark. There was a mark at Greenwich, which was found to be wrong by observation, and, on inquiry, it was discovered that it had been moved four inches during the making of some repairs. (Mr. Leach promised cross sections of the river at Woolwich and other places up to Battersea, made in 1854.)

In answer to question, Mr. Leach said that there were two Private Bills before Parliament for carrying out embankments of the Thames; but he did not believe that it could be carried out by them, from the enormous expense necessary, over and above the value of the reclaimed land.

Mr. Leach objected to carrying intercepting sewers along the foreshore of the river, as it would prevent additional depth being given for wharf accommodation.

Another objection would be, that whereas the fall of the river is only one foot, the required fall of the sewers would be five feet, which would carry them to an immense depth.

Mr. Leach did not think it would be possible to carry out more than a mile of such a sewer in a year, and that only at great expense; and altogether thought such a scheme impracticable.

Mr. Leach described the objectionable state of the sewers discharging into the Thames. The conservators have no power over filth thrown into the sewers, or any other inlets into the Thames, beyond the tidal influence.

Mr. Leach described the effect upon the river and banks, of the wave made by a passing steam-boat.

In answer to Mr. Blackwell, Mr. Leach said that the landwater freshes were sensibly felt at Greenwich in flood time, by increasing the velocity of the ebb tide.

Mr. Leach related the effects of the flood of 1852 at Kew Bridge, where the river, at low water of the ebb tide, did not fall to within several inches above Trinity high-water mark.

Mr. Leach alluded to some glue works near Erith, which caused a very offensive smell. He thought that the larger the volume of water at Sea Reach, into which the sewage was discharged the better.

The saline character of the water at Sea Reach is much more decided than that of the river at Erith.

4.—REPORTS by Captain *Burstal*, R.N., on TIDAL EXPERIMENTS, made under the Superintendence of the Referees.

(i.)

REMARKS on the Tidal Stream near the *Hoo* Outfall, on the Coast of *Essex*, proposed as the Sewage Outfall by Mr. *M'Clean*.

Reports by Captain Burstal, R.N., on Tidal Experiments.

ON the ebb tide the stream begins directly after high water, and runs for the first hour at the rate of about three quarters of a mile per hour, taking the direction of the outfall, and occupies 1¾ hour in drifting clear of the line of low-water mark; here, being met by the stream from the Crouch through the Ray Sand Channel, it is diverted from its course out of the outfall to a N.E. direction, or to the Bachelor Spit, running at the rate of nine-tenths of a mile per hour until 1½ hour before low water, when the stream slackens, and ends in a sluggish drain at the last three-quarters of an hour before low water.

At one hour before low water the outset from the outfall was three-tenths of a mile during the last hour of the ebb. There being no stream on the N.E. side of the flat near the Ray Beacon after three hours' ebb to carry bodies floating from the outfall with any velocity to sea, they are consequently held in suspension until the flood stream comes, which sets them on the Ray Sand, which is covered at 3½ hours' flood, after which the stream sets direct to the shore in a W. to W.N.W. direction at the rate of half to three-quarters of a mile per hour, until one hour before high water, when it ceases, and is slack for an hour.

After the water has left the flats, the various rills running into the outfall cause a strong stream to run out, which may probably force its way some little distance into the Ray Sand Channel, but not far enough to meet the main body of the stream, thus expending itself in the slack formed below the Ray Beacon.

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It will thus seem that the stream from the outfall at one mile from the Coast-guard buildings, will not, from the sluggish nature of its character, get, in an ebb tide, more than five miles towards the North Sea, and on the returning flood all the particles which left the outfall during the last quarter of the ebb would be set ashore between the Coast-guard house and the River Crouch, whilst those which found their way into the Ray Sand Channel would be drifted into the River Crouch.

(signed) *Edwd Burstal*,
Commander, R.N.

23 May 1857.

[*See* Sketch showing the result of the experiment made with floats at Burnham, Plate 1, Appendix V.]

(ii.)

REPORT upon the FLOAT EXPERIMENTS made in the River Thames on 3 June 1857.

Gentlemen, 32, Abingdon-street, Westminster, 10 July 1857.

I BEG to submit for your consideration my remarks on the stream in the River Thames, from two positions suggested by you as points of outfall for the drainage of London, viz. from Higham Creek, in the Lower Hope, on the south shore, and from a position half a mile eastward of the Mucking Lighthouse on the north shore.

With reference to the time of starting, supposing it to be at 1½ hour before high water, which was the time chosen for the experiments on 3d June 1857, at which I was present; I then observed that 25 floats, submerged 12 feet, were thrown into the river between Higham and Cliffe Creeks, about 30 yards outside the line of low-water mark, and although the stream in mid-channel ran up or towards Gravesend 1 hour 40 minutes after these floats were put in, not one of them found its way into the stream, but they were, on the contrary, moved by the eddy which exists on this shore to positions lower down the river before the flood stream had ceased in mid-channel; some of them having been set on shore below Cliffe Creek.

On the north shore, at half a mile below Mucking Lighthouse, several floats (about 30) were put into the river outside the line of low-water mark, at one hour before high water. At this position I observed that many of the floats remained stationary, some being set on shore by the slight eddy and by the wind. The river stream on the flood is turned off by the point above Shell Haven, and a slack is therefore formed above it and between the point and Mucking Lighthouse.

During the time these floats were held in suspension on the north shore, a boat was in attendance watching a float in mid-channel, which drifted 1½ mile upwards, and which might be taken as the last hour's drift of the flood stream on that day.

It appears therefore quite evident to me that from the fact of these 25 or 30 floats being put into the river, and spread over an area of 100 square feet, and during a period of 1½ hour, their not becoming dispersed, or in any way set into the stream, the sewage, which being ejected at the same time of the tide, would not be carried above those points, but, like the floats, would be held in suspension until carried downwards by the ebb stream.

Having thus remarked upon the effect of the last 1½ hour of the flood stream, I will now refer to the drifts on the ebb.

Those floats which were immersed at Higham Creek at 1½ hour before high water (being held in suspension there until the ebb stream made) were watched from a boat, and observed to be set by the first of the ebb to the West Blythe buoy, towards the north shore below Hole Haven, and reached as far as the river middle buoy, off the upper part of Southend; some of them, however, grounded upon the Chapman Sand at a quarter of a mile above the lighthouse; had the stream been that of a spring ebb, an acceleration of distance downwards of about 1½ mile would probably have been attained.

The main body of the ebb stream from mid-channel, off Cliffe Creek, was found to set on to the Essex shore above Shell Haven Point, or very near to the place proposed for the outfall.

Those floats which were immersed at half a mile below Mucking Lighthouse were also held in suspension during the last hour of the flood; some, however, were set on shore, partly by eddy and partly by the wind, which was blowing fresh from the S. W.; those which were not set on shore (about 15 in number) were followed in a boat and observed to be carried down by the ebb stream clear of Shell Haven Point, and grounded upon the Chapman Sand, off Canvey Island, with the exception of four or five of them, which had the best hold of the water and were the least affected by the wind; these were carried by the ebb through the Leigh Channel towards Southend Pier, before reaching which the stream from Leigh Ray set them out in a S.S.E. direction, to one mile below and half a mile outside Southend Pier, which was the eastern limit of the drift on that occasion. Had it been spring tides, I believe the floats would have reached 1½ mile further, or to the buoy off Shoeburyness. Here the steamer in attendance was anchored, and the progress of the floats carefully watched; the young flood setting them slowly towards the new chapel at Southend; after two hours' drifting they arrived at the outer part of Southend Flats, and at 2½ hours flood they were setting towards Thorpe Cliff, doubtless in consequence of the eddy formed by Shoeburyness.

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Having thus described the general character of the stream, and its effects on the floats on June 3d, I would now remark upon the positions proposed by you as points of outfall, and the constant admixture of clean water from the sea to dilute the sewage and wash the shores.

At both points, viz., Higham Creek and Mucking, the fact of there being an eddy, or slack on the flood, is a satisfactory proof to me that no particles of sewage ejected into the Thames during the last 1½ hour of the flood would find their way into Gravesend Reach.

On the ebb, the sewage from Higham Creek would drift freely towards the Essex shore, and after going through seven miles of space for dilution would be set partly upon the foreshore of Canvey Island, and partly in mid-channel to the river middle buoy.

On the ebb, the sewage from the Mucking outfall will, with the stream, impinge on the Essex coast, a part depositing at Shell Haven, other parts on the foreshore of Canvey Island, and the rest be carried outside Southend Pier, undergoing in its passage a dilution through 10 miles of surface, and in many places 10 fathoms of depth; this latter portion so diluted will, on the succeeding flood, be set on to the Southend and Leigh Flats.

It will thus be seen that a large portion of Sea Reach on the south side, probably from opposite Hole Haven to the Nore Sand, will not be affected by sewage, and of course the whole space to the eastward of Southend will also contain clean sea water; therefore on every flood tide there will be the clean sea water from the Nore and that part on the south side of Sea Reach coming up to further dilute the water previously affected, and to wash the shores on which the ebb stream (containing sewage) impinged.

In conclusion, I beg to state the advantages which present themselves to my mind arising from the metropolitan drainage being ejected into the upper part of Sea Reach over that of other positions on the banks of the river.

First. That it will be carried by a strong stream through a space of 12 miles, where there is an average depth of eight fathoms, thereby offering great opportunity for dilution and dispersion, and that where it will be washed on shore is a neighbourhood very thinly populated, viz., Canvey Island; whereas at other positions in the upper part of the river, the whole breadth of the river would become charged with sewage matter, which would be continually passing and repassing densely inhabited districts; so that in case the river water became so polluted as to render it unhealthy, the inhabitants of such districts would have reasonable cause for complaint.

Secondly. That, provided a great quantity of heavy material, such as road drift, &c., finds its way into the river through the sewers, I am decidedly of opinion that there is much less probability of a shoal being formed which would be detrimental to the navigation at the points proposed by you than at any place in the narrow river-way.

From my local knowledge of the river I may venture to state, that there is no place so eligible below the Lower Hope as that at Higham or Cliffe Creeks; because the stream over the Blythe Sand would not be sufficient to carry away the sewage, it would, consequently, be always depositing on the flat, and on the shore near the point from which it was discharged; I therefore have no hesitation in stating, that in my opinion you have selected the best points on the banks of the river for the purpose required.

I am, &c.,
(signed) *Edw[t] Burstal*,
Commander R.N.

To the Referees on the Main Drainage of the Metropolis.

[*See* Diagram of the experiments made with floats by the late Mr. F. Forster; and also, Sketch showing the results of the experiments made with floats by the Referees in the River Thames, Plates 2 and 3, Appendix V. *See* also Diagram of Mr. Homfray's experiments with floats, Appendix IX., Plate 1.]

Appendix V.—*continued.*

5.—TABLE SHOWING HIGH TIDES IN RIVER THAMES.

PLACE OF OBSERVATION.	DATE.		Tide.	Depth Above T.H.W.M.		Depth on Sill of Dock.*		By whom Information given.
				Feet.	*Inches.*	*Feet.*	*Inches.*	
London Docks: Shadwell Entrance -	1844	Dec. 12	P.M.	1	11	27	4	Jas. Maitland, Esq., Dock-master.
Ditto - - -	1845	Dec. 12	A.M.	3	5½	28	10½	- - - Ditto.
Ditto - - -	1846	Jan. 1	P.M.	2	8	28	1	- - - Ditto.
Ditto - - -	1847	April 15	P.M.	2	4	27	9	- - - Ditto.
Ditto - - -	1848	April 8	A.M.	2	2	27	7	- - - Ditto.
Ditto - - -	1850	Feb. 29	P.M.	3	7	29	0	- - - Ditto.
Ditto - - -	1851	Jan. 21	P.M.	2	1	27	6	- - - Ditto.
Ditto - - -	1851	March 6	A.M.	2	4	27	9	- - - Ditto.
Ditto - - -	1852	Nov. 12	P.M.	3	8	29	1	- - - Ditto.
Ditto - - -	1852	Nov. 13	A.M.	2	11	28	4	- - - Ditto.
Ditto - - -	1852	Nov. 13	P.M.	2	1	27	6	- - - Ditto.
Ditto - - -	1854	Feb. 15	P.M.	3	5	28	10	- - - Ditto.
Ditto - - -	1856	May 7	P.M.	2	1	27	6	- - - Ditto.
Ditto - - -	1856	Aug. 19	A.M.	2	2	27	7	- - - Ditto.
Ditto - - -	1856	Nov. 13	A.M.	2	3	- -	- -	Captain Burstal, R.N.
Ditto - - -	1856	Nov. 14	P.M.	2	3	- -	- -	- - - Ditto.
Ditto - - -	1856	Dec. 13	P.M.	2	5	- -	- -	- - - Ditto.
Ditto - - -	1857	May 26	P.M.	1	7	27	0	Jas. Maitland, Esq.
Wapping Entrance -	1852	Nov. 12	P.M.	3	9	- -	- -	Captain Burstal, R.N.
Westminster - - -	1856	Nov. 13	A.M.	2	3	—	—	Captain Burstal, R.N.
Ditto - - -	1856	Dec. 13	P.M.	2	6	—	—	- - - Ditto.
Lambeth: Bishop's Walk - -	1841	Oct. 18	- -	3	4	—	—	Captain Burstal, R.N.
Ditto - - -	1852	Nov. 12	- -	4	1†	—	—	- - - Ditto.

* T. H. W. M. is 25 feet 5 inches above Sill of Dock. † This is the highest Tide on Record.

6.—LETTER from Professor *Airy* upon the Influence of the SEWAGE upon the River.

Royal Observatory, Greenwich, London, S.E.
28 March 1857.

My dear Sir,

I HAVE to acknowledge your letter of yesterday regarding the proposed outfall of the Metropolitan drainage. In accordance with your request, I offer the following remarks on the different parts of it:

General Information upon River: Letter from Professor Airy.

1. The movement of a float on the river, as determined by experiment, is precisely the same in character as must have been anticipated (viewing the large amount of tide, and the small supply of water from the interior), though the exact measure of descent and ascent, and ultimate gain of descent, could not be known. In my opinion it is very unimportant in the comparison of places of discharge, as the same series of descents and ascents (nearly) will take place anywhere in the narrow part of the estuary.

2. It is totally impossible that the important points of the inquiry can be treated mathematically. The utmost that could be done would be, from numerous physical data, to find the daily descent of the float, which you have done a great deal better by the simple experiment above.

3. In regard to the commixture of the sewage and the river water, I should be in no fear. You cannot at once shoot the sewage into the full stream; it will enter from a bank, or from a shore, or from the bottom of the river; the water close to that place of entrance will be moving slowly, and the water nearer mid-channel will be moving more quickly; some of the sewage will be seized by one of these flows of river water, and some by another. I should expect that the mass of sewage, instead of being carried in a body, would be thus pulled to pieces.

4. I do not conceive that the removal of the sewage discharge from London to a lower point will have any discoverable effect on the tides. Large as is the amount of sewage, it is a very petty thing compared with the heavy flow through the bridges.

I am, &c.,
(signed) *G. B. Airy.*

Captain Douglas Galton, R.E.
&c. &c &c.

LIST of PLATES to APPENDIX V.

Plate 1. Experiments with Floats at Burnham.

„ 2. Diagram of Mr. F. Forster's Experiments with Floats in 1851.

„ 3. Experiments with Floats in the River Thames on the 3d June 1857.

„ 4. Sections of the Thames at Mucking and Higham.

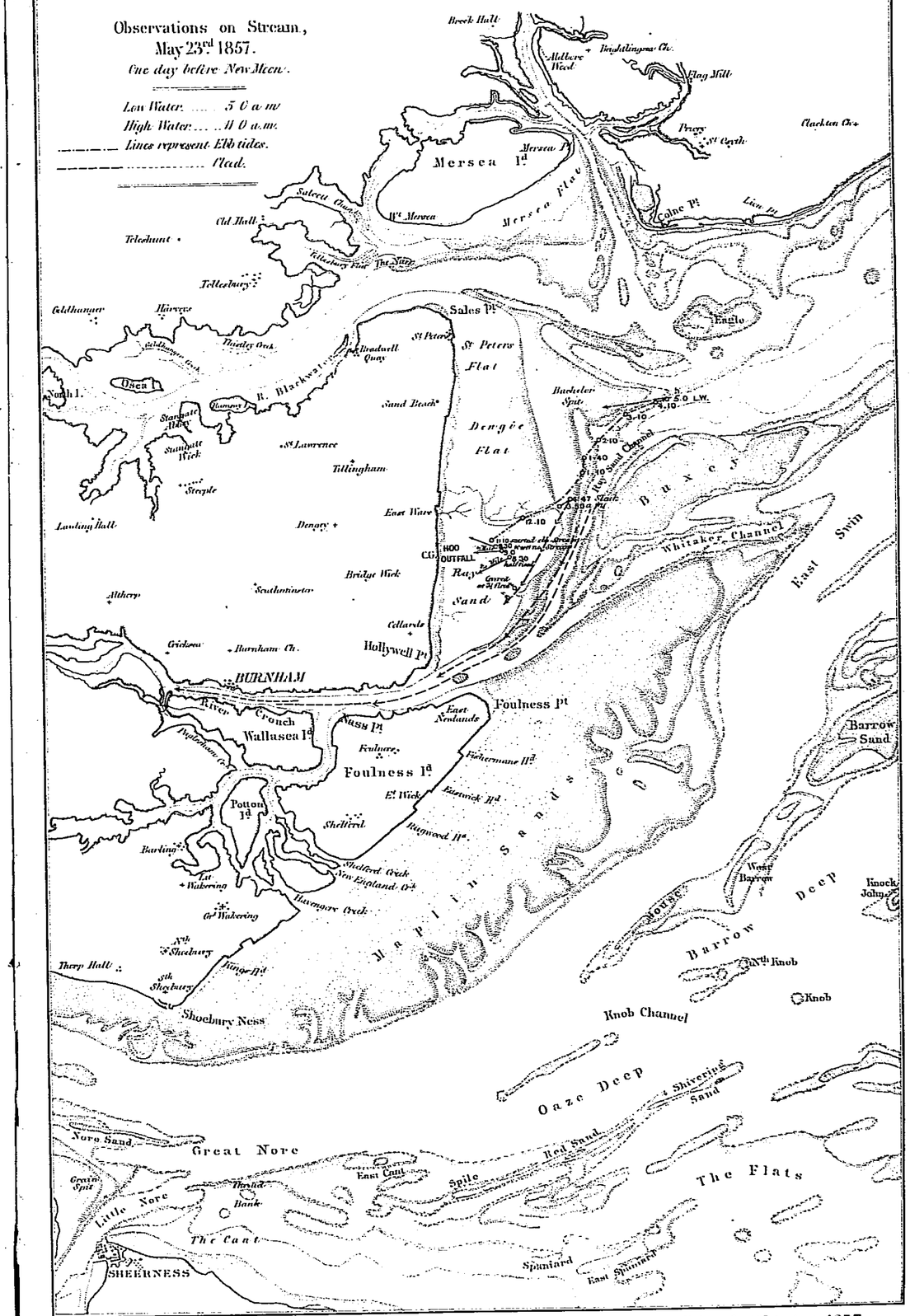
„ 5. Diagram of Rise and Fall of Tide at Blackwall, Woolwich, Erith, and Mucking Lighthouse, July 1857.

„ 6. Diagram of Flood Tides, 8th, 14th, 18th, and 22d July 1857, at Blackwall, Woolwich, Erith, and Mucking Lighthouse.

„ 7. Diagram of Ebb Tides, 8th, 14th, 18th and 22d July 1857, at Blackwall, Woolwich, Erith, and Mucking Lighthouse.

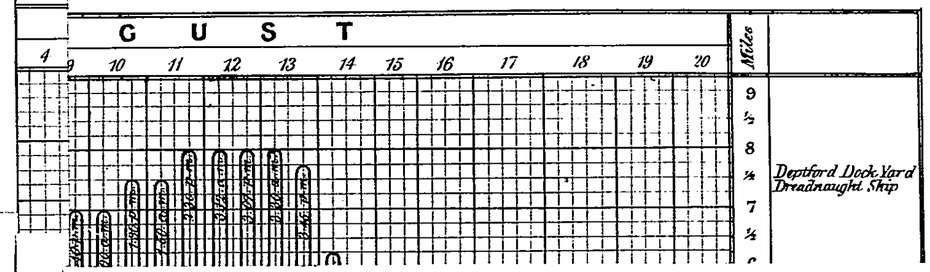
APPENDIX V.
(Plate 1.)

SKETCH SHOWING THE RESULTS OF THE EXPERIMENTS MADE WITH FLOATS AT BURNHAM, 22ND MAY, 1857.



Nº 233. Ordered, by The House of Commons, to be Printed 3rd August, 1857.
Henry Hansard, Printer.

APPENDIX, V.
(Plate. 2.)



Ordered, by The House of Commons, to be Printed, 3rd August, 1857.
Henry Hansard, Printer.

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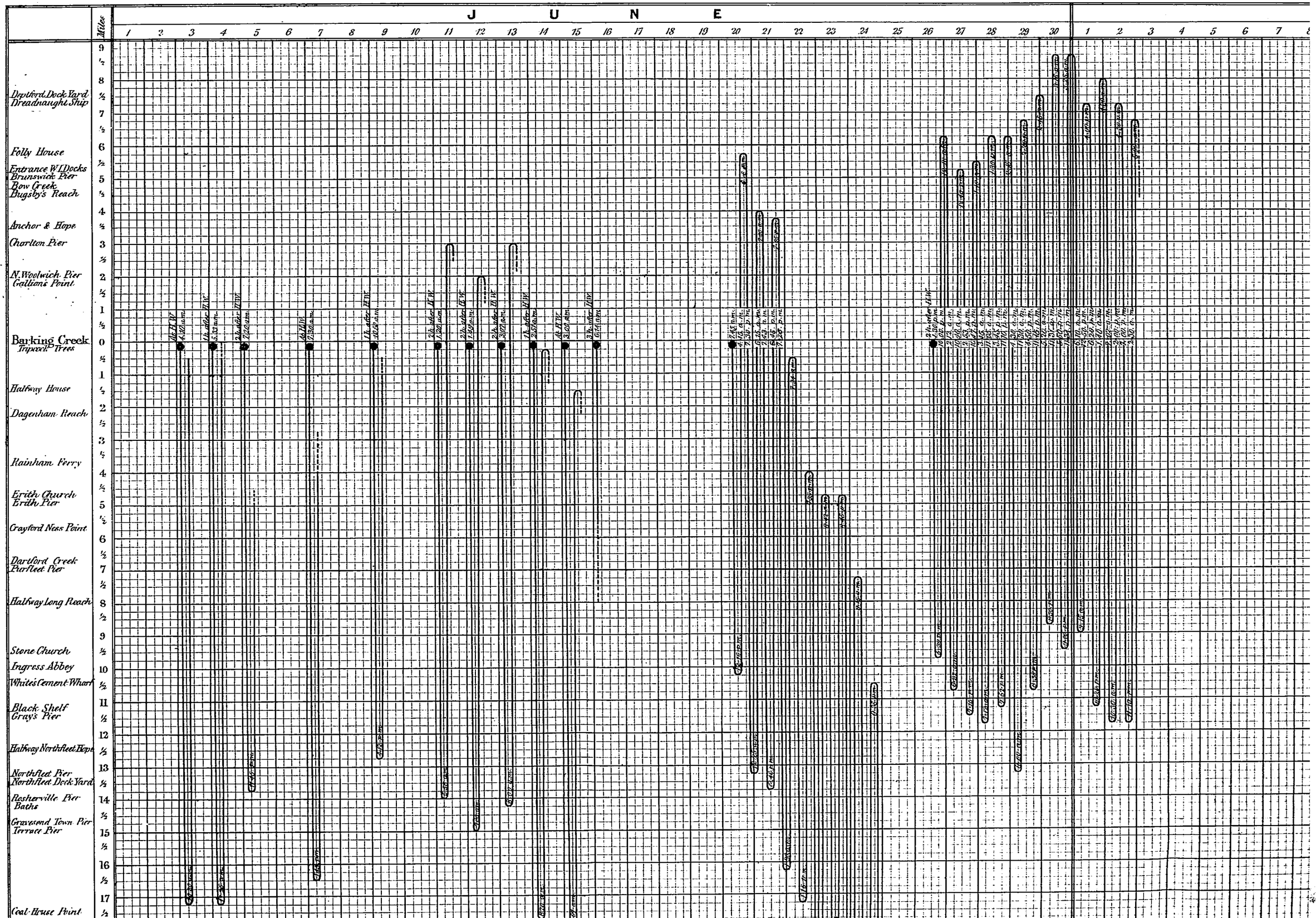
SHEWING THE RESULTS OF EXPERIMENTS WITH

R I V E

ABOVE AND

Made by the late Mr Frank Forster,

As reduced



DIAGRAM

RESULTS OF EXPERIMENTS WITH FLOATS TO ASCERTAIN THE REACH OF FLOOD AND EBB TIDE,

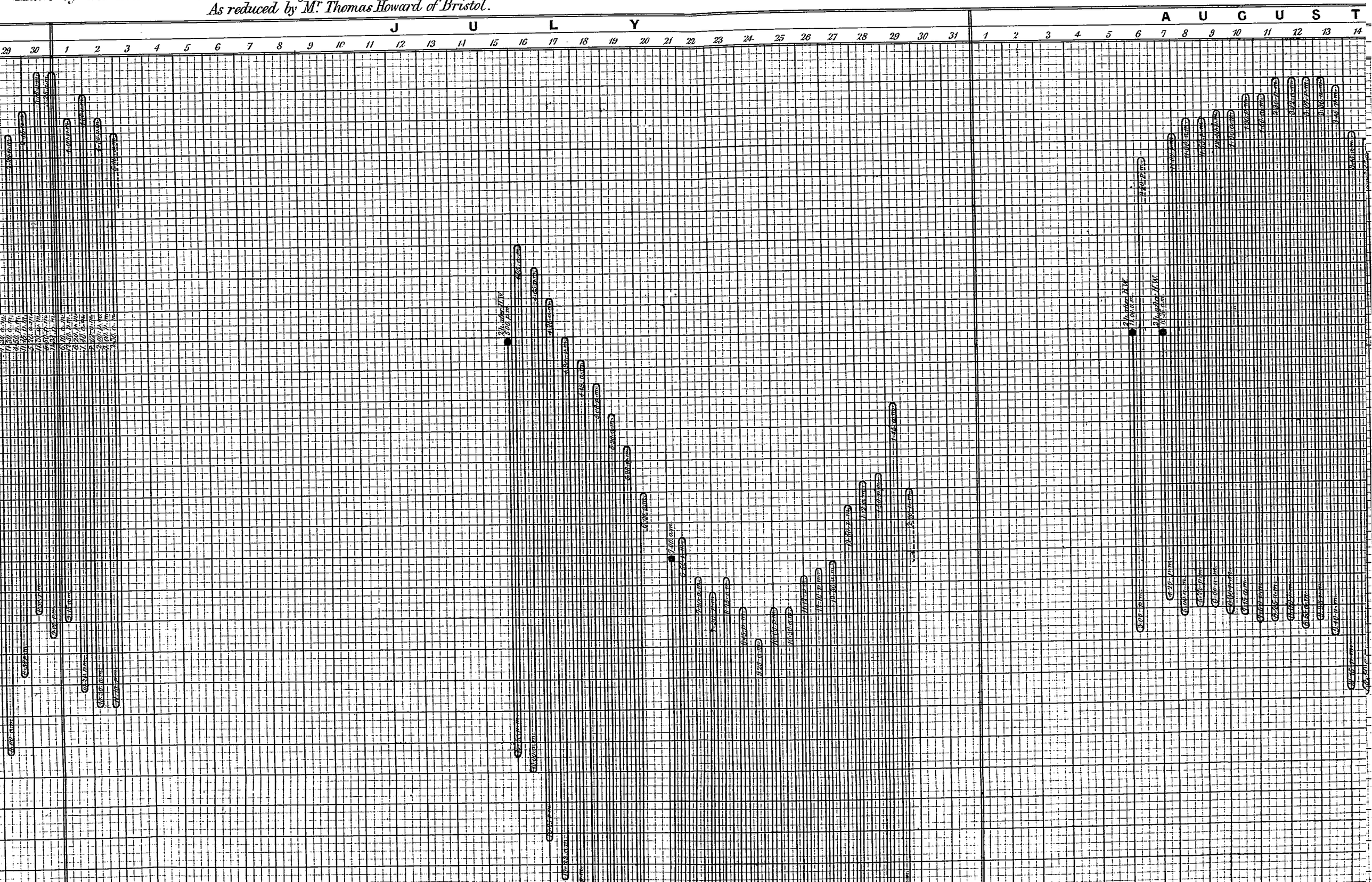
IN THE

RIVER THAMES,

ABOVE AND BELOW BARKING CREEK.

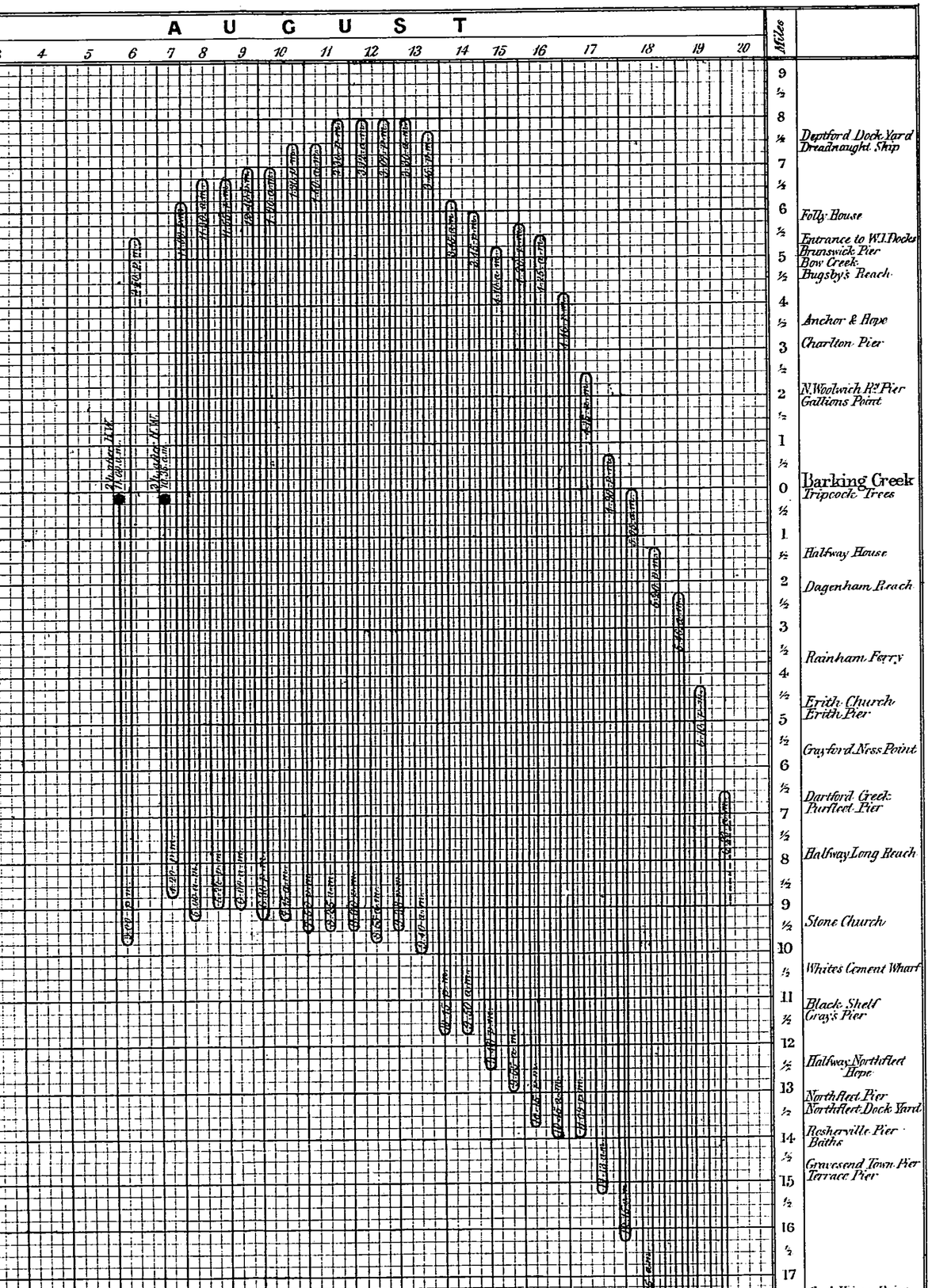
Made by the late M.r Frank Forster, Engineer to the Metropolitan Commissioners of Sewers 1851.

As reduced by M.r Thomas Howard of Bristol.



APPENDIX, V.

(Plate, 2.)



Rainham Ferry
Erith Church
Erith Pier
Grayford Ness Point
Dartford Creek
Purfleet Pier
Halfway Long Reach
Stone Church
Ingress Abbey
White's Cement Wharf
Black Shelf
Grays Pier
Halfway Northfleet Hope
Northfleet Pier
Northfleet Dock Yard
Rosherville Pier
Baths
Gravesend Town Pier
Terrace Pier
Coal House Point
Cliff Station
Hope Point Battery
Thames Haven
Shell Haven
Hole Haven
Chapman Beacon

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

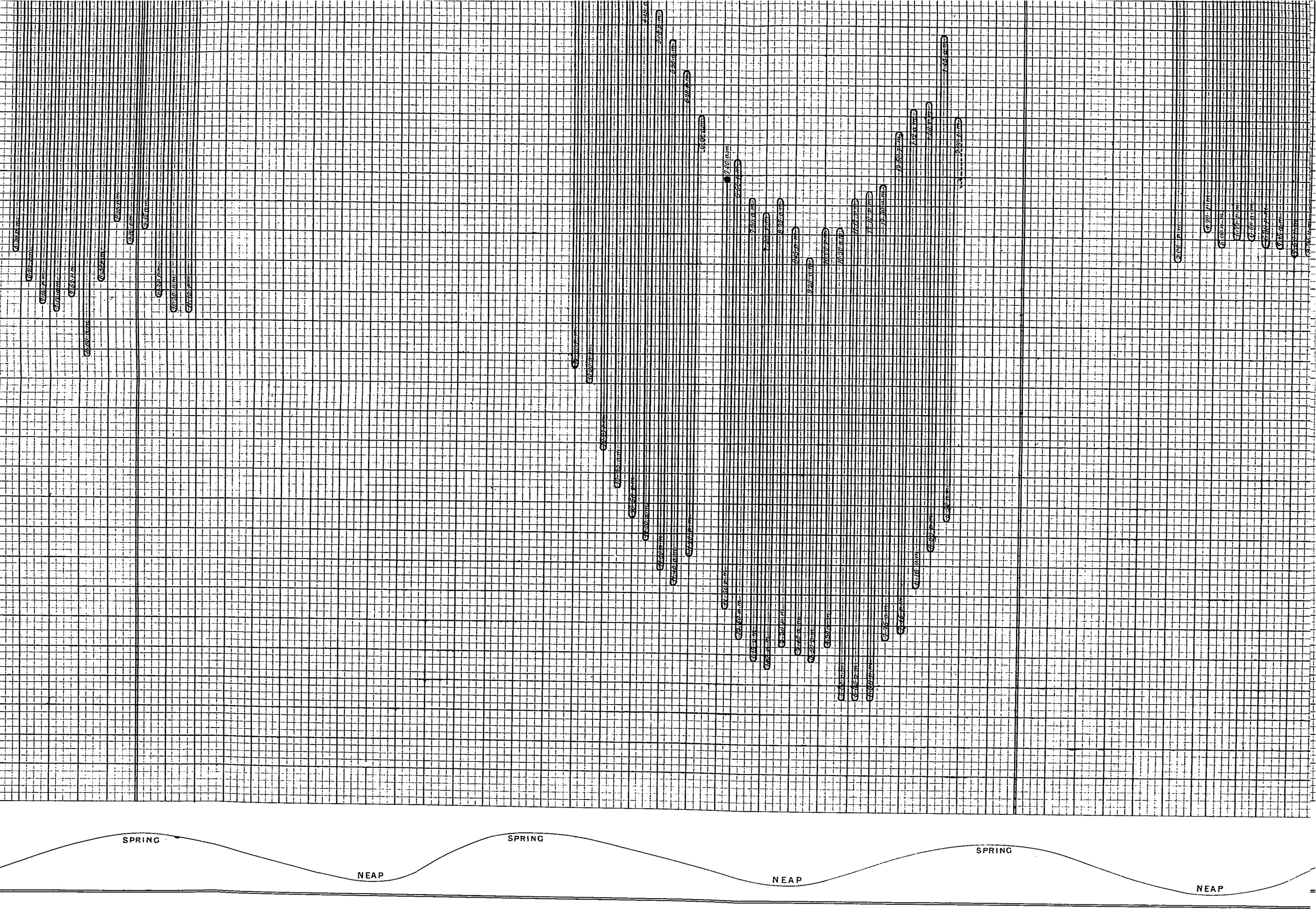
EXPLANATION.

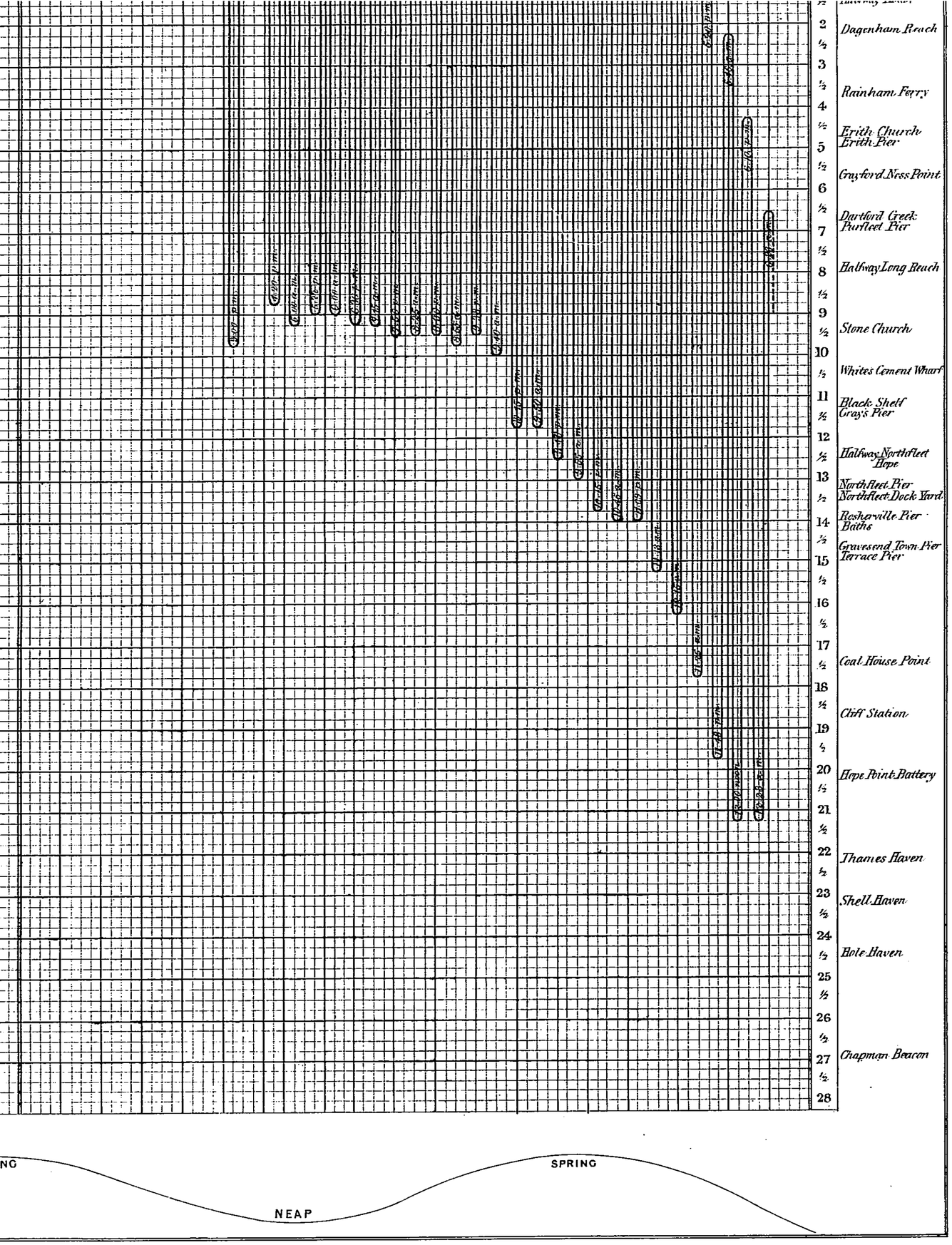
In these experiments the middle of the Stream opposite Barking Creek was made the Datum or starting point. The distance the Float was carried with each tide will be seen by reference to the plates and distances marked in the margin: the downward lines shew Ebb and the upward the course of flood tides.

The commencement of each experiment, when the Float was put in afresh is shewn by a circular mark thus ●. The time of tide at which the Float was put in is marked at the beginning of each trial: the time of high and low water is marked at the turn of each tide.

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Kell, Print. Lith.rs Castle.St Holborn.


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ILLUSTRATIVE PLAN

OF

FLOAT EXPERIMEN

in the

RIVER THAMES,

ON THE 3RD JUNE, 1857,

Referred to in the Report of the Referees

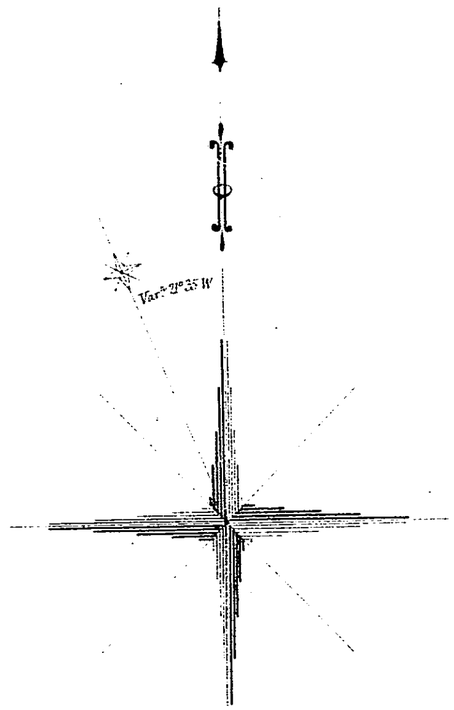
on the

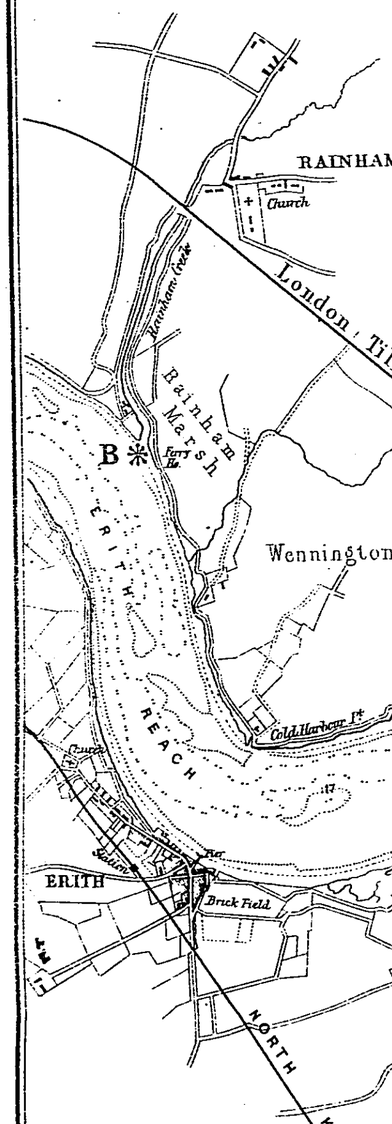
Main Drainage of the Metropolis

AND IN

Captain Burstal's Report

TO THE REFEREES.





1 2 3 } *Fathoms Line.*

NOTE. High Water at the Lower Hope at 10-
on which day the Experiments were ma
The Red and Black lines in the River
of the Floats.
The Figures mark the hours at which
positions shown by the Crosses, and the
direction in which they were proceeding
The line _____ shows the
which was submerged to within about 9 fee
indicate the under current.
The other floats consisted of poles 14 fe
square, which were immersed about 18 feet fr
the bottom.

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PERIMENTS

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HAMES,

UNE, 1857,

ort of the Referees

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IN

stal's Report

FEREES.

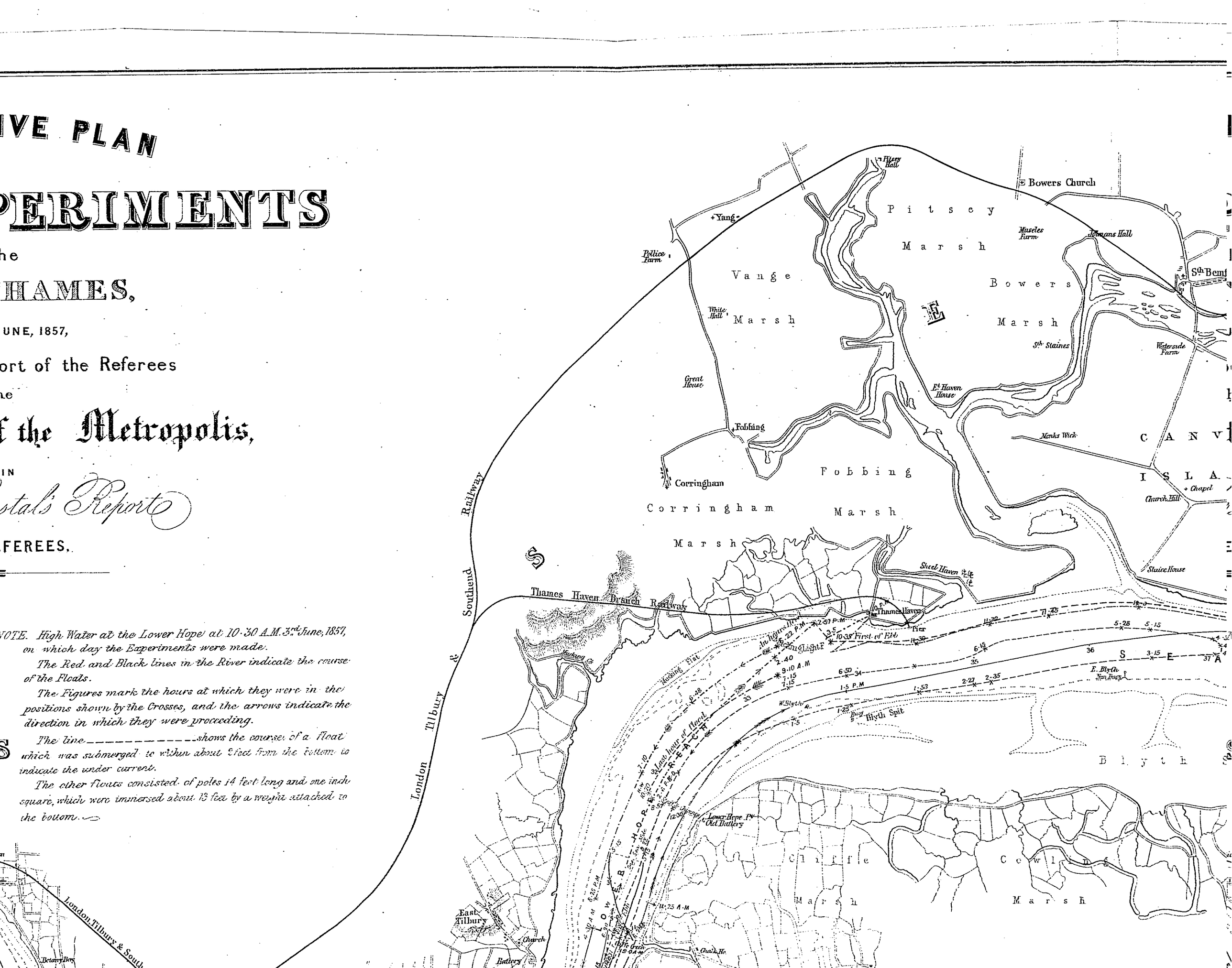
NOTE. *High Water at the Lower Hope at 10·30 A.M. 3rd June, 1857, on which day the Experiments were made.*

The Red and Black lines in the River indicate the course of the Floats.

The Figures mark the hours at which they were in the positions shown by the Crosses, and the arrows indicate the direction in which they were proceeding.

The line ---------- shows the course of a Float which was submerged to within about 8 feet from the bottom to indicate the under current.

The other floats consisted of poles 14 feet long and one inch square, which were immersed about 13 feet by a weight attached to the bottom.



APPEN

Bowers Church
Museles Farm
Johnans Hall
Hadleigh
Leigh Green
Prittlewell
Lawn
Sᵗ Bemfleet
Potters in the hole
Hadleigh Castle
Folly
Leigh Hall
London & Tilbury & Southend Railway
Leigh
Milton Hall
Southchurch
Porters Farm
Sᵗ Staines
Waterside Farm
New Southend
Chapel
Old Southend
Thorp Hall
Leigh Mud Flat
S. T. LEIGH CREEK
Marsh
Hadleigh Ray
Leigh Ray
Shallow
Monks Wick
CANVEY ISLAND
New Land
Chapel
Church Hill
Further Wick
Lorens Farm
Sluice House
Scar House
Chapman Sand
Little Middle
Spit Buoy
2½ hours flood
7·15 P.M.
6.30 P.M.
Southend Light F
Yantlet Flood
Rye Gut
The I
LEIGH CHANNEL
LEIGH MIDDLE
River Middle Buoy
River Middle East Buoy
4·40 P.M.
Low Water
Shoebury Ness B
8·45 P.M
Chapman Light F.
Scar Elbow
SEA REACH
FAIRWAY CHANNEL
E. Blyth Sand Buoy
Yantlet Buoy
Yantlet Middle Ground
Blyth Sand
Yantlet Spit
Yantley Flats
W.ᵖ Nore Buoy
Nore San
Swatch-way
Leaden Head
Grain Spit Buoy
Grain Spit
Allhallows
Marsh
St Mary's Marsh

APPENDIX V. *(Plate 3)*

The Red and Black lines in the River indu
of the Floats.

The Figures mark the hours at which they
positions shown by the Crosses, and the arro
direction in which they were proceeding.

The line _____ shows the cour
which was submerged to within about 9 feet fro
indicate the under current.

The other floats consisted of poles 14 feet lo
square, which were immersed about 13 feet by a we
the bottom.

Wennington Marsh

Aveley Marsh

Cold Harbour Pt

ERITH REACH

ERITH RANDS

PURFLEET

Station

Church

ERITH

Brick Field

Crayford Ness

Crayford Creek

Long Reach Pt

Dartford Creek

Old Sea Wall

LONG REACH

Thurrock Marshes

Grays Thurrock

Black Shelf

London Tilbury & Southend Railway

NORTH KENT RAILWAY

Dartford Marshes

Little Powder Ck

River Cray

CLEMENTS REACH

Stonecut

Beacon

NORTHFLEET HOPE

Botany Bay

Wharf

Tilbury Ness

Tilbury Fort

Swanscombe Marshes

Ingress Abbey

Galley Hill

DARTFORD

GREENHITHE

NORTHFLEET

Rosherville

GRAVESEND

Octagon

Windmill Hill

S C A L E S .

80 Chains 60 40 20 0 1 2 3 4 5 6 Statute Miles

1 Mile 3/4 1/2 0 1/4 1 2 3 4 5 6 Sea Miles

10 Cables 1/4 1/2 3/4

Day & Son, Lith.rs to the Queen.

on which day the Experiments were made.

The Red and Black lines in the River indicate the course of the Floats.

The Figures mark the hours at which they were in the positions shown by the Crosses, and the arrows indicate the direction in which they were proceeding.

The line _____ shows the course of a float which was submerged to within about 9 feet from the bottom to indicate the under current.

The other floats consisted of poles 14 feet long and one inch square, which were immersed about 13 feet by a weight attached to the bottom.

London Tilbury &

London Tilbury & Southend Raily

Tilbury Marsh

East Tilbury

Church

Battery

Coalhouse Pt.

Coalhouse Fort

Tilbury Fort

Tilbury Pier

Tilbury Docks

Wharf

Mucking Ch.

Mucking Flat

Mucking Light

Lower Hope Pt.

Old Battery

Chalk Ho.

Fleet

Church

Cliffe

Cliffe Marsh

Cowling Marsh

Decoy

Cowling Church

Cowling Street

Northward Hill

High Halstow Church

Blyth Spit

Blyth S

E. Blyth Fair Buoy

W. Blyth

Fairy

Lower Hope Reach

Gravesend Reach

Gravesend

Rosherville

Church

Station

Terrace Pier

Denton Wharf

Lobster Inn

T. & Medway Canal

Gravesend Marshes

Shornemead Battery

Higham

Milton

Odagers

Windmill Hill

Chalk

North Kent Raily

Hoo

Hoo C

6 Statute Miles

5 6 Sea Miles

S E A R E A C H

F A I R W A Y C H A N N E L

E. Blyth Fog Buoy

Blyth Sand

Yantlet Buoy

Yantlet Middle Ground

Yantlet Spit

Yantley Flats

W.C. Nore Buoy

Nore Sand

Swatch-way

The Yantlet

Leader Stake

Grain Spit Buoy

Grain Spit

Little Nore

Cowling Marshes

St. Mary's Marsh

Decoy Farm

St. Mary's Church

Allhallows

Northward Hill

Clinch Farm

Cowling Church

Cuckolds Farm

Osterland

High Halstow Church

Stoke

ISLE OF GRAIN

St. James's Church

The Oak

Mortella Tower

Home Farm

Outer Black Beacon

Inner Black Beacon

Grain Bridge

White Beacon

Southern Tree

Garrison Pt.

SHEERNESS HARBOUR

Dock Yard

Blue Town

Mile Town

Stoke Marsh

Upper Stoke Marsh

Stoke Ooze

C.G. Lightstone Pt

Colemouth Spit

Lapwell Bank

Old Reed

ISLE

Stoke Ness

Stoke Shoal

RIVER MEDWAY Saltpan Reach

Blackstakes Pt

East Hoo Creek

Bee Ness

Smale Ness

Queenborough

Hoo Marshes

Okcham Marsh

Slede Ooze

Ritchale Reach

Burntwick Marsh

Stangate Creek

Shepherds Creek

Queenborough

Hoo

Hoo Church

T

River Middle East Buoy

CHANNEL

44 45 46 47 48

W.S.W. Nore Buoy

Nore Sand

Nore Light

Swatch-way

GREAT NORE

Grain Spit Buoy

Middle Buoy

Middle Grounds

Grain Spit

Little Nore

The Cant

Cheney Spit

Cheney Rock

Garrison Pt.

SHEERNESS HARBOUR

Dock Yard

Chat

Rite Town

Beach Mill

New Church

Cheney House

Mile Town

Lapwell Bank

Old Fleet

ISLE OF SHEPPEY

Blackstakes

Scale Ness

Shepherds Gut

Queenborough

Queenborough

Halfway House

St. Mary's Church

The Gate

Martella Tower

Outer Black Beacon

Inner Black Beacon

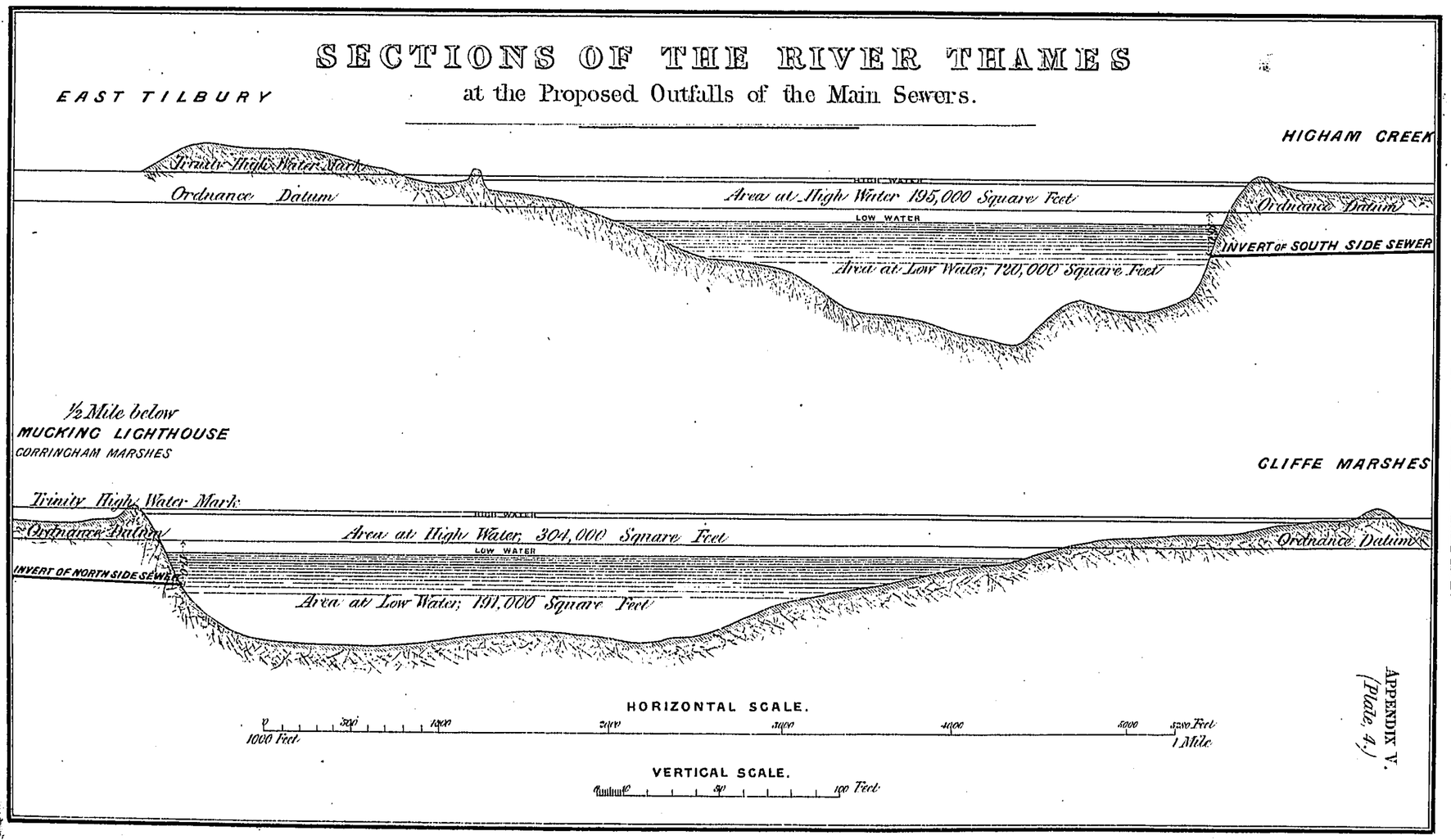
White Beacon

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SECTIONS OF THE RIVER THAMES

at the Proposed Outfalls of the Main Sewers.

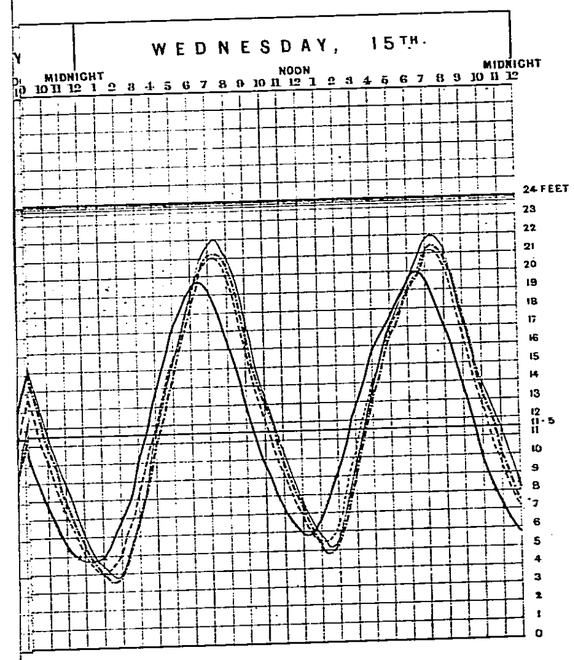


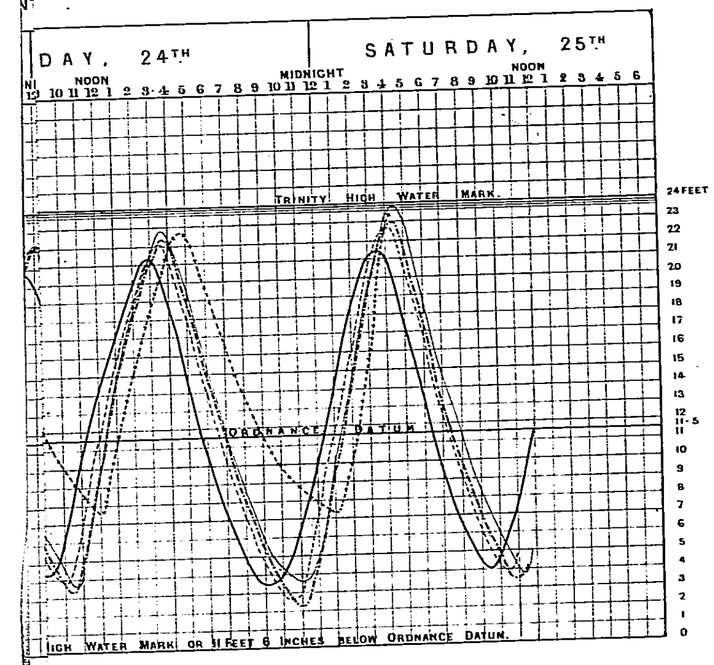
APPENDIX V. [Plate 4.]

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Henry Hansard, Printer.

APPENDIX, V.

(Plate, 5)

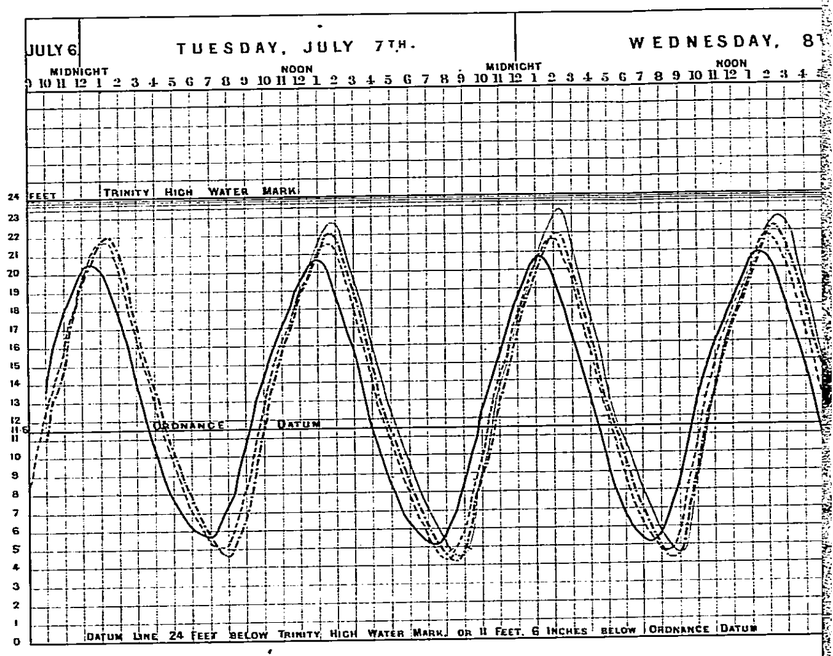


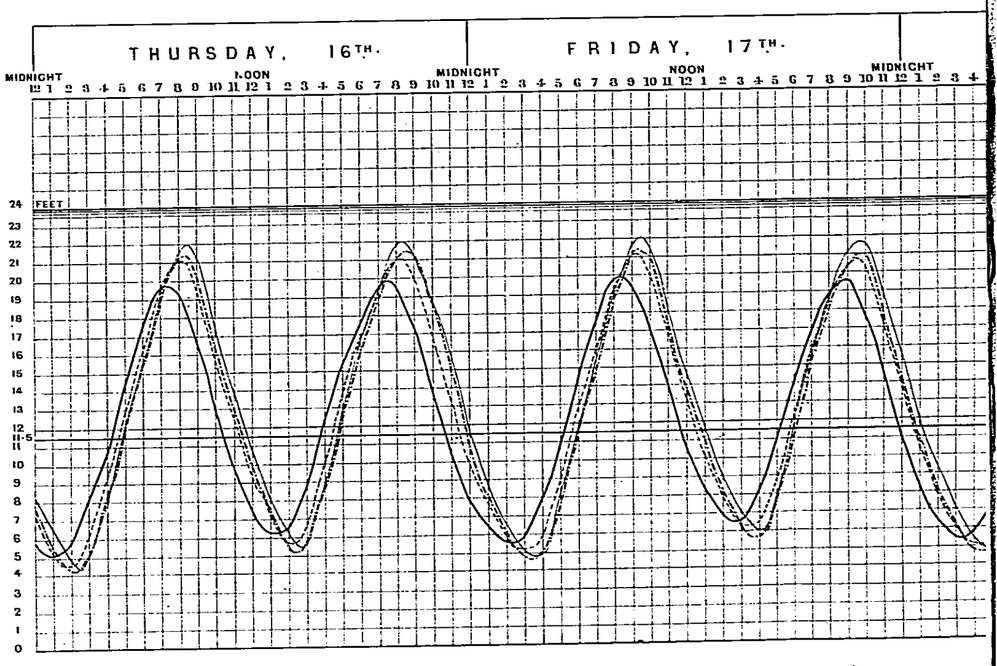


Sandidge

Nº 233. Ordered, by The House of Commons, to be Printed 3rd. August 1857.

Henry Hansard Printer.



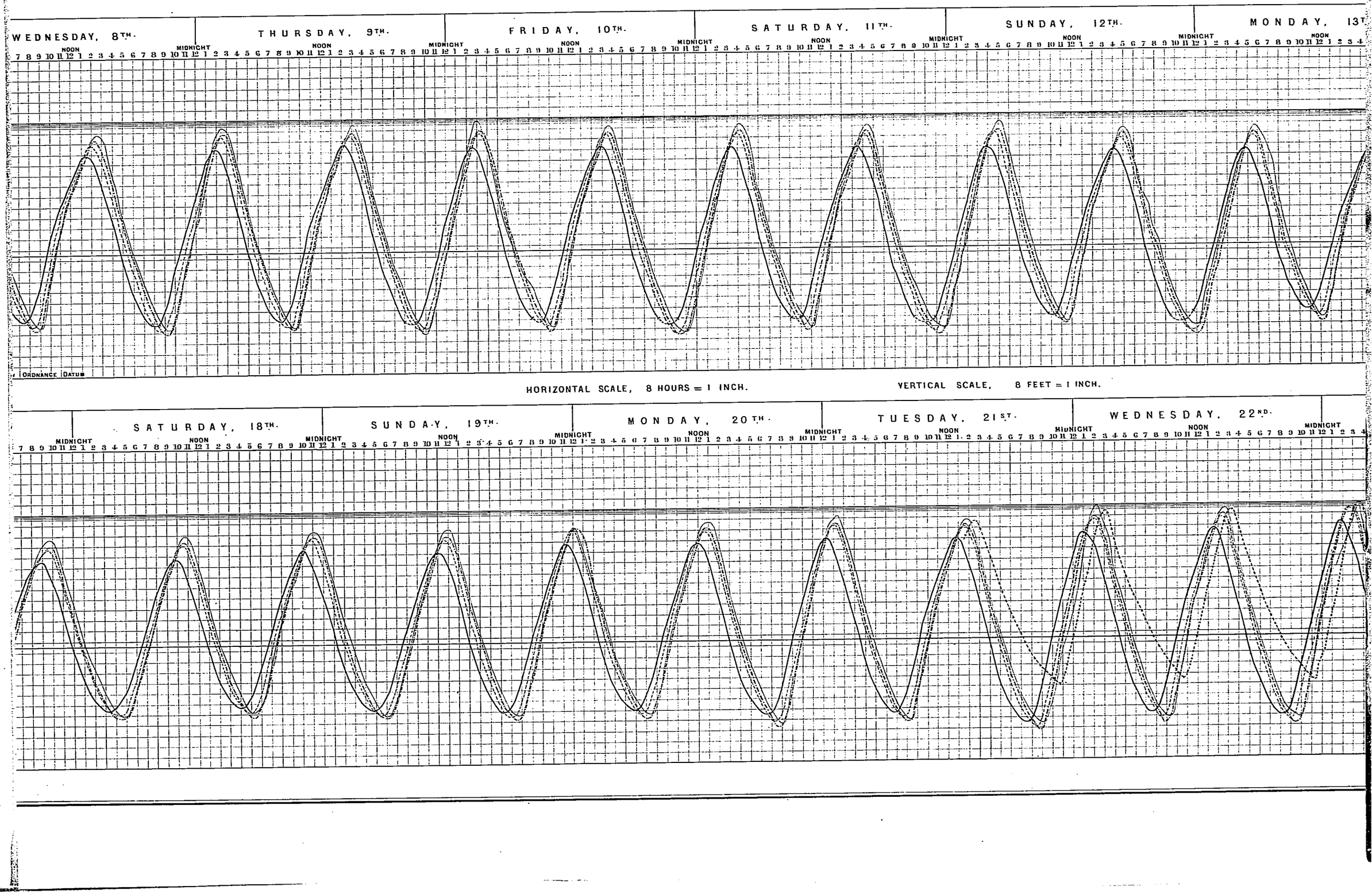


Standidge & Co. Lith. London

DIAGRAM OF TIDAL OBSERVATIONS AT SEA-REACH, ERITH, WOOLWICH, BLACKWALL

TAKEN IN 1857.

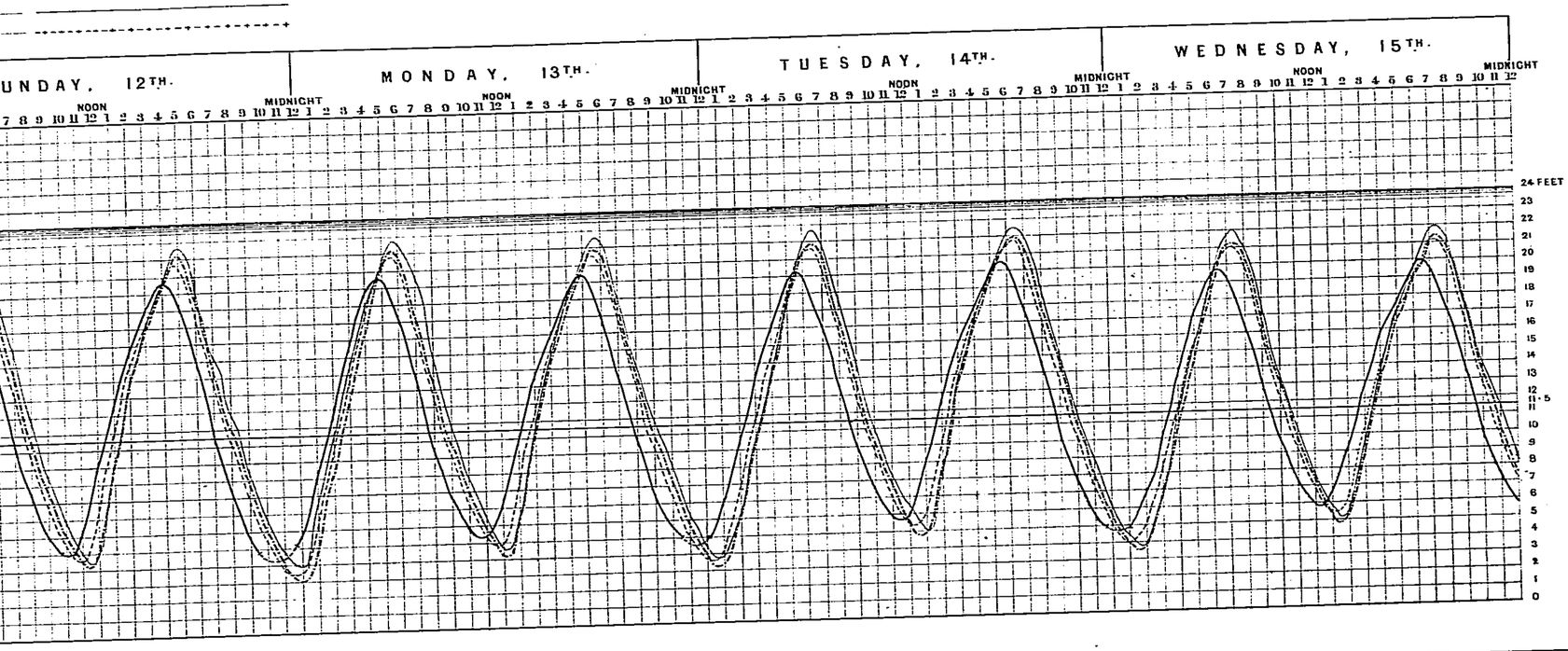
Note. *The Rise & Fall of the Tide at Mucking Lighthouse, Sea Reach, is shown by a Line, thus* _____
Do _____ *the Steam Boat Pier, Erith,* ..... *do* .....
Do _____ *Rolf's Pier, Woolwich,* _ _ _ _ _ *do* _ _ _ _ _
Do _____ *Victoria Dock Pier, Blackwall,* _ . _ . _ *do* _ . _ . _
Do _____ *Cadogan Pier, Chelsea,* _____ *do* _____



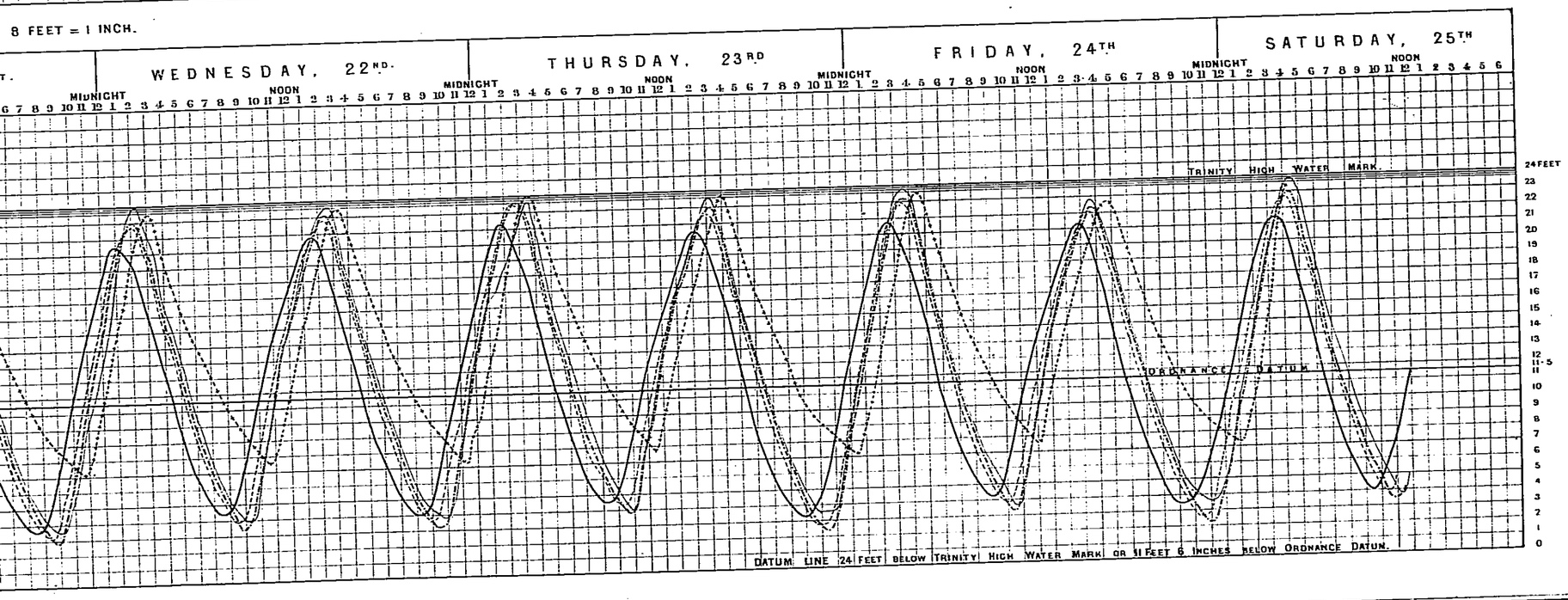
APPENDIX, V.
(Plate, 5.)

WOOLWICH, BLACKWALL AND CHELSEA,

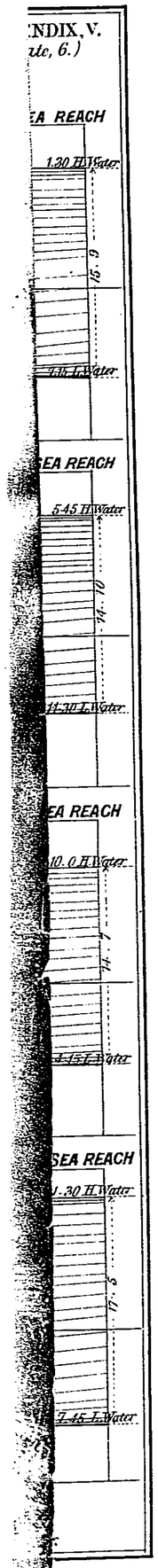
us _____
_____
_____
_____
_____



8 FEET = 1 INCH.



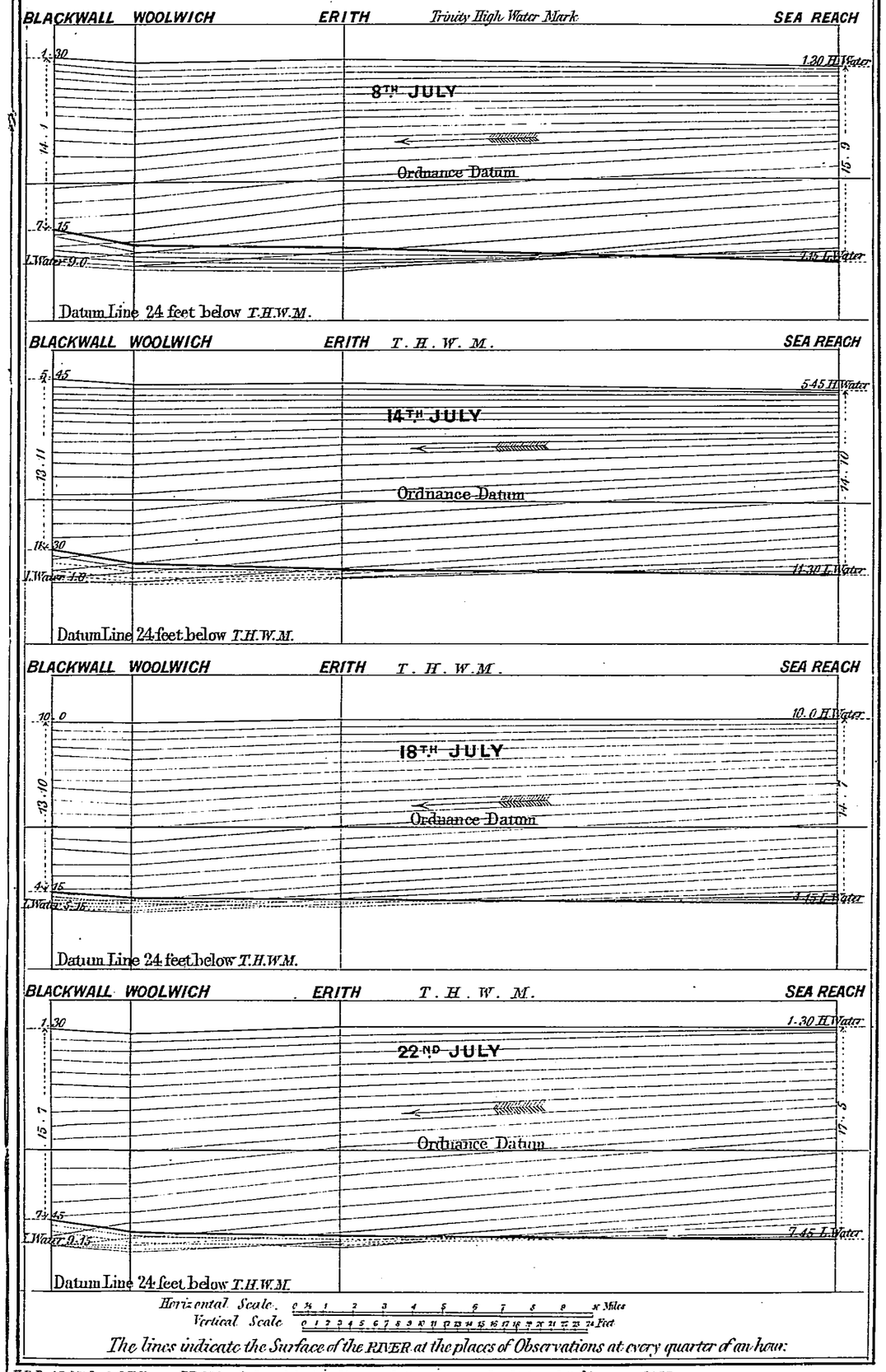
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Henry Hansard Printer.



RIVER THAMES.

APPENDIX, V.
(Plate, 6.)

Diagram of the Flood Tides of the 8th. 14th. 18th. & 22nd. July 1857.



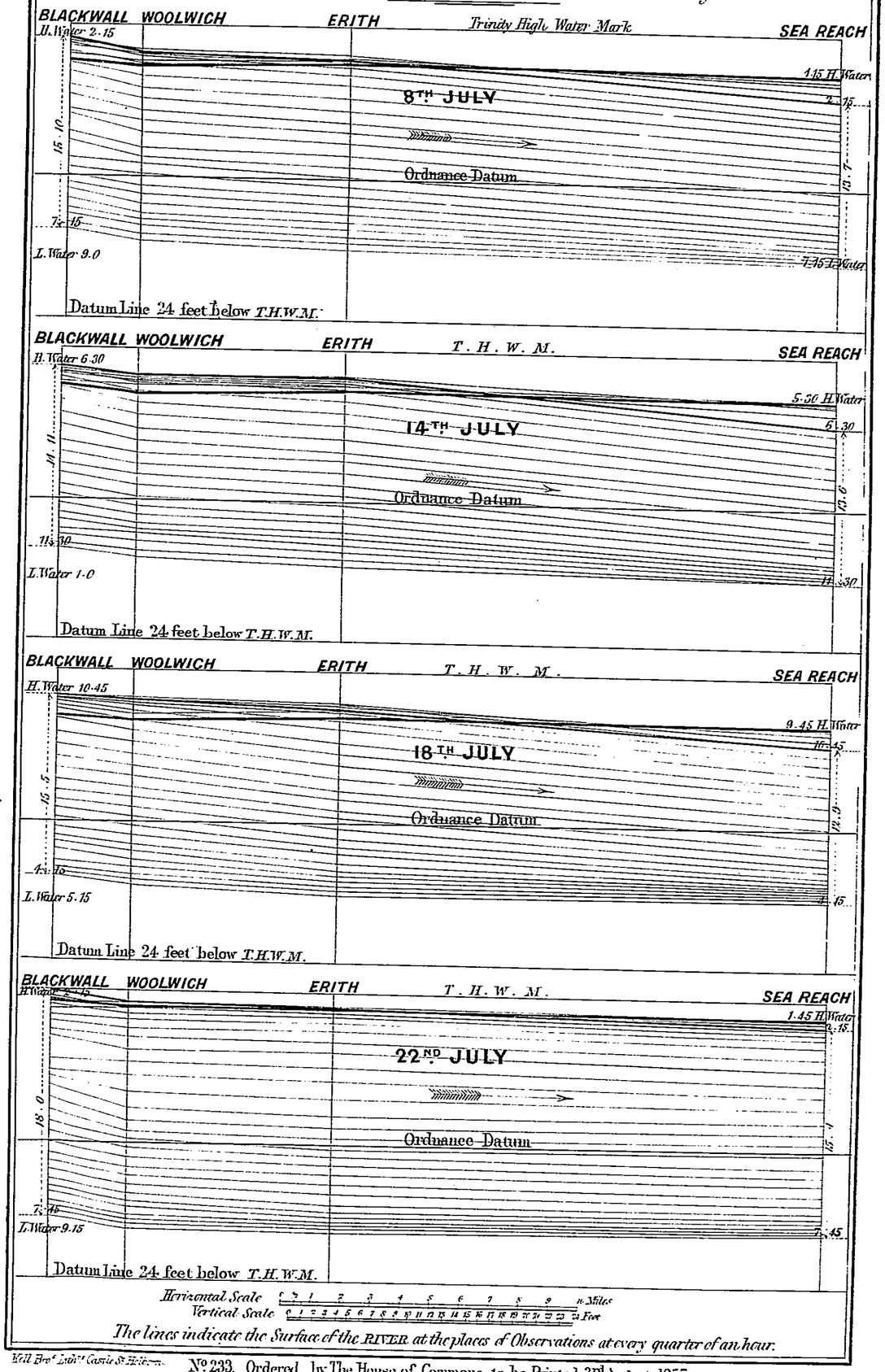
The lines indicate the Surface of the RIVER at the places of Observations at every quarter of an hour.

Kell, Bros. Lith.rs Castle St. Holborn. N°233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.
Henry Hansard, Printer.

RIVER THAMES.

APPENDIX, V.
(Plate, 7.)

Diagram of the Ebb Tides of the 8th. 14th. 18th., & 22nd July, 1857.



The lines indicate the Surface of the RIVER at the places of Observations at every quarter of an hour.

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Henry Hansard Printer.

APPENDIX VI.

INFORMATION furnished by Mr. *Bazalgette*.

Appendix VI.

Information furnished by Mr. Bazalgette.

Evidence, Jan. 12.

1.—MINUTES of EVIDENCE given by *Joseph W. Bazalgette*, Esq., Engineer to the METROPOLITAN BOARD of WORKS.

Meeting of Referees, 29, Great George-street, 12 January 1857.

Mr. *Bazalgette* attended by appointment.

MR. BAZALGETTE handed in a copy of the "Report on the Plans for the Drainage of the Metropolis, 1850," with a classification of those plans appended.

Stated that the plan the Metropolitan Board of Works had adopted was almost the same as prepared in 1853 and 1854 by Mr. Haywood and himself, when Mr. Roe also prepared a plan. Both plans were referred to Sir W. Cubitt and Mr. Stephenson, copies of whose reports he (Mr. Bazalgette) handed in.

Mr. Bazalgette stated that 164 plans were sent in to the Commissioners in 1850. All that was done in the matter would be found in the Report handed in.

Mr. Bazalgette stated that all the plans were at the office of the Metropolitan Board of Works, and at the service of the Referees. There were also concise statements of the main features of those plans by their authors handed in.

Mr. H. Austin, their consulting engineer, and Mr. Phillips, chief surveyor to the Commissioners of Sewers, both prepared plans in 1848, for the drainage of the Metropolis; Mr. Austin's was a sumpt scheme; Mr. Phillips', a tunnel scheme. The Commissioners then advertised, and large numbers of plans were sent in.

In 1849 the new commission re-arranged these plans and reported upon them, some as deserving of attention, but stating that there was not one which they could recommend to be carried out. Mr. F. Forster, their engineer, then prepared a plan, which he did not complete, in consequence of his resignation of office.

The great drainage scheme was announced in 1850. Mr. Bazalgette and Mr. Haywood reported on this, and Mr. Bazalgette engaged to furnish copies of that report. This scheme was before a Committee of the House of Commons in 1850. Mr. Fowler, Mr. Gibbs, Mr. John Mitchell, and Mr. Morewood's engineer were examined in favour, and several engineers against the measure, including Sir W. Cubitt, Mr. Stephenson, Mr. Brunel, Mr. Hawksley, Mr. Haywood, and Mr. Bazalgette. The Bill was rejected by committee on the clause requiring the guarantee for the outlay.

He (Mr. Bazalgette), and Mr. Haywood, were then desired to prepare plan reported on by Sir W. Cubitt and Mr. Stephenson. Mr. Roe's plan was also referred to the same gentlemen.

The late Commissioners of Sewers re-opened the subject, and invited schemes, which were included in a table attached to one of the reports to the Metropolitan Board of Works.

Mr. Bazalgette was directed by the Metropolitan Board of Works to prepare a plan, which he had done, slightly modifying his former plan.

The general features of Mr. *Morewood*'s Plan were,—

North.—A tunnel sewer parallel with the Thames to Barking, and the establishment of sewage manure works.

South.—A low level sewer, in connection with sewage manure works.

The surplus sewage would have risen to the level of existing sewers, and would then have discharged into the river at low water, as at present.

And of Mr. *Roe*'s Plan,—

No great variation from his (Mr. Bazalgette's) own plan, except a difference in the sizes of sewers. Mr. Roe proposed to make his high level sewer smaller; and also proposed to syphon under the River Lea.

DESCRIPTION of Mr. *Bazalgette*'s Plan B*. (*See* Plate 1.)

SOUTH SIDE.

THE South District is divided into two areas, high level and suburban, and low level and urban. In the high level district building is going on rapidly, and the necessity for sewers is increasing. It is now drained by ditches which discharge into the sewers in the low level district. The surface of the low level district is from 4 to 6 feet below high water, and the sewers are tide-locked 18 hours out of the 24.

The sewers in Lambeth, Bermondsey, &c., require a deep and free outlet, which can only be provided by the proposed low level sewer. Many houses connected with these sewers

Appendix VI.

Information furnished by Mr. Bazalgette.

Evidence, Jan. 12.

have basements, below which sewers have necessarily been constructed. These sewers are now, therefore, sewage reservoirs, 18 hours out of every 24. In heavy rains they overflow, and basements of houses are flooded, the ground becomes saturated with wet, and many days elapse before the sewers are relieved, and consequently they cannot be cleansed.

If flood in river three feet above low water, sewage is held back in sewers, and the district flooded. In some years large amount of property damaged. There are a number of open sewers which it is very desirable should be covered, but they have no sufficient outfalls at present; if these outlets are constructed, the sewers would not have to act as reservoirs, and might be made comparatively small.

As the upper districts which discharge into the lower are drained, of course the lower sewers will have to receive more drainage, and they are therefore still more frequently overcharged.

His (Mr. B.'s) object is to carry as much off by gravitation as possible, and so reduce pumping to the minimum.

High-level sewer to Deptford Creek with branch from Dulwich, whilst it intercepts flood waters, provides outfalls for district drainage, and thereby saves the cost of forming such outlets out of the district rates, by the present more costly and less effective routes.

Upland water would go into low-level sewer, if only a low-level sewer was formed, and discharge would be intermittent and only at low water. The valley lines of sewers to be covered would be much longer; therefore the cost of covering present valley lines would be greater than that of constructing a high-level sewer which would give outlets to upper drainage: for instance, Dulwich is flooded in wet weather, and cannot at present be properly drained. High-level sewer would give relief at once, having a quick fall and free discharge at high-level.

Mr. Bazalgette's project is to provide outfalls for the extension of the high-level drainage, which is now urgently required, and is rapidly extending.

The low-level sewer having been relieved of upland waters is to carry off sewage and so much downfall as will drain the district and purify the river.

High-level sewer to carry off all rainfall, and have no overflow until it arrives at Deptford.

The low-level sewer will convey all ordinary rainfall; on occasion of storms, when it is overgorged, the waters will rise to level of existing sewers, which will relieve themselves by discharging the surplus at present outlets, into the Thames.

Present sewers fall west to east, which Bermondsey branch of proposed sewers will intercept, with very small exceptions. Mr. Bazalgette produced a plan illustrating this.

Could let in water from the Thames at high water for flushing sewers in Bermondsey, and other low-level districts in dry seasons, at a period when the pumps would be only partially employed.

The Kennington-lane sewer is occasionally flushed from the Effra sewer, when those waters flow into the Thames through the Duffield sewer.

Flushing is restricted now owing to its not being possible to let off water at or near high tide, the only time Thames water is available for that purpose.

All house-drains in the lowest district have flaps at their junctions with the sewers, to prevent water rising into houses.

The metropolitan area or district on the south, which the Board is bound to drain, is defined by green line on plan.

Lower-level sewer to be of sufficient size to be extended to Richmond, but in that case a pumping station would be requisite at Putney.

By constructing sewers as far as Deptford Creek, drainage may be assumed to be perfected. The sewers beyond that are not required for the better drainage of the Metropolis, but for the interception of the sewage from the Thames alone.

Greenwich has sufficient fall to drain into the river.

Improved drainage more important to health than purification of river.

Question by Mr. Simpson.—In Southwark and Bermondsey, manufacturers obtain river water at present from the sewers; will they not require this privilege to be continued?

Answer.—They have no right of water from the sewers.

Mr. Simpson.—They used the ditches as a means of obtaining water, many years before the Commissioners took possession of and covered them over, and they will insist on their rights.

St. Saviour's Dock or Bermondsey Mill Stream, which for many years supplied Rain's mills, has been filled up; the mill no longer exists. The persons formerly entitled to water from this source are now supplied by an 18-inch iron-pipe laid from the Thames to their premises. A mill in Mill Pond-street, Rotherhithe, is worked by tidal water let into a system of ditches forming the "Seven Islands;" these rights would have to be maintained. The tidal ditches in the Greenwich and Rotherhithe marshes supply the cattle with water. Mr. Bazalgette stated that he knew of no other water rights, and none of these would be interfered with by the main drainage works.

Mr. Bazalgette undertook to furnish an account of sewers entering the Thames within the limits of the Metropolitan Board of Works. (*See* page 185.)

Mr. Bazalgette stated that persons could be required to construct sewers for drainage of property; but if any sewer were constructed by private persons, the privilege of draining into it must be paid for by any other persons using it. The sewers, however, are the property of the Board.

Question

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Information furnished by Mr. Bazalgette.

Evidence, Jan. 12.

Question by Mr. Simpson.—In Stangate, Belvedere-road, Commercial-road, and other places on the banks of the river, they suffer from high tides; how is this to be dealt with?

Answer.—The river water will be controlled by double flaps and penstocks; the number of outlets will be reduced very much; in fact, it is proposed to reduce them to main valley lines, and turn many into inlets; 9 and 12-inch pipes will be stopped up.

House-drains and small sewers to be carried back to intercepting sewers.

The present Board have complete control over the river banks, as to sewers within the Metropolitan area

NORTH SIDE.

The population of the North side is more dense than that of the South, the areas being compared with one another.

There will be three lines of sewers on the north side.

1st. A high-level sewer, covering the Hackney Brook, which is an open sewer, and improving its route, with an extension from Holloway to Hampstead, &c. The extension of one mile and a half in the upper part renders it an intercepting sewer. 2d. A middle level sewer and branches, to carry off as much as possible by gravitation. 3d. A low-level sewer, to be carried to the West Ham marshes.

Two propositions were laid before the Metropolitan Board of Works.

1. For carrying it on in conjunction with Thames embankment.
2. For constructing it through the streets.

Should the Thames embankment be carried out within a reasonable time, the Board propose to construct a sewer with the Thames embankment; on this account, and to reduce the flow of sewage, the high-level sewers should be constructed first.

WEST END OF LONDON.

The levels rise about the Edgware-road, &c., and then fall east to west—Mr. Bazalgette therefore proposes a pumping station for the western district. Population, thin; rainfall, larger in proportion than over the town districts.

Does not believe deodorising to be profitable; and having ascertained that it will separate foul water, finds there will be a large saving by deodorising, compared with having to convey it to Barking Creek, taking no credit for the value of manure. This does not apply to the rest of the Metropolis, where the population is greater and the distance shorter.

The cost of carrying the sewers to B*, would be the same as deodorising all the sewage, including capitalization of annual expense.

(*Vide* calculations in Reports.)

District of Fulham, &c. increasing, but does not anticipate so great a density there as in other parts of the metropolis.

The sewers are designed so as to be capable of extension, in order to drain Brentford.

The sewage from Richmond is now carried to the railway, and runs through an open ditch. It is designed to carry it into the river at Mortlake.

Deodorising works would do away with the proposed lift at Vauxhall Bridge.

As to sewage at Erith being a nuisance to river, stated that the argument was based on the discharge at one point, whereas calculations show that the discharge would not be a nuisance to the inhabitants of Erith.

Taking human excrements, and comparing with water supply.

The proportion of dry excrement, &c. to water supply, calculated at five cubic feet per head, is - - - - - - - - - - 1 to 2,578.

When discharged into river at point B*, the proportion will be 1 to 2,495,504.

The sewage is now discharged two hours before and two hours after low-water.

Produced a section of the Thames at London Bridge at low-water, showing the area to be 4,130 feet.

Each gallon of sewage now has 50 gallons of water, and at B* would have 1,000 gallons of water.

It is proposed to carry pipes down to low-water at Rainham Creek.

Has divided metropolis into natural drainage areas, and from census tables ascertained population on each area.

Has increased the suburban districts to 30,000 inhabitants per square mile, with some few exceptions, which are increased to 20,000 only.

Mr. Bazalgette stated his estimates of population to be approximate only.

The total increase provided for in estimates is about 50 per cent. of the present population.

The water supply is taken at five cubic feet per head.

Flow of sewage is not uniform throughout the day; it becomes necessary to estimate it, which he (Mr. Bazalgette) does at half the total quantity in six hours.

Rainfall is assumed at ¼ inch per day running off.

The ordinary quantity of sewage is 1-4th of the rainfall intercepted.

All parties seem to agree to the above proportions, and that the sewers should be constructed accordingly.

The above mode has reference to—

Middle level sewer	- - - -	North.
Low „	- - - -	North.
High „	- - - -	South.
Low „	as far as Battersea	South.

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Evidence, Jan. 12.

If Barnes, Wandsworth, &c., were to be taken in this way, the proportion of rain would be enormous as regards sewage; the quantity of rain is therefore reduced to ⅛th of an inch.

Drainage sewers provide for carrying off storm-water, if 1 inch per hour.

Overflows are provided at Deptford Creek and the River Lea.

Propose to carry the above quantities of ¼th and ⅛th of an inch rainfall to outfalls.

Excludes rural areas at Putney, &c.; Blackheath is to drain into the Wandle and Ravensbourne, being rural, and not affected by foul drainage.

Not possible, within reasonable limits of expense, to construct sewers of sufficient capacity to carry off all storm-waters.

Mr. Bazalgette's observations on the proportions of storm rainfall to ordinary ditto to be put in in Answer to Question No. 9. *See* page 183.

Main Outlet Sewer, Northern Division.

It was proposed by Mr. Roe to carry syphon under River Lea; but a syphon of that depth and length, and so situated, was considered objectionable, occurring at the outfall of such an extensive system; Mr. Bazalgette therefore proposes an aqueduct.

Produced section; brick piers, with sewer in two compartments of cast-iron.

Does not think frost would affect it, because exposed so short a time, and from the fact that the water would be warmer than the atmosphere.

The smallest depth in aqueduct would be one division half-full four feet deep.

No gaugings of sewers made since Mr. Phillips' and Mr. Hawkins' Report in 1845.

Commenced gaugings two years ago; but not completed.

Gaugings of the sewers two years ago considerably below the present water supply.

The gaugings were only approximate, and might be roughly summed up as follows:

Quantity per day (22 per cent. being added for sewers not gauged):

North Side.—9,000,000 cubic feet.

South Side.—3,000,000 ,,

Tables as to rainfall flowing into sewers, &c. handed in.

Mr. Bazalgette gave the following explanation as to capacities of reservoirs.

The drainage to the south of the Thames is not at present so complete as that to the north; 1-10th in. to 1-5th in. rainfall would not fill the north reservoir within 1 foot, while the same quantity would overflow the south reservoir.

Sections of reservoirs produced: the area of the north reservoir would be 9 acres, that of the south 4½ acres.

An Answer to Sir B. Hall's statement as to the alleged discrepancy in estimating the quantity of sewage upon which his plan was based, was here put in by Mr. Bazalgette as a reply to Question 6. *See* page 193.

Reservoir at B* sufficient to take the present flow of sewage, &c., with 1-10th to 1-5th of an inch rainfall; when this quantity was exceeded, the surplus would be discharged into the river.

As to the disproportion between the quantity which the reservoir would be capable of holding, and the discharging power of sewer, Mr. Bazalgette stated that the extra rainfall would be better discharged at B* to go into the river at all times, than held in a reservoir to be constructed larger for the purpose.

(Paper put in.)

In first report, had proposed to make reservoirs at Plumstead larger; but in subsequent report, altered that opinion. (Read extract from Report, dated 7th August 1856.)

Proposes to construct reservoirs of smaller size, and if afterwards necessary, enlarge them.

Mr. Bazalgette said he had prepared a memorandum of rival schemes submitted to the Metropolitan Board of Works lately, showing that the estimates of the cost were erroneous; and offered to supply the Referees with copies.

Has prepared a plan and estimate for carrying outfalls to Sea Reach, and finds the sewers can be carried there cheaper separately than by crossing the river with the south sewer.

Site of Outfall.

1. Foster's - - - - - - Greenwich Marshes; and Mr. M'Clean's, the same place, but to low water instead of high water.
2. Mr. Bazalgette's and Mr. Haywood's, Point A. Plumstead and Barking Creek.
3. Ditto - - - - - Point B. 1½ mile above B*, opposite Dagenham and the powder magazine.
4. Ditto - - - - - Point B*, Rainham Creek. (*Vide* Captain Burstal's Report.)

Had made a further survey to Sea Reach.

South side.—Tunnel under Northfleet and Gravesend, also under Medway Canal; two pumping stations, Northfleet, and at outfall near Cliffe.

North side.—High level; no pumping; the small rivers the great difficulty; must syphon them.

If

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Information furnished by Mr. Bazalgette.

Evidence, Jan. 12.

If sewage works, established near London, turn out profitable, the advantage will be greater the nearer to the Lea they are established.

Numerous applications have been received from districts during the last seven years, as to covering sewers, defective drainage, &c., and are requiring early attention. This portion of the question is urgently pressing.

Mr. Simpson inquired the points which guided Mr. Bazalgette in determining the levels of the intercepting sewers.

Answer.—The requisite gradient or fall was first determined, and the minimum depth which would be required fixed from existing sewers, so as to reduce the pumping on the south side at Battersea-fields; the great object being to have as little pumping as possible.

The middle level, on the north side, was a difficult line; the Fleet would be intercepted at low level, and a branch thrown out; sewer near Victoria Park intercepted; cannot construct sewer otherwise, in consequence of Duckett's Canal, River Lea, Railways, &c.

South Side.—When the Effra Sewer should be charged with storm-water, a given quantity of water would go to the pump-well, and the rest to river.

This would explain the reduced size of sewers in connexion with pump-wells.

Mr. Bagalzette stated, that he was now preparing a report, with plans, &c. for putting main sewers in proper repair, &c., assuming the main drainage decided on, so as to form the outfalls for such sewers.

Answers to Questions put by Referees.

2.—PAPER containing QUESTIONS handed to Mr. *Bazalgette* by the Referees, 12th January 1857, and returned with the Answers attached, 17th January 1857.

As to the principles upon which the sewers have been designed.

1. Be so good as to describe the plans and sections of the proposed drainage, and the exact site of plan B*.

Explained in evidence, 12th January 1857.

2. What levels have been adopted at the commencement and junction of the sewers on the north and south sides respectively?

Answer given 12th January 1857.

3. How have the quantities of sewage been ascertained?

Explained in evidence, 12th January 1857.

4. Can a list and description of the Sewers entering the Thames be furnished?

Paper in answer put in 17th January 1857, *see* page 185.

4*a*. Can copies of Messrs. Hawkins' and Phillips's experiments, and reports on flow in sewers between Chelsea and the Temple be furnished?

Also, of any other reports and papers connected with this portion of the subject?

Paper in answer put in on the 17th January 1857, *see* page 185.

5. What is the formula made use of generally for ascertaining the flow of sewage, and more particularly the formula for the main drainage?

Paper in answer put in 17th January 1857, *see* page 193.

6. As to the alleged discrepancy in reported quantity of sewage to be conveyed away? *Vide* Referee's Instructions, 31st December 1856.

Paper in answer put in 17th January 1857, *see* page 193.

7. Whether any and what distinction is made between rainfall and sewage?

Shown in tables attached to Reports, and generally explained, on 12th January 1857.

8. As to flow of rainfall and sewage in—

a. Urban districts?
b. Suburban districts?
c. Urban and suburban districts conjointly?

Shown in tables attached to Reports, and generally explained, on 12th January 1857.

9. What observations have been made on amount of flood-waters in the several sewers? Taking the Ranelagh sewer, for instance.

a. Section of ordinary flow. } *See* page 209, and
b. Section of flow in an extreme flood? } Plate 2, Appendix VI.
c. At what point, as a general rule, flood-waters may be taken to commence?

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Answers to Questions put by Referees.

d. The quantity of sewage and flood-waters in the sewer?
Minimum?
Ordinary or mean?
Maximum?
Maximum in floods?

No answer put in.

10. As to the mode of dealing with flood-waters, and working the proposed sewers, so as to exclude—

1. The upland waters from the low lands?
2. The flood-waters of the low lands?

and how are these flood-waters to be passed into the river?
Described in evidence, 12th January 1857.

11. In dry seasons, it has been stated the sewers frequently have not sufficient water in them. Is there any ground for such a report since the improvement and extension of the sewers during the last two years?

Some of the branch sewers, at the upper end of the drainage basins, have not sufficient water in them in dry weather, and require periodical flushing; but this is not so with main or valley lines, in which there is always a good stream running.

12. What control is proposed to be exercised regarding the letting off water?

1. By Water Companies:

These are required to give three clear days' notice, before letting off large bodies of water.

2. From canal, St. James's Park:

The same rule should apply as in the case of the Water Companies.

3. From ornamental water in Buckingham Palace gardens:

Same as No. 2.

4. Grosvenor Canal:

Same as No. 1.

5. Kensington Basin: Serpentine River: Lake in the Regent's Park. &c. &c.

Same as Nos. 2 & 3.

13. Assuming a high tide, and flood in the river, what would be the effect of letting off three or four feet depth from the Serpentine into the sewers of Belgravia and parts of Chelsea and Westminster?

It would flood those districts, and might seriously damage the sewers, and drown the workmen employed in them.

14. As to the construction of the proposed large sewers—

1. What saving will accrue from reduced sizes of sewers in parts of the lines where the gradients warrant it?

A very large saving will be effected by the construction of the intercepting sewers. They will reduce the sizes, and shorten the lengths of the district or branch sewers.

2. With reference to obstructions, &c. is it advisable to adopt these reduced dimensions?

It is desirable to reduce the sizes, for with the improved fall there would be no obstructions.

15. How is it proposed to lift the sewage at the several places?

By pumps and steam engines, the details of which have not yet been determined upon.

How is the obstruction or debris of solid matter at the stations to be dealt with?

The heavier matters would be caught in pits before they reach the pumps, and removed by "Jacob's Ladders."

What objection would there be to greater subdivision of the lifts?

The difficulty of finding sites for pumping stations, and the objection raised to pumping sewage in London; also increased expenditure of separate stations.

16. As to the construction of the sewers generally?

1. Form and materials.

Form: Circular.—Materials: Brickwork.

2. Means of access:

By side entrances, in the usual way.

3. Expediency

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Answers to Questions put by Referees.

3. Expediency of portions being in double lines to facilitate repairs, &c. &c.

Double lines are much more costly, and, although they possess this advantage, are not absolutely required.

4. As to construction of portions of sewers in iron [*N.B.*—The line in Surrey is of great length—], with general observations.

Iron is resorted to only where absolutely necessary, on account of its great cost.

17. What is proposed to be done with the duplicate system of sewers in Lambeth—high and low?

The high are now nearly exploded, and will soon be completely so, for they are defective in construction and design.

18. Estimates: Will you be so good as to furnish copies of estimates, and detailed plans or sketches used in forming them?

Detailed estimates put in 17th January 1857. Plans deposited on the 12th January 1857.

19. Plans received in answer to advertisement by second Board of Sewers. Classification of the same, and report thereon. Can this be furnished?

Two series of "Concise Statements" of the above plans put in, 12th January 1857.

(*Answer to Question* 4.)

Approximate Number of Outlets and Sluices entering the *Thames* within the Metropolitan Area.

	North.	South.
From the Lea to somewhere about the Tunnel - -	17	25
„ Tunnel to London Bridge - - - - -	15	6
„ London Bridge to Blackfriars - - - -	23	6
„ Blackfriars to Westminster - - - -	36	3
„ Westminster to Vauxhall - - - - -	4	2
„ Vauxhall to Battersea - - - - -	15	4
„ Battersea to Fulham - - - - - -	5	3
	115	49

Mem.—A list of all the principal sewers which can be identified by name was put in on the 12th January 1857.

17th January 1857. *J. W. Bazalgette.*

(*Answer to Question, No.* 4*a.*)

Sewage of Westminster, and Part of Middlesex.

Average Discharge of Sewage.

(Printed by Order of Court, 3d October 1845).

Sewers Office, No. 1, Greek-street, Soho, 3 October 1845.

In compliance with the order of Court of 6th October 1843, to report "on the average discharge of sewage from the following outlets, viz., Church-lane and Smith-street, Chelsea, Ranelagh, King's Scholars' Pond, Grosvenor, Horseferry-road, Wood-street, King-street, Northumberland-street, Durham-yard, Norfolk-street, and Essex-street, under ordinary and extraordinary circumstances," I beg leave to present the accompanying tabulated results of some experiments at the above mentioned outlets, made during the months of May, June and July of the last year.

The accompanying plan of the district of this Commission shows the comparative surface drained by each of the above outlets; their total area being about 7,000 acres, of which nearly one-half may be considered urban. As the observations were made during fine weather, the results will only indicate the discharge under ordinary circumstances.

 The

Appendix VI.

Information furnished by Mr. Bazalgette.

Answers to Questions put by Referees.

The general conclusions deducible from these experiments are,—

1st. That the mean discharge per acre, taking the whole surface drained, urban and suburban, is about 256 cubic feet in the 24 hours.

2d. Considering the dryness of the weather during these observations, the above quantity of sewage may be assumed as solely derived from artificial sources, and due to house-drainage; supposing, therefore, the entire surface to be urban, we have 540 cubic feet as the mean daily discharge per acre. If, however, the average be taken of the first eight outlets, viz., from Essex-street to Grosvenor Wharf inclusive, which drain a surface wholly urban, the result is 1,260 cubic feet per acre in the 24 hours. This excess may be attributed to the number of manufactories and the densely populated nature of the locality drained; but, as indicative of the general amount of sewage due to ordinary urban districts, the former ought perhaps to be considered the fairer average.

3d. Assuming (as regards the relative proportion of urban and suburban) the district to which the accompanying observations refer to be a fair type of that included within the whole of the Metropolitan Commissions of Sewers, and taking the extent of the active jurisdictions of those on the north side of the River Thames at 43 square miles, and the jurisdiction of the Surrey Commission at 15 square miles, the ordinary daily amount of sewage discharged into the river on the north side would be 7,045,120 cubic feet, and on the south side, 2,457,600 cubic feet, making a total of 9,502,720 cubic feet, or a quantity equivalent to a surface of more than 36 acres in extent, and six feet in depth.

(signed) *George Hawkins*, Assistant Surveyor.

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* RESULT of some EXPERIMENTS made during the Months of May, June and July 1844, upon the Amount of Sewage discharged by the principal Outlets under the jurisdiction of the Commissioners of Sewers for *Westminster*, and part of *Middlesex*. Pursuant to the Order of Court, 6th October 1843.

ESSEX-STREET SEWER, Numbered 1.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water Discharged per Second.	REMARKS.
1844:	P. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 4	1 45	2 40	2 45	3	·030	·207	·090	·018630	
„ - 9	4 0	7 10	1 10	„	·100	·577	·300	·173100	
June - 5	2 30	4 40	1 40	„	·250	1·500	·750	1·125000	
„ - 10	7 45	9 20	3 25	„	·120	·600	·360	·216000	Fair weather.
„ - 11	7 30	10 10	1 40	„	·280	1·800	·840	1·512000	Ditto.
	P. M.		falling						
„ - 16	9 30	2 10	6 40	„	·200	1·040	·600	·624000	Ditto.
	A. M.		rising						
July - 12	8 30	10 40	2 10	„	·170	1·080	·510	·550800	Ditto.
								4·219530	
								·602790	= mean discharge per second, or
								52081·0	cubic feet per 24 hours.

* The calculations in these Tables are so erroneous, according to any approved formula of discharge, and as arrived at from the data given, that the results cannot be depended upon. The Tables were, however, handed over in the above form to the Referees, and are consequently published without correction. The quantity for the 12 sewers, as given in the Summary, is 1,798,094 cubic feet per day; while the actual quantity, as calculated, from the data given in the Tables, by the ordinary formula for the discharge over weirs, is more than 1,000,000 cubic feet per day in excess of the above, or about 55 per cent.; the quantities in the case of the Northumberland-street sewer are nearly double what they ought to be, and in all other cases not more than from one-fourth to one-half of the actual amount. Not one of the results is correct. (Note by Referees.)

Appendix VI.—*continued.*

EXPERIMENTS made during May, June and July 1844, upon the Amount of Sewage discharged, &c.—*continued.*

NORFOLK STREET SEWER, Numbered 4.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water Discharged per Second.	REMARKS.
1844:	P. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 4	12 15	2 41	1 11	2	·353	1·428	·706	1·008168	
„ - 9	3 45	7 11	1 4	„	·220	·875	·440	·385000	
June - 5	2 15	4 41	1 26	„	·104	·630	·208	·131040	
„ - 10	7 30	9 21	3 11	„	·380	1·280	·760	·972800	Fair weather.
„ - 11	7 15	10 11	1 26	„	·320	1·000	·640	·640000	Ditto.
		P. M.	falling						
„ - 16	8 45	2 11	5 56	„	·180	·640	·360	·230400	Ditto.
	A. M.		rising						
July - 12	8 0	10 41	1 41	„	·094	·270	·188	·050760	Ditto.
								3·418168	
								·488309	= mean discharge per second, or
								42189·0	cubic feet per 24 hours.

DURHAM YARD, OR SAVOY SEWER, Numbered 7.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water Discharged per Second.	REMARKS.
1844:	P. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 4	12 0	2 46	1 1	3	·100	1·000	·300	·300000	
„ - 9	3 30	7 16	0 46	„	·100	1·000	·300	·300000	
June - 5	1 45	4 46	1 1	„	·110	1·000	·330	·330000	
„ - 10	7 15	9 26	3 1	„	·100	1·000	·300	·300000	Fair weather.
„ - 11	7 0	10 16	1 16	„	·100	1·000	·300	·300000	Ditto.
		P. M.	falling						
„ - 16	8 30	2 16	5 46	„	·060	·820	·180	·147600	Ditto.
	A. M.		rising						
July - 12	7 30	10 46	1 16	„	·080	·910	·240	·218400	Ditto.
								1·896000	
								·270857	= mean discharge per second, or
								23402·0	cubic feet per 24 hours.

Appendix VI.—*continued.*

EXPERIMENTS made during May, June and July 1844, upon the Amount of Sewage discharged, &c.—*continued.*

NORTHUMBERLAND STREET SEWER, Numbered 20.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water Discharged per Second.	REMARKS.
1844:	A. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 4	11 30	2 52	0 52	5	·457	4·600	2·285	10·511000	
	P. M.								
„ - 9	3 15	7 22	1 7	„	·340	4·000	1·700	6·800000	
June - 5	1 15	4 52	0 37	„	·340	4·000	1·700	6·800000	
„ - 10	7 0	9 32	2 52	„	·450	4·600	2·250	10·350000	Fair weather.
„ - 11	6 15	10 22	1 7	„	·500	4·920	2·500	12·300000	Ditto.
		P. M.	falling						
„ - 16	8 15	2 22	5 37	„	.330	3·600	1·650	5·940000	Ditto.
	A. M.		rising						
July - 12	7 0	10 52	0 52	„	·246	2·760	1·230	3·394800	Ditto.
								56·095800	
								8·013685	= mean discharge per second, or
								692382·0	cubic feet per 24 hours.

KING STREET SEWER, Numbered 27.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water Discharged per Second.	REMARKS.
1844:	A. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 4	11 15	3 0	0 45	4	·037	·147	·148	·021756	
	P. M.								
„ - 9	2 45	7 30	0 45	„	·060	·333	·240	·079920	
June - 5	12 45	5 0	0 15	„	·030	·170	·120	·020400	
„ - 10	6 30	9 40	2 30	„	·052	·311	·208	·064688	Fair weather.
„ - 11	6 0	10 30	1 0	„	·040	·300	·160	·048000	Ditto.
		P. M.	falling						
„ - 16	8 0	2 30	5 30	„	·010	·101	·040	·004040	Ditto.
	A. M.		rising						
July - 12	6 45	11 0	0 45	„	·020	·103	·080	·008240	Ditto.
								·247044	
								·035292	= Mean discharge per second, or
								3049·0	cubic feet per 24 hours.

Appendix VI.—*continued.*

EXPERIMENTS made during May, June and July 1844, upon the Amount of Sewage discharged, &c.—*continued.*

WOOD STREET SEWER, Numbered 28.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water discharged per Second.	REMARKS.
1844:	A. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 4	11 0	3 6	0 36	3	·155	·400	·465	·186000	
	P. M.								
„ - 9	2 15	7 36	0 21	„	·150	·385	·450	·173250	
			falling.						
June - 5	12 15	5 6	7 21	„	·180	·500	·540	·270000	
			rising.						
„ - 10	6 15	9 46	2 21	„	·156	·389	·468	·182052	Fair weather.
„ - 11	5 30	10 36	0 36	„	·100	·360	·300	·108000	Ditto.
		P. M.	falling.						
„ - 16	7 45	2 36	5 21	„	·060	·260	·180	·046800	Ditto.
	A. M.		rising.						
July - 12	6 30	11 6	0 36	„	·100	·360	·300	·108000	Ditto.
								1·073102	
								·153300	= mean discharge per second, or,
								13245·0	cubic feet per 24 hours.

HORSEFERRY ROAD SEWER, Numbered 29.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water Discharged per Second.	REMARKS.
1844:	A. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 4	10 30	3 9	0 9	4	·073	·200	·292	·058400	
	P. M.		falling.						
„ - 9	1 45	7 39	6 24	„	·095	·333	·380	·126540	
June - 5	12 0	5 9	7 9	„	·580	2·500	2·320	5·800000	(*See* Note).
			rising.						
„ - 10	6 0	9 49	2 9	„	·180	·480	·720	·345600	Fair weather.
„ - 11	5 0	10 39	0 9	„	·240	·520	·960	·499200	Ditto.
		P. M.	falling.						
„ - 16	7 30	2 39	5 9	„	·040	·130	·160	·020800	Ditto.
	A. M.		rising.						
July - 12	6 0	11 9	0 9	„	·073	·192	·292	·056064	Ditto.
								1·106604	
								·184436	= mean discharge per second, or,
								15935·0	cubic feet per 24 hours.

Note.—This experiment must be eliminated, as the discharge was increased by turning some of the water from the King's Scholars' Pond Sewer at Buckingham Palace.

Appendix VI.—*continued.*

EXPERIMENTS made during May, June and July 1844, upon the Amount of Sewage discharged, &c.—*continued.*

GROSVENOR WHARF SEWER, Numbered 30.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water discharged per Second.	REMARKS.
1844:	P. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 8	2 30	6 41	1 11	3	·130	·285	·390	·111150	Fair weather.
June - 6	3 0	6 11	2 11	„	·146	·432	·438	·183216	Light rain.
„ - 8	5 30	7 41	3 11	„	·168	·500	·504	·252000	Fair weather.
„ - 10	5 45	9 51	1 56	„	·152	·460	·456	·209760	Ditto.
„ - 11	4 30	10 41	falling 6 11	„	·194	·500	·582	·291000	Ditto.
„ - 16	7 15	P. M. 2 41	4 56	„	·100	·420	·300	·126000	Ditto.
July - 12	A. M. 5 45	11 11	4 56	„	·080	·384	·240	·092160	Ditto.
								1·271286	
								·181612	= mean discharge per second, or
								15691·0	cubic feet per 24 hours.

KING'S SCHOLARS' POND SEWER, Numbered 31.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second at Surface.	Mean Velocity according to Du Buat.	Sectional Area of the Discharge.	Quantity of Water discharged per Second.	REMARKS.
1844:	P. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 8	1 30	6 52	0 22	- -	·800	2·142	1·76	5·657050	9·9564	Fair weather.
June - 6	2 30	6 22	1 52	- -	·625	1·640	1·31	3·922450	5·1384	Light rain.
„ - 8	4 15	7 52	2 7	- -	·700	2·100	1·72	4·591300	7·8970	Fair weather.
„ - 10	5 30	10 2	1 52	- -	·684	2·000	1·63	4·251975	6·9257	Ditto.
„ - 11	4 0	10 50	falling. 5 52	- -	·730	2·130	1·72	4·591300	7·8970	Ditto.
„ - 16	7 0	P. M. 2 52	4 52	- -	·390	1·240	·96	1·877925	1·7027	Ditto.
July - 12	A. M. 5 30	11 22	6 52	- -	·390	1·250	1·03	1·877925	1·9342	Ditto.
									41·4514	
									5·9216	= mean discharge per second, or
									511626·0	cubic feet per 24 hours.

Appendix VI.—*continued.*

EXPERIMENTS made during May, June and July 1844, upon the Amount of Sewage discharged, &c.—*continued.*

RANELAGH SEWER, Numbered 34.

DATE.	Time of Observation.	Time of High Water previous.	Tide rising.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second at Surface.	Mean Velocity according to Du Bunt.	Sectional Area of the Discharge.	Quantity of Water discharged per Second.	REMARKS.
1854:	P. M. h. m.	A. M. h. m.	HOURS. h. m.		*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 8	1 0	7 15	0 13	–	·750	2·678	2·23	4·412252	9·8393	Fair weather.
June - 6	1 15	6 43	0 58	–	·550	1·8	1·50	2·724956	4·0874	Light rain.
„ - 8	3 45	8 13	1 58	–	·630	1·95	1·59	3·121768	4·9635	Fair weather.
„ - 10	5 0	10 23	1 43	–	·590	1·9	1·55	2·921672	4·5285	Ditto.
„ - 11	3 30	11 13	falling. 5 43	–	·560	1·9	1·55	2·724956	4·2236	Ditto.
„ - 16	6 30	P. M. 3 13	4 43	–	·380	1·48	1·17	1·486524	1·7392	Ditto.
July - 12	A. M. 5 0	11 43	6 43	–	·370	1·5	1·19	1·486524	1·7689	Ditto.
									31·1504	
									4·4500	= mean discharge per second, or
									384480·0	cubic feet per 24 hours.

SMITH-STREET SEWER, Numbered 35.

DATE.	Time of Observation.	Time of High Water previous.	Tide falling	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water discharged per Second.	REMARKS.
1844:	P. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	
May - 8	12 0	7 15	6 15	3 5 or 3 41	·145	·377	·494	·186238	Fair weather.
June - 6	12 0	6 45	6 45 rising.	„	·168	·398	·572	·228156	Light rain.
„ - 8	3. 30	8 15	1 45	„	·184	·400	·627	·250844	Fair weather.
„ - 10	4 30	10 25	1 15	„	·194	·432	·661	·285552	Ditto.
„ - 11	3 15	11 15	falling. 5 15	„	·198	·440	·675	·297001	Ditto.
„ - 16	6 15	P. M. 3 15	4 15	„	·166	·390	·545	·212550	Ditto.
July - 12	A. M. 4 30	11 45	6 15	„	·134	·358	·456	·163248	Ditto.
								1.623589	
								·231941	= mean discharge per second, or
								20037·0	cubic feet per 24 hours.

Appendix VI.—*continued.*

EXPERIMENTS made during May, June, and July 1844, upon the Amount of Sewage discharged, &c.—*continued.*

CHURCH-LANE SEWER, Numbered 43.

DATE.	Time of Observation.	Time of High Water previous.	Tide falling.	Width of Sewer at the Discharge.	Height of Water above the Weir.	Velocity of the Discharge per Second.	Sectional Area of the Discharge.	Quantity of Water Discharged per Second.	REMARKS.
1844:	A. M. h. m.	A. M. h. m.	h. m.	*Feet.*	*Feet.*	*Feet.*	*Sq. Feet.*	*Cubic Feet.*	
May - 8	11 0	7 28	5 28	3	·178	·515	·534	·275010	Fair weather.
June - 6	11 30	6 58	6 28	„	·194	·536	·582	·312952	Light rain.
	P. M.		rising.						
„ - 8	3 0	8 28	1 28	„	·205	·620	·615	·381300	Fair weather.
„ - 10	4 0	10 38	0 58	„	·186	·530	·558	·295740	Ditto.
			falling.						
„ - 11	3 0	11 28	5 13	„	·185	·550	·555	·305250	Ditto.
		P. M.							
„ - 16	6 0	3 28	4 13	„	·142	·460	·426	·195960	Ditto.
	A. M.								
July - 12	4 0	11 58	5 58	„	·130	·460	·390	·179400	Ditto.
								1·942612	
								·277516	= mean discharge per second, or
								23977·0	cubic feet per 24 hours.

DISCHARGE from the principal OUTLETS in the *Westminster* Commission of Sewers, being the mean of Seven Observations taken during the Summer of 1844.

Numbers.	NAMES.	Mean Discharge per 24 Hours.	Number of Acres Drained.	Urban or Suburban.	GENERAL REMARKS.
		Cubic feet.	A. R. P.	*Urban (about.)*	
1	Essex-street - - -	52,081	100 3 28	The whole -	- - A portion of the Holborn and Finsbury District is drained into this line of sewer, containing 30 acres.
4	Norfolk-street - -	42,189	30 0 0		
7	Durham-yard - -	23,402	31 2 14	- ditto.	
20	Northumberland-street -	692,382	337 0 35 8 0 0	- ditto -	Ditto - - ditto, containing eight acres.
27	King-street - - -	3,049	27 3 13	- ditto.	
28	Wood-street - - -	13,245	92 3 8	- ditto.	
29	Horseferry-road - -	15,935	21 3 14	- ditto.	
30	Grosvenor Wharf - -	15,691	28 2 6	- ditto.	
31	King's Scholars' Pond -	511,626	1,753 1 19	4-5ths.	
34	Ranelagh - - -	384,480	4,227 2 12	1-4th.	
35	Smith-street - - -	20,037	161 0 27	4-5ths.	
43	Church-lane - - -	23,977	186 0 12	1-4th.	
		1,798,094	7,006 3 28	3,313 3 4	acres, urban (approximately).

(*Answer*

Appendix VI.

Information furnished by Mr. Bazalgette.

Answers to Questions put by Referees.

(*Answer to Question, No.* 5.)

FORMULA to ascertain the discharging power of the Intercepting Sewers.

$v = \frac{9}{10}\sqrt{2\,F \times HMD.}$

v = Velocity in feet per second.

F = Fall in feet per mile.

HMD = Hydraulic mean depth.

FORMULA employed in determining the sizes of Drainage Outfall Sewers.

$\frac{3 \log A + \log N + 6{\cdot}8}{10}$ = log of diameter of sewer in inches, required to carry off 1″ rain per hour.

A = Acres to be drained.

N = Length in feet in which sewer falls 1 foot.

(*Answer to Question, No.* 6.)

AT an early interview with Sir B. Hall, he enquired, what was the quantity of sewage discharged into the river? The only information on the subject then existing, was the gaugings of the Westminster sewers by Mr. Hawkins in 1844, and from those limited results, he had assumed the proportionate total Metropolitan discharge to be about 7 million cubic feet on the north side, and 2½ millions on the south side, or a total of 9½ millions. I did not anticipate, and therefore did not prepare myself to answer Sir B. Hall's question; and having no opportunity of refreshing my memory, I answered him off hand, and to the best of my recollection, stating that I believed it to be about 6 million cubic feet on the north side, and 1¾ millions on the south side.

At a subsequent interview with Sir B. Hall, on the 20th November last, I explained to him that I could then only give him a very approximate idea of the present flow of sewage, because the gaugings commenced by Mr. Haywood and myself in 1854-5, had not been completed; but I believed I had on the previous occasion understated the flow on the south side, it being more nearly 3 million cubic feet.

The Report of the Board of Health on the Metropolitan Water Supply was afterwards issued, which showed that the quantity had been doubled within the last six years; and the result of our more recent and more extensive, though still not complete gaugings, have also been worked up, and the improved information has been applied in my Report of the 1st December 1856.

But neither the past nor the present flow of sewage at all affects the sizes of the proposed main drainage sewers, because they are designed to carry off the rainfall and a largely increased quantity of sewage due to a future increase of population and water supply.

The sizes of the reservoirs, recommended in my Reports at different periods, were as follows:

On the 3d of April 1856, I recommended a reservoir on the south side to contain four million cubic feet, and on the north side to contain nine million cubic feet. These dimensions provided for the increased quantity of sewage due to the prospective population. In my Report of the 7th August following, I recommended the construction of smaller sized reservoirs in the first instance, providing for the present rather than the prospective flow of the sewage, upon the grounds that it would be better to enlarge them hereafter, if necessary, than now to spread their contents over a more extended surface. On the 20th November, I also explained to Sir B. Hall, as a reason for this reduction of the sizes of the reservoirs, that it appeared unwise, in a sanitary point of view, to have the sewage spread over a large evaporating surface for the greater portion of the year, for the mere purpose of receiving the storm waters on a few exceptional days. I had then proposed to reduce the southern reservoirs to 2½ million cubic feet. In my last Report, dated the 1st December 1856, for the foregoing reasons, I proposed to make the northern reservoir contain six million cubic feet, and the southern reservoir 2¾ million cubic feet, and I should still recommend a reduction, rather than an enlargement of the reservoirs.

Captain Burstal, in his Report of the 18th November, called attention to the fact that the reservoir I proposed to construct on the north side, was only double the capacity of that proposed on the south side, whilst the present quantity of the northern sewage was stated to be in a much larger proportion to the quantity of the southern sewage, and this he termed "a discrepancy of proportion." But I cannot acknowledge this as a competent opinion upon that point, for he does not appear to have been aware that the area drained on the south side is much larger in proportion to its sewage than on the north side, therefore the rainfall to be provided for on the south side is proportionately greater. Moreover, the southern drainage, having been hitherto retarded by the want of drainage outfalls, less sewage is carried off in proportion to its population than on the north side; but when the proposed main drainage outfalls are completed, that apparent disproportion will be at once rectified; and it will then be found that the comparative sizes of the reservoirs are fairly adjusted.

J. W. B.

Appendix VI.—*continued.*

3.—MISCELLANEOUS PAPERS on Sewer Gaugings, furnished by Mr. *Bazalgette.*

(1.) Tables of Sewer Gaugings made by Mr. *Bazalgette* in 1853.

North Side of the Thames.

Discharge of Sewage in Dry Weather as Gauged in 1853 and 1854.					Discharge with the undermentioned Quantities of Rain.			
NAME OF SEWER.	Acres Drained.	Per Minute.	Per Hour.	Per Diem.	With from 0 to $\frac{1}{10}$ of an Inch.	With from $\frac{1}{10}$ to $\frac{1}{2}$ of an Inch.	With from $\frac{1}{2}$ to $\frac{2}{10}$ of an Inch.	
		Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet per diem.*	*Cubic feet per diem.*	*Cubic feet per diem.*	
Hammersmith Creek	3,180	57·23	3,433·8	82,411·2	150,394	241,114	409,939	
Queen-street, Hammersmith	934	17·78	1,066·8	25,602·0	31,593	67,998	89,366	
Eel Brook	187	11·02	660·9	15,861·6	24,048	39,427	70,668	
Stamford Bridge	46	10·16	610·1	14,642·4	18,057	24,000*	30,000	*Assumed.
Old Counter's Creek	50	0·86	51·3	1,231·0	4,414	5,702	10,181	
Counter's Creek	1,804	134·90	8,090·4	194,170·0	238,982	314,150	455,558	
Kensington Sewer	314	0·63	38·8	909·0	1,750	17,086	21,427	
Millman's-row	57	5·89	353·4	8,481·6	24,048	40,550	63,590	
Church-street, Chelsea	416	41·89	2,513·6	60,328·8	69,322	97,718	134,784	
Queen-street, Chelsea	83	6·97	418·1	10,034·0	16,488	34,444	63,806	
Smith-street, Chelsea	262	56·72	3,402·9	81,670·0	112,795	203,860	300,000*	*Assumed.
Ranelagh	4,150	427·06	25,623·8	614,971·2	934,502	1,942,157	3,507,494	
Commercial-road, Ranelagh	32	8·54	512·6	12,301·2	34,387	65,750	110,016	
King's Scholars' Pond	1,820	463·84	27,830·3	667,927·2	945,792	1,489,824	1,777,824	
Grosvenor Ditch	22	12·84	770·2	18,484·0	23,731	37,368	66,499	
Horseferry-road	25	6·85	410·8	9,858·	19,900	30,729	37,368	
Wood-street	48	16·9	1,014·0	24,321·0	36,230	38,520	40,000*	*Assumed.
Victoria-street	172	95·2	5,712·0	137,090·4	165,974	229,104	377,309	
Whitehall-place	652	11·38	683·0	16,393·0	34,171	159,581	247,147	
Northumberland-street	370	307·18	18,431·0	442,357·0	554,256	720,619	1,097,237	
Savoy-street	152	60·28	3,619·9	86,805·6	108,461	162,950	227,117	
Norfolk-street	19	13·58	815·3	19,566·0	31,147	57,888	66,557	
Essex-street	92	40·1	2,402·9	57,670·8	80,755	133,114	167,760	
Nightingale-lane, Smithfield	216	203·33	12,199·8	292,795·2	328,954	412,355	703,296	
nion Stairs	20	1·76	105·6	2,534·4	5,832	13,622	112,233	
Wapping Dock	10	0·33	19·8	475·8	2,376	9,173	49,363	
New Crane Stairs	4	26·92	1,615·0	38,766·0	44,299	67,997	139,276	
Wapping Wall, or King James	49	31·93	1,916·0	45,984·0	53,078	75,197	124,906	
Shadwell Dock-street	11	4·22	253·1	6,074·4	8,842	15,552	25,948	
Shadwell Dock Stairs	34	40·63	2,437·9	58,510·8	77,500	89,366	102,787	
Ratcliffe Cross	1,098	452·52	27,151·2	651,627·6	1,166,112	1,440,000	1,800,000*	*Assumed.
Nightingale-lane, Limehouse	23	10·87	652·2	15,653·4	19,166	30,514	58,420	
Limekiln Dock	810	55·83	3,349·9	8,039·8	99,374	113,126	134,208	
Great Sluice	397	50·93	3,056·7	73,336·0	113,486	177,638	300,715	
Blackwall Sluice	205	52·62	3,157·3	75,776·4	85,018	127,613	177,437	
Hackney Brook	5,130	592·18	17,531·1	420,746·4	552,614	735,780	1,000,000*	*Assumed.
		3,031·87	181,907·5	4,366,766·	6,218,208	9,461,586	14,100,236	
City Sewers		2,083·00	125,000·0	3,000,000·	4,000,000*	5,000,000*	6,000,000*	*Assumed.
Add 22 per Cent. for Sewers not gauged, and assumed increased Water-supply up to 1856				1,620,688·	1,620,688	1,620,688	1,620,688	
Total		5,114·87	306,907·5	8,987,454·	11,838,896	16,082,274	21,720,924	

(1.) Tables of Sewer Gaugings, &c.—*continued.*

South Side of the Thames.

Discharge of Sewage in Dry Weather as Gauged in 1853 and 1854.					Discharge with the under-mentioned Quantities of Rain.		
NAME OF SEWER.	Acres Drained.	Per Minute.	Per Hour.	Per Diem.	With from 0 to $\frac{1}{10}$ of an Inch.	With from $\frac{1}{10}$ to $\frac{1}{2}$ of an Inch.	With from $\frac{1}{2}$ to $\frac{2}{10}$ of an Inch.
		Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet per diem.*	*Cubic feet per diem.*	*Cubic feet per diem.*
Falcon Brook	2,170	84·31	5,058·6	121,399	229,738	689,299	1,285,978
Heath Wall	2,155	158·54	9,512·4	228,298	394,330	863,654	1,583,193
Effra	4,560	89·56	5,373·6	128,974	221,054	657,720	1,714,406
Arnold		117·88	7,072·8	169,753	265,205	427,507	724,464
Dover		14·71	882·6	21,186	47,059	90,835	198,576
Puddiug Mill		19·39	1,163·4	27,920	47,462	67,536	138,700
Bear		15·53	932·8	22,373	49,824	74,275	120,010
Welsh Trooper		·19	10·4	263	1,685	6,970	15,278
Boar's Head		27·06	1,623·6	38,968	57,629	89,320	122,285
Black Lion	2,200	·51	30·6	736	1,123	3,197	5,126
Green Bank		8·10	486·0	11,664	17,482	22,464	47,059
Bridge Yard		1·72	103·2	2,477	9,748	30,513	65,995
Battle Bridge		94·82	5,689·2	136,550	248,717	478,310	775,102
Great St. John's		36·22	2,173·2	52,165	78,365	124,675	265,205
Duffield		402·60	24,155·0	579,741	883,138	1,431,043	2,430,518
Globe	100	19·72	1,183·2	28,404	35,122	48,427	65,362
Limekiln	144	22·90	1,374 0	33,007	66,182	139,158	400,320
Rotherhithe Pier	83	21·39	1,283·4	30,807	62,294	280,022	584,236
Earl	4,800	740·87	44,452·2	1,066,856	1,576,022	2,898,080	4,993,920
		1,876·02	112,561·2	2,701,543	4,292,179	8,573,005	15,535,733
Assumed for Woolwich and Ravensbourne, 10 per Cent.		187·60	11,256·4	270,154	540,308	540,308	540,308
Assumed for small Sewers not gauged, and increased Water-supply to 1856		187·60	11,256·4	270,154			
Total		2,251·22	135,074·0	3,241,861	4,832,487	9,113,313	16,076,041

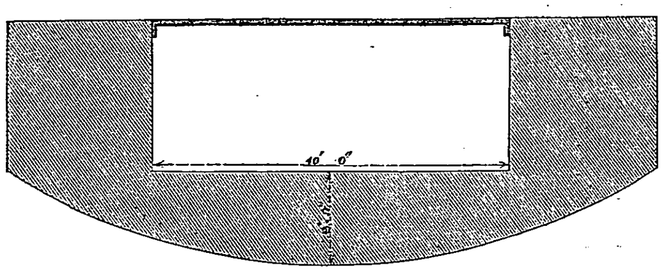
7 December 1856.

(signed) *J. W. Bazalgette*, Engineer.

Appendix VI.—*continued.*

(2.) Gaugings of the King's Scholars' Pond and Ranelagh Sewers, taken by Mr. *Bazalgette* in 1853, and furnished by him to the Referees as Examples of his Sewer Gaugings.

Section of Gauge in the King's Scholars' Pond Sewer.——Scale, ½ inch to a Foot.



DATE.	TIME.	——	HEIGHT ON GAUGE						Amount of Rainfall.	TIME of LOW WATER.
			Before Low Water.			After Low Water.				
			3d Hour.	2d Hour.	1st Hour.	1st Hour.	2d Hour.	3d Hour.		
1853:									*Inches.*	
Oct. 20	9 10 a.m.	·550	- -	0·550	- -	- -	- -	- -	- -	Oct. 20, 11 6 a.m.
	9 27 –	·540	- -	0·540	- -	- -	- -	- -	0·415	
	9 45 –	·520	- -	0·520	- -	- -	- -	- -		
	10 2 –	·470	- -	0·470	- -	- -	- -	- -		
	10 21 –	·475	- -	- -	0·475	- -	- -	- -		
	10 43 –	·420	- -	- -	0·420	- -	- -	- -		
	11 5 –	·325	- -	- -	0·325	- -	- -	- -		
	11 27 –	·270	- -	- -	- -	0·270	- -	- -		
	11 49 –	·215	- -	- -	- -	0·215	- -	- -		
	9 5 p.m.	·490	0·490	- -	- -	- -	- -	- -	- -	Oct. 20, 11 23 p.m.
	9 22 –	·480	0·480	- -	- -	- -	- -	- -		
	9 39 –	·440	- -	0·440	- -	- -	- -	- -		
	9 54 –	·420	- -	0·420	- -	- -	- -	- -	0·010	
	10 39 –	·360	- -	- -	0·360	- -	- -	- -		
	10 53 –	·305	- -	- -	0·305	- -	- -	- -		
	11 22 –	·260	- -	- -	0·260	- -	- -	- -		
– 21	12 4 a.m.	·190	- -	- -	- -	0·190	- -	- -	- -	Oct. 21, 11 37 a.m.
	12 30 –	·265	- -	- -	- -	0 265	- -	- -		
	12 55 –	·250	- -	- -	- -	- -	0·250	- -		
	1 16 –	·220	- -	- -	- -	- -	0·220	- -		
	9 53 –	·605	- -	0·605	- -	- -	- -	- -		
Carried forward -										

DATE.	TIME.	——	HEIGHT ON GAUGE						Amount of Rainfall.	TIME of LOW WATER.
			Before Low Water.			After Low Water.				
			3d Hour.	2d Hour.	1st Hour.	1st Hour.	2d Hour.	3d Hour.		
Brought forward - -									*Inches.*	
1853:										
Oct. 21	10 12 a.m.	·645	- -	0·645	- -	- -	- -	- -	- -	Oct. 21, 11 37 a.m.
	10 30 –	·710	- -	0·710	- -	- -	- -	- -		
	10 47 –	·730	- -	- -	0·730	- -	- -	- -		
	11 4 –	·790	- -	- -	0·790	- -	- -	- -		
	11 17 –	·770	- -	- -	0·770	- -	- -	- -		
	11 32 –	·590	- -	- -	0·590	- -	- -	- -		
	11 58 –	·580	- -	- -	- -	0·580	- -	- -		
	12 18 p.m.	·600	- -	- -	- -	0·600	- -	- -	- -	Oct. 21, 11 51 p.m.
	12 44 –	·640	- -	- -	- -	- -	0·640	- -		
	12 52 –	·585	- -	- -	- -	- -	0·585	- -		
	9 21 –	·430	0·430	- -	- -	- -	- -	- -		
	9 40 –	·460	0·460	- -	- -	- -	- -	- -	0·010	
	10 13 –	·450	- -	0·450	- -	- -	- -	- -		
	10 31 –	·470	- -	0·470	- -	- -	- -	- -		
	10 50 –	·440	- -	0·440	- -	- -	- -	- -		
	11 14 –	·400	- -	- -	0·400	- -	- -	- -		
	11 33 –	·360	- -	- -	0·360	- -	- -	- -		
" 22	12 2 a.m.	·330	- -	- -	- -	0·330	- -	- -		
	12 35 –	·270	- -	- -	- -	0·270	- -	- -		
	9 38 –	·690	0·690	- -	- -	- -	- -	- -		
	9 55 –	·720	0·720	- -	- -	- -	- -	- -		
	10 16 –	·660	- -	0·660	- -	- -	- -	- -		
	10 33 –	·640	- -	0·640	- -	- -	- -	- -		
	10 48 –	·630	- -	0·630	- -	- -	- -	- -		
	11 7 –	·610	- -	0·610	- -	- -	- -	- -		
	11 25 –	·560	- -	- -	0·560	- -	- -	- -		
	11 45 –	·590	- -	- -	0·590	- -	- -	- -		
	12 – p.m.	·580	- -	- -	0·580	- -	- -	- -	- -	Oct. 21, 12 9 p.m.
	12 20 –	·540	- -	- -	- -	0·540	- -	- -		
	12 46 –	·520	- -	- -	- -	0·520	- -	- -		
	1 0 –	·510	- -	- -	- -	0·510	- -	- -		
	10 27 –	·470	- -	0·470	- -	- -	- -	- -	0·010	
	10 48 –	·460	- -	0·460	- -	- -	- -	- -		
	11 0 –	·400	- -	0·400	- -	- -	- -	- -		
	11 18 –	·370	- -	0·370	- -	- -	- -	- -		
	11 50 –	·350	- -	- -	0·350	- -	- -	- -		
– 23	12 20 a.m.	·380	- -	- -	0·380	- -	- -	- -	- -	Oct. 23, 12 25 a.m.
	12 35 –	·360	- -	- -	- -	0·360	- -	- -		
	12 53 –	·350	- -	- -	- -	0·350	- -	- -		
	1 10 –	·290	- -	- -	- -	0·290	- -	- -		
	1 47 –	·280	- -	- -	- -	- -	0·280	- -		
	2 8 –	·260	- -	- -	- -	- -	0·260	- -		
	10 39 –	·400	0·400	- -	- -	- -	- -	- -		
	10 57 –	·320	- -	0·320	- -	- -	- -	- -		
	11 18 –	·290	- -	0·290	- -	- -	- -	- -		
	11 33 –	·330	- -	0·330	- -	- -	- -	- -		
	11 50 –	·335	- -	- -	0·325	- -	- -	- -		
	12 7 p.m.	·340	- -	- -	- -	0·340	- -	- -	- -	Oct. 23, 12 46 p.m.
	12 27 –	·290	- -	- -	- -	0·290	- -	- -		
	12 47 –	·320	- -	- -	- -	0·320	- -	- -		
	1 0 –	·310	- -	- -	- -	0·310	- -	- -		
	1 16 –	·230	- -	- -	- -	0·230	- -	- -		
	10 39 –	·220	0·220	- -	- -	- -	- -	- -	0·000	
	11 0 –	·200	0·200	- -	- -	- -	- -	- -		
	11 25 –	·145	- -	0·145	- -	- -	- -	- -		
	11 45 –	·155	- -	0·155	- -	- -	- -	- -		
– 24	12 2 a.m.	·155	- -	- -	0·155	- -	- -	- -	- -	Oct. 24, 1 1 a.m.
	12 30 –	·165	- -	- -	0·165	- -	- -	- -		
	12 45 –	·165	- -	- -	0·165	- -	- -	- -		
	1 0 –	·160	- -	- -	0·160	- -	- -	- -		
	1 30 –	·145	- -	- -	- -	0·145	- -	- -		
	2 0 –	·135	- -	- -	- -	0·135	- -	- -		
Carried forward - -										

DATE.	TIME.	—	HEIGHT ON GAUGE: Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
Brought forward - -									*Inches.*	
1853:										
Oct. 24	11 3 a.m.	·520	0·520	- -	- -	- -	- -	- -	- -	Oct. 24, 1 1 a.m.
	11 20 –	·510	0·510	- -	- -	- -	- -	- -		
	11 40 –	·490	- -	0·490	- -	- -	- -	- -		
	11 55 –	·500	- -	0·500	- -	- -	- -	- -		
	12 15 p.m.	·480	- -	0·480	- -	- -	- -	- -	- -	Oct. 24, 1 22 p.m.
	12 44 –	·500	- -	- -	0·500	- -	- -	- -	0·000	
	1 5 –	·520	- -	- -	0·520	- -	- -	- -		
	1 20 –	·515	- -	- -	0·515	- -	- -	- -		
	1 45 –	·500	- -	- -	- -	0·500	- -	- -	- -	Oct. 24, 1 23 p.m.
	2 0 –	·510	- -	- -	- -	0·510	- -	- -		
	2 24 –	·480	- -	- -	- -	- -	0·480	- -		
– 28	4 35 a.m.	·625	- -	- -	0·625	- -	- -	- -	- -	Oct. 28, 5 29 a.m.
	6 0 –	·605	- -	- -	- -	0·605	- -	- -		
	7 23 –	·490	- -	- -	- -	- -	0·490	- -	0·520	Thunder and lightning between 5 and 6 p.m.
	7 56 –	·460	- -	- -	- -	- -	- -	- -		
– 29	7 53 –	·650	- -	- -	- -	- -	0·650	- -	- -	Oct. 29, 6 46 a.m.
	8 15 –	·610	- -	- -	- -	- -	0·610	- -	0·018	
	4 30 p.m.	·630	0·630	- -	- -	- -	- -	- -	- -	Oct. 29, 7 12 p.m.
	5 54 –	·500	- -	0·500	- -	- -	- -	- -		
	6 30 –	·480	- -	0·480	- -	- -	- -	- -		
	8 3 –	·440	- -	0·440	- -	- -	- -	- -		
– 30	5 52 a.m.	·210	- -	0·210	- -	- -	- -	- -	- -	Oct. 30, 7 39 a.m.
	6 35 –	·230	- -	0·230	- -	- -	- -	- -		
	8 24 –	·190	- -	- -	- -	0·190	- -	- -		
	8 39 –	·170	- -	- -	- -	- -	0·170	- -		
	5 47 p.m.	·590	0·590	- -	- -	- -	- -	- -		Sunday included.
	6 28 –	·270	- -	0·270	- -	- -	- -	- -	0·000	Oct. 30, 7 58 p.m.
	8 20 –	·220	- -	- -	- -	0·220	- -	- -		
	8 49 –	·230	- -	- -	- -	0·230	- -	- -		
– 31	6 50 a.m.	·230	- -	0·230	- -	- -	- -	- -	- -	Oct. 31, 8 19 a.m.
	8 20 –	·405	- -	- -	- -	0·405	- -	- -		
	8 30 –	- -	- -	- -	- -	- -	- -	- -		
	8 35 –	·415	- -	- -	- -	0·415	- -	- -		
	9 56 –	·435	- -	- -	- -	- -	0·435	- -		
	7 0 p.m.	·570	- -	0·570	- -	- -	- -	- -	- -	Oct. 31, 8 39 p.m.
	8 40 –	·430	- -	- -	- -	0·430	- -	- -		
	9 0 –	- -	- -	- -	- -	- -	- -	- -		
	9 5 –	·405	- -	- -	- -	0·405	- -	- -		
	10 23 –	·375	- -	- -	- -	- -	0·375	- -	0·000	
Nov. 1	8 0 a.m.	·520	- -	- -	0·520	- -	- -	- -	- -	Nov. 1, 5 58 a.m.
	8 44 –	·500	- -	- -	0·500	- -	- -	- -		
	9 25 –	- -	- -	- -	- -	- -	- -	- -		
	10 10 –	·645	- -	- -	- -	- -	- -	0·645		
	7 30 p.m.	·260	- -	0·260	- -	- -	- -	- -	- -	Nov. 1, 9 18 p.m.
	8 43 –	·425	- -	- -	0·425	- -	- -	- -		
	9 0 –	·510	- -	- -	0·510	- -	- -	- -		
	9 20 –	- -	- -	- -	- -	- -	- -	- -		
	10 35 –	·365	- -	- -	- -	- -	- -	0·365	0·000	
	11 0 –	·330	- -	- -	- -	- -	- -	0·330		
– 2	8 40 a.m.	·690	- -	- -	0·690	- -	- -	- -	- -	Nov. 2, 9 37 a.m.
	9 48 –	·670	- -	- -	- -	- -	0·670	- -		
	10 3 –	·650	- -	- -	- -	- -	0·650	- -		
	10 10 –	- -	- -	- -	- -	- -	- -	- -		
	11 8 –	·610	- -	- -	- -	- -	- -	0·610		
	8 23 p.m.	·320	- -	0·320	- -	- -	- -	- -	- -	Nov. 2, 9 59 p.m.
	10 25 –	- -	- -	- -	- -	- -	- -	- -		
	10 55 –	·395	- -	- -	- -	- -	0·395	- -		
	11 14 –	·415	- -	- -	- -	- -	- -	0·415	0·000	
	11 50 –	·435	- -	- -	- -	- -	- -	0·435		
– 3	12 8 a.m.	·475	- -	- -	- -	- -	- -	- -	- -	Nov. 3, 10 19 a.m.
	8 54 –	·490	- -	0·490	- -	- -	- -	- -		
	10 15 –	·610	- -	- -	0·610	- -	- -	- -		
Carried forward - -										

DATE.	TIME.	—	HEIGHT ON GAUGE: Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
Brought forward - -									*Inches.*	
1853:										
Nov. 3	10 30 a.m.	·620	- -	- -	- -	0·620	- -	- -	- -	Nov. 3, 10 19 a.m.
	10 47 –	- -	- -	- -	- -	- -	- -	- -		
	11 44 –	·640	- -	- -	- -	- -	0·640	- -	0·000	
	9 8 p.m.	·160	- -	0·160	- -	- -	- -	- -	- -	Nov. 3, 10 39 p.m.
	10 35 –	·276	- -	- -	0·276	- -	- -	- -		
	10 52 –	·270	- -	- -	- -	0·270	- -	- -		
– 4	10 11 a.m.	·740	- -	- -	0·740	- -	- -	- -	- -	Nov. 4, 11 0 a.m.
	11 20 –	·645	- -	- -	- -	0·645	- -	- -		
	11 35 –	·625	- -	- -	- -	0·625	- -	- -	0·000	
	12 36 p.m.	·605	- -	- -	- -	- -	0·605	- -	- -	Nov. 4, 11 21 p.m.
– 12	5 50 p.m.	·540	- -	0·540	- -	- -	- -	- -	- -	Nov. 12, 7 24 p.m.
	6 35 –	·540	- -	- -	0·540	- -	- -	- -		
	7 20 –	·520	- -	- -	0·520	- -	- -	- -		
– 13	6 40 p.m.	·250	- -	0·250	- -	- -	- -	- -	- -	Nov. 13, 8 9 p.m. Sunday included.
	7 18	·250	- -	- -	0·250	- -	- -	- -	0·015	
	8 0 –	·225	- -	- -	0·225	- -	- -	- -		
– 14	6 50 a.m.	·250	- -	0·250	- -	- -	- -	- -	- -	Nov. 14, 8 28 a.m.
	7 33 –	·280	- -	0·280	- -	- -	- -	- -		
	8 22 –	·370	- -	- -	0·370	- -	- -	- -		
	9 18 –	·450	- -	- -	- -	0·450	- -	- -		
– 15	7 50 a.m.	·330	- -	0·330	- -	- -	- -	- -	- -	Nov. 15, 9 4 a.m.
	8 35 –	·440	- -	- -	0·440	- -	- -	- -	0·000	
	9 25 –	·500	- -	- -	- -	0·500	- -	- -		
– 16	9 35 a.m.	·680	- -	- -	0·680	- -	- -	- -	- -	Nov. 16, 9 39 a.m.
	10 30 –	·580	- -	- -	- -	0·580	- -	- -	0·058	
– 17	9 10 a.m.	·750	- -	0·750	- -	- -	- -	- -	- -	Nov. 17, 10 13 a.m.
	9 57 –	·660	- -	- -	0·660	- -	- -	- -	0·000	
	10 45 –	·630	- -	- -	- -	0·630	- -	- -		
	9 15 p.m.	·400	- -	0·400	- -	- -	- -	- -	- -	Nov. 17, 10 27 p.m.
	10 7 –	·300	- -	- -	0·300	- -	- -	- -	0·000	
	11 25 –	·250	- -	- -	- -	0·250	- -	- -		
– 18	11 3 a.m.	·620	- -	- -	- -	0·620	- -	- -	- -	Nov. 18, 10 44 a.m.
	11 50 –	·530	- -	- -	- -	- -	0·530	- -	0·000	
– 19	11 13 a.m.	·620	- -	- -	0·620	- -	- -	- -	- -	Nov. 19, 11 17 a.m.
	11 55 –	·620	- -	- -	- -	0·620	- -	- -	0·055	
– 21	11 35 p.m.	·260	- -	- -	0·260	- -	- -	- -	- -	Nov. 21, 12 23 p.m.
– 22	12 30 a.m.	·260	- -	- -	0·260	- -	- -	- -	0·000	Nov. 22, 12 39 a.m.
	1 20 –	·250	- -	- -	- -	0·250	- -	- -		
– 24	12 40 a.m.	·270	- -	0·270	- -	- -	- -	- -	- -	Nov. 24, 2 15 a.m.
	1 20 –	·250	- -	- -	0·250	- -	- -	- -		
	2 0 –	·225	- -	- -	0·225	- -	- -	- -	0·000	
	2 23 –	·600	- -	- -	- -	0·600	- -	- -		
	3 5 –	·520	- -	- -	- -	0·520	- -	- -		
– 25	3 40 p.m.	·620	- -	- -	0·620	- -	- -	- -	- -	Nov. 25, 3 58 p.m. Rain began 11 p.m. night of 25th.
	4 25 –	·610	- -	- -	- -	0·610	- -	- -	0·535	
	4 55 –	·580	- -	- -	- -	0·580	- -	- -		
	5 45 –	·570	- -	- -	- -	- -	0·570	- -		
– 26	- -	- -	- -	- -	- -	- -	- -	- -	0·270	
– 27	4 50 p.m.	·290	- -	0·290	- -	- -	- -	- -	- -	Nov. 27, 6 22 p.m.
	5 35 –	·280	- -	- -	0·280	- -	- -	- -	0·000	
	6 23 –	·270	- -	- -	- -	0·270	- -	- -		
	7 12 –	·270	- -	- -	- -	0·270	- -	- -		
Carried forward - -										

DATE.	TIME.	—	HEIGHT ON GAUGE: Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
									Inches.	
Brought forward -										
1853:										
Nov. 28	7 7 p.m.	·660	- -	0·660	- -	- -	- -	- -	- -	Nov. 28, 7 16 p.m.
	6 43 –	·540	- -	- -	0·540	- -	- -	- -		
	7 50 –	·430	- -	- -	- -	0·430	- -	- -	0·020	
	8 10 –	·410	- -	- -	- -	0·410	- -	- -		
– 30	7 35 p.m.	·440	- -	0·440	- -	- -	- -	- -	- -	Nov. 30, 8 49 p.m.
	8 20 –	·410	- -	- -	0·410	- -	- -	- -		
	9 15 –	·330	- -	- -	- -	0·330	- -	- -		
	9 40 –	·300	- -	- -	- -	0·300	- -	- -	0·000	
Dec. 1	7 55 a.m.	·440	- -	0·440	- -	- -	- -	- -	- -	Dec. 1, 9 11 a.m.
	8 38 –	·490	- -	- -	0·490	- -	- -	- -		
	9 30 –	·550	- -	- -	- -	0·550	- -	- -		
	8 18 p.m.	·440	- -	0·440	- -	- -	- -	- -	- -	Dec. 1, 9 34 p.m.
	9 0 –	·470	- -	- -	0·470	- -	- -	- -	0·000	
	10 15 –	·350	- -	- -	- -	0·350	- -	- -		
– 2	9 25 p.m.	·440	- -	- -	0·440	- -	- -	- -	- -	Dec. 2, 10 24 p.m. Frosty.
	10 13 –	·330	- -	- -	0·330	- -	- -	- -		
	10 57 –	·290	- -	- -	- -	0·290	- -	- -	0·000	
	11 45 –	·260	- -	- -	- -	- -	0·260	- -		
– 3	9 44 a.m.	·500	- -	0·500	- -	- -	- -	- -	- -	Dec. 3, 10 47 a.m.
	10 27 –	·400	- -	- -	0·400	- -	- -	- -		
	11 13 –	·620	- -	- -	- -	0·620	- -	- -		
	12 0 p.m.	·580	- -	- -	- -	- -	0·580	- -	- -	Dec. 3, 11 9 p.m.
	10 0 –	·400	- -	0·400	- -	- -	- -	- -	0·000	
	10 45 –	·350	- -	- -	0·350	- -	- -	- -		
	11 32 –	·300	- -	- -	- -	0·300	- -	- -		
– 4	12 8 a.m.	·290	- -	- -	- -	0·290	- -	- -	- -	Dec. 4, 11 33 a.m.
	10 52 –	·320	- -	- -	0·320	- -	- -	- -		
	11 33 –	·320	- -	- -	- -	0·320	- -	- -		
	12 15 p.m.	·320	- -	- -	- -	0·320	- -	- -	- -	Dec. 4, 11 59 p.m.
	12 30 –	·310	- -	- -	- -	0·310	- -	- -	0·000	
	10 49 –	·225	- -	0·225	- -	- -	- -	- -		
	11 35 –	·215	- -	- -	0·215	- -	- -	- -		
– 5	12 20 –	·215	- -	- -	- -	0·215	- -	- -	- -	Dec. 5.
	1 10 –	·195	- -	- -	- -	- -	0·195	- -		
	11 30 p.m.	·260	- -	0·260	- -	- -	- -	- -		
6	12 20 a.m.	·250	- -	- -	0·250	- -	- -	- -		
	1 0 –	·250	- -	- -	- -	0·250	- -	- -	0·000	Dec. 6, 12 52 a.m.
	1 44 –	·240	- -	- -	- -	0·240	- -	- -		
– 7	12 35 a.m.	·550	- -	0·550	- -	- -	- -	- -	- -	Dec. 7, 1 46 a.m.
	1 20 –	·250	- -	- -	0·250	- -	- -	- -	0·000	
	2 15 –	·220	- -	- -	- -	0·220	- -	- -		
– 8	1 25 a.m.	·300	- -	0·300	- -	- -	- -	- -	- -	Dec. 8, 2 46 a.m.
	2 10 –	·240	- -	- -	0·240	- -	- -	- -		
	3 0 –	·220	- -	- -	- -	0·220	- -	- -	0·000	
	3 25 –	·230	- -	- -	- -	0·230	- -	- -		
	1 55 p.m.	·600	- -	0·600	- -	- -	- -	- -	- -	Dec. 8, 3 18 p.m.
	2 30 –	·590	- -	- -	0·590	- -	- -	- -		
	3 10 –	·530	- -	- -	0·530	- -	- -	- -		
	3 55 –	·540	- -	- -	- -	0·540	- -	- -	0·050	Dec. 9, 3 53 a.m.
– 9	2 46 a.m.	·250	- -	0·250	- -	- -	- -	- -		
	3 38 –	·480	- -	- -	0·480	- -	- -	- -		
	3 10 p.m.	·550	- -	0·550	- -	- -	- -	- -	- -	Dec. 9, 4 30 p.m.
	3 52 –	·520	- -	- -	0·520	- -	- -	- -	0·030	
	4 40 –	·520	- -	- -	- -	0·520	- -	- -		
Carried forward -										

DATE.	TIME.	—	HEIGHT ON GAUGE: Before Low Water. 3 Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
									Inches.	
Brought forward -										
1853:										
Dec. - 10	4 20 p.m.	·570	- -	0·570	- -	- -	- -	- -	- -	Dec. 10, 5 37 p.m.
	4 55 –	·550	- -	- -	0·550	- -	- -	- -		
	5 6 –	·540	- -	- -	0·540	- -	- -	- -		
	5 45 –	·500	- -	- -	- -	0·500	- -	- -		
	6 30 –	·600	- -	- -	- -	0·600	- -	- -	0·000	
– 11	4 52 a.m.	·240	- -	0·240	- -	- -	- -	- -	- -	Dec. 11, 6 10 a.m.
	5 25 –	·230	- -	- -	0·230	- -	- -	- -		
	6 12 –	·270	- -	- -	- -	0·270	- -	- -		
	6 30 –	·260	- -	- -	- -	0·260	- -	- -		
	5 13 p.m.	·240	- -	0·240	- -	- -	- -	- -	- -	Dec. 11, 6 43 p.m.
	5 55 –	·230	- -	- -	0·230	- -	- -	- -		
	6 30 –	·230	- -	- -	0·230	- -	- -	- -		
	7 15 –	·220	- -	- -	- -	0·220	- -	- -	0·000	
– 12	5 45 a.m.	·220	- -	0·220	- -	- -	- -	- -	- -	Dec. 12, 7 10 a.m. Frosty.
	6 30 –	·210	- -	- -	0·210	- -	- -	- -		
	7 18 –	·330	- -	- -	- -	0·330	- -	- -		
	7 55 –	·320	- -	- -	- -	0·320	- -	- -		
	6 0 p.m.	·530	- -	0·530	- -	- -	- -	- -	- -	Dec. 12, 7 30 p.m.
	6 45 –	·490	- -	- -	0·490	- -	- -	- -		
	7 37 –	·450	- -	- -	- -	0·450	- -	- -		
	8 14 –	·410	- -	- -	- -	0·410	- -	- -		
– 13	6 5 –	·205	- -	0·205	- -	- -	- -	- -	0·000	Dec. 13, 7 57 a.m.
	6 47 –	·235	- -	0·235	- -	- -	- -	- -		
	7 37 –	·350	- -	- -	0·350	- -	- -	- -		
	8 21 –	·490	- -	- -	- -	0·490	- -	- -		
	6 55 p.m.	·400	- -	0·400	- -	- -	- -	- -	- -	Dec. 13, 8 16 p.m.
	7 45 –	·435	- -	- -	0·435	- -	- -	- -		
	8 25 –	·460	- -	- -	- -	0·460	- -	- -		
	9 7 –	·440	- -	- -	- -	0·440	- -	- -	0·000	
– 14	8 35 a.m.	·480	- -	- -	0·480	- -	- -	- -	- -	Dec. 14, 8 38 a.m.
	9 28 –	·500	- -	- -	- -	0·500	- -	- -		
– 15	8 5 a.m.	·490	- -	0·490	- -	- -	- -	- -	- -	Dec. 15, 9 17 a.m.
	8 46 –	·520	- -	- -	0·520	- -	- -	- -	0·000	Water frozen in gauges.
	9 30 –	·530	- -	- -	- -	0·530	- -	- -		
		116·251	6·340	29·475	33·246	34·630	11·625	0·935		

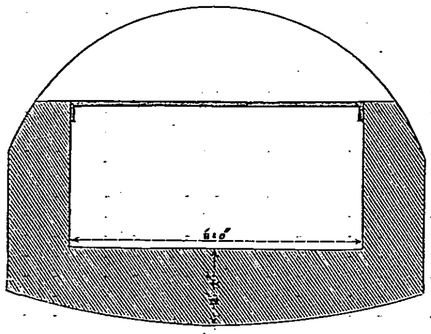
SUMMARY.

Greatest height - - - -	0·720	0·750	0·790	0·670	0·650	0·475
Least height - - - - -	0·200	0·145	0·160	0·135	0·170	0·460
Mean height - - - - -	0·487	0·415	0·426	0·400	0·447	0·467
Mean of all the Observations -	* 0·419					

* *Vide* Note on p. 208.

Appendix VI.—*continued.*

(2.) *Continued.*—Section of Gauge at Bridge over *Ranelagh* Sewer; Scale, ½ Inch to a Foot.



DATE.	TIME.	4th Hour.	HEIGHT ON GAUGE. Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
1823:									*Inches.*	
Nov. 12	2 25 p.m.	·405	- -	- -	- -	- -	- -	- -	- -	Nov. 12, 7 39 p.m.
	3 35 –	·375	- -	- -	- -	- -	- -	- -		
	4 30 –	·335	- -	- -	- -	- -	- -	- -		
– 13	6 15 a.m.	·415	- -	- -	- -	- -	- -	- -	- -	Nov. 13, 8 3 a.m.
	7 10 –	·355	- -	- -	- -	- -	- -	- -		
	8 19 –	·303	- -	- -	- -	- -	- -	- -		
	9 30 –	·293	- -	- -	- -	- -	- -	- -		
	2 35 p.m.	·435	- -	- -	- -	- -	- -	- -	0·015	Nov. 13, 8 24 p.m. Sunday included.
	3 15 –	·375	- -	- -	- -	- -	- -	- -		
	4 25 –	·335	- -	- -	- -	- -	- -	- -		
	6 55 –	·315	- -	- -	- -	- -	- -	- -		
– 14	6 30 a.m.	·540	- -	- -	- -	- -	- -	- -	- -	Nov. 14, 8 43 a.m.
	7 25 –	·500	- -	- -	- -	- -	- -	- -		
	10 25 –	·355	- -	- -	- -	- -	- -	- -		
	10 40 –	·335	- -	- -	- -	- -	- -	- -		
	3 50 p.m.	·425	- -	- -	- -	- -	- -	- -	- -	Nov. 14, 9 2 p.m.
	4 20 –	·395	- -	- -	- -	- -	- -	- -		
	4 45 –	·385	- -	- -	- -	- -	- -	- -	0·000	
	6 26 –	·375	- -	- -	- -	- -	- -	- -		
	9 55 –	·355	- -	- -	- -	- -	- -	- -		
– 15	7 25 a.m.	·335	- -	- -	- -	- -	- -	- -	- -	Nov. 15, 9 19 a.m.
	9 25 –	·290	- -	- -	- -	- -	- -	- -		
	10 40 –	·645	- -	- -	- -	- -	- -	- -		
	11 27 –	·585	- -	- -	- -	- -	- -	- -		
	4 30 p.m.	·565	- -	- -	- -	- -	- -	- -	- -	Nov. 15, 9 37 p.m.
	5 15 –	·460	- -	- -	- -	- -	- -	- -		
	7 10 –	·415	- -	- -	- -	- -	- -	- -	0·058	
	8 25 –	·395	- -	- -	- -	- -	- -	- -		
	10 20 –	·460	- -	- -	- -	- -	- -	- -		
– 16	7 20 a.m.	·565	- -	- -	- -	- -	- -	- -	- -	Nov. 16, 9 54 a.m.
	8 45 –	·500	- -	- -	- -	- -	- -	- -		
Carried forward -										

DATE.	TIME.	4th Hour.	HEIGHT ON GAUGE. Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
Brought forward -									*Inches.*	
1853:										
Nov. 16	10 20 a.m.	·625	- -	- -	- -	- -	- -	- -	- -	Nov. 16, 9 54 a.m.
	11 40 –	·665	- -	- -	- -	- -	- -	- -		
	7 35 p.m.	·480	- -	- -	- -	- -	- -	- -	- -	Nov. 16, 10 21 p.m.
	8 0 –	·415	- -	- -	- -	- -	- -	- -		
– 17	12 10 a.m.	·345	- -	- -	- -	- -	- -	- -	0·000	Nov. 17, 10 38 a.m.
	12 40 –	·315	- -	- -	- -	- -	- -	- -		
	7 35 –	·480	- -	- -	- -	- -	- -	- -		
	8 30 –	·335	- -	- -	- -	- -	- -	- -		
	9 0 –	·325	- -	- -	- -	- -	- -	- -		
	9 45 –	·290	- -	- -	- -	- -	- -	- -		
	12 0 p.m.	·510	- -	- -	- -	- -	- -	- -	- -	Nov. 17, 10 42 p.m.
	5 35 –	·520	- -	- -	- -	- -	- -	- -		
	6 15 –	·415	- -	- -	- -	- -	- -	- -		
	8 10 –	·375	- -	- -	- -	- -	- -	- -		
	9 0 –	·355	- -	- -	- -	- -	- -	- -	0·000	
– 18	12 15 a.m.	·375	- -	- -	- -	- -	- -	- -	- -	Nov. 18, 10 59 a.m.
	7 10 –	·435	- -	- -	- -	- -	- -	- -		
	7 40 –	·375	- -	- -	- -	- -	- -	- -		
	9 50 –	·335	- -	- -	- -	- -	- -	- -		
	12 50 p.m.	·595	- -	- -	- -	- -	- -	- -		
	1 25 –	·625	- -	- -	- -	- -	- -	- -		
	6 20 –	·395	- -	- -	- -	- -	- -	- -	- -	Nov. 18, 11 14 p.m.
	9 10 –	·500	- -	- -	- -	- -	- -	- -		
	10 20 –	·520	- -	- -	- -	- -	- -	- -	0·000	
– 19	12 5 a.m.	·415	- -	- -	- -	- -	- -	- -	- -	Nov. 19, 11 28 a.m.
	1 10 –	·375	- -	- -	- -	- -	- -	- -		
	7 35 –	·440	- -	- -	- -	- -	- -	- -		
	8 20 –	·365	- -	- -	- -	- -	- -	- -		
	9 55 –	·395	- -	- -	- -	- -	- -	- -		
	1 0 p.m.	·625	- -	- -	- -	- -	- -	- -	- -	Nov. 19, 11 44 p.m.
	1 35 –	·660	- -	- -	- -	- -	- -	- -		
	8 5 –	·670	- -	- -	- -	- -	- -	- -		
	8 30 –	·625	- -	- -	- -	- -	- -	- -		
	9 0 –	·520	- -	- -	- -	- -	- -	- -		
– 20	12 10 a.m.	·450	- -	- -	- -	- -	- -	- -	- -	Nov. 20, a.m.
	1 25 –	·415	- -	- -	- -	- -	- -	- -		
	8 15 –	·405	- -	- -	- -	- -	- -	- -	0·055	
	11 10 –	·335	- -	- -	- -	- -	- -	- -		
	2 5 p.m.	·310	- -	- -	- -	- -	- -	- -	- -	Nov. 20, 12 0 p.m. Sunday included.
	2 35 –	·290	- -	- -	- -	- -	- -	- -		
	9 10 –	·540	- -	- -	- -	- -	- -	- -		
– 21	12 40 a.m.	·480	- -	- -	- -	- -	- -	- -	- -	Nov. 21, 12 18 a.m.
	1 35 –	·520	- -	- -	- -	- -	- -	- -		
	11 0 –	·595	- -	- -	- -	- -	- -	- -		
	12 15 p.m.	·750	- -	- -	- -	- -	- -	- -	- -	Nov. 21, 12 38 p.m.
	1 15 –	·845	- -	- -	- -	- -	- -	- -		
	1 50 –	·940	- -	- -	- -	- -	- -	- -		
	10 5 –	·500	- -	- -	- -	- -	- -	- -		
	11 10 –	·480	- -	- -	- -	- -	- -	- -		
– 22	12 5 a.m.	·415	- -	- -	- -	- -	- -	- -	- -	Nov. 22 12 54 a.m. Frosty.
	1 20 –	·405	- -	- -	- -	- -	- -	- -		
	2 10 –	·355	- -	- -	- -	- -	- -	- -		
	10 20 –	·585	- -	- -	- -	- -	- -	- -		
	11 7 –	·690	- -	- -	- -	- -	- -	- -		
	1 15 p.m.	·740	- -	- -	- -	- -	- -	- -	- -	Nov. 22, 1 16 p.m.
	1 45 –	·895	- -	- -	- -	- -	- -	- -		
	10 35 –	·490	- -	- -	- -	- -	- -	- -	0·000	
	11 20 –	·440	- -	- -	- -	- -	- -	- -		
– 23	12 35 a.m.	·335	- -	- -	- -	- -	- -	- -	- -	Nov. 23, 1 40 a.m.
	9 40 –	·520	- -	- -	- -	- -	- -	- -		
Carried forward -										

DATE.	TIME.	4th Hour.	HEIGHT ON GAUGE: Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
									Inches.	
Brought forward -										
1853:										
Nov. 23	10 35 a.m.	·625	- -	- -	- -	- -	- -	- -	- -	Nov. 23, 1 40 a.m
	12 20 p.m.	·605	- -	- -	- -	- -	- -	- -	- -	Nov. 23, 2 3 p.m.
	1 15 –	·670	- -	- -	- -	- -	- -	- -		
	2 20 –	·740	- -	- -	- -	- -	- -	- -		
	3 10 –	·710	- -	- -	- -	- -	- -	- -	0·000	
	10 20 –	·490	- -	- -	- -	- -	- -	- -		
	11 15 –	·375	- -	- -	- -	- -	- -	- -		
– 24	12 5 a.m.	·335	- -	- -	- -	- -	- -	- -	- -	Nov. 24, 2 30 a.m.
	3 30 –	·310	- -	- -	- -	- -	- -	- -		
	11 0 –	·585	- -	- -	- -	- -	- -	- -		
	12 0 p.m.	·550	- -	- -	- -	- -	- -	- -	- -	Nov. 24 3 1 p.m.
	1 37 –	·625	- -	- -	- -	- -	- -	- -		
	2 20 –	·690	- -	- -	- -	- -	- -	- -		
	3 5 –	·670	- -	- -	- -	- -	- -	- -		
	4 55 –	·605	- -	- -	- -	- -	- -	- -	0·535	
	11 45 –	- -	- -	- -	- -	- -	- -	- -		
– 25	12 50 a.m.	- -	- -	- -	- -	- -	- -	- -	- -	Nov. 25, 3 35 a.m.
	2 10 –	- -	- -	- -	- -	- -	- -	- -		
	3 5 –	- -	- -	- -	- -	- -	- -	- -		
	5 10 –	- -	- -	- -	- -	- -	- -	- -		
	12 56 p.m.	1·210	- -	- -	- -	- -	- -	- -	- -	Nov. 25, 4 13 p.m.
	1 15 –	1·085	- -	- -	- -	- -	- -	- -		
	2 10 –	1·145	- -	- -	- -	- -	- -	- -		
	5 45 –	1·165	- -	- -	- -	- -	- -	- -	0·270	
– 26	12 45 a.m.	1·250	- -	- -	- -	- -	- -	- -	- -	Nov. 26, 4 53 a.m
	2 5 –	1·210	- -	- -	- -	- -	- -	- -		
	4 50 –	1·270	- -	- -	- -	- -	- -	- -		
	1 7 p.m.	1·290	- -	- -	- -	- -	- -	- -	- -	Nov. 26, 5 30 p.m.
	1 50 –	1·335	- -	- -	- -	- -	- -	- -		
	4 0 –	1·435	- -	- -	- -	- -	- -	- -		
	5 25 –	1·500	- -	- -	- -	- -	- -	- -	0·000	
– 27	2 0 a.m.	1·105	- -	- -	- -	- -	- -	- -	- -	Nov. 27, 6 3 a.m.
	2 50 –	·955	- -	- -	- -	- -	- -	- -		
	3 45 –	·835	- -	- -	- -	- -	- -	- -		
	4 40 –	·770	- -	- -	- -	- -	- -	- -		
	12 46 p.m.	·650	- -	- -	- -	- -	- -	- -	- -	Nov. 27, 6 36 p.m.
	2 5 –	·510	- -	- -	- -	- -	- -	- -		
	4 40 –	·415	- -	- -	- -	- -	- -	- -		
	5 45 –	·395	- -	- -	- -	- -	- -	- -		
– 28	3 0 a.m.	·875	- -	- -	- -	- -	- -	- -		
	3 35 –	·770	- -	- -	- -	- -	- -	- -	0·025	Nov. 28, 7 7 a.m.
	4 5 –	·585	- -	- -	- -	- -	- -	- -		
	5 25 –	·520	- -	- -	- -	- -	- -	- -		
	7 0 –	·415	- -	- -	- -	- -	- -	- -		
	7 45 –	·470	- -	- -	- -	- -	- -	- -		
	8 25 –	·490	- -	- -	- -	- -	- -	- -		
	2 40 p.m.	·730	- -	- -	- -	- -	- -	- -	- -	Nov. 28, 7 41 p.m.
	5 10 –	·750	- -	- -	- -	- -	- -	- -		
	7 45 –	·790	- -	- -	- -	- -	- -	- -		
	9 10 –	·835	- -	- -	- -	- -	- -	- -		
– 29	6 20 a.m.	·625	- -	- -	- -	- -	- -	- -	0·000	Vov. 29, 7 56 a.m.
	7 25 –	·480	- -	- -	- -	- -	- -	- -		
	8 20 –	·490	- -	- -	- -	- -	- -	- -		
	9 45 –	·645	- -	- -	- -	- -	- -	- -		
	10 50 –	·720	- -	- -	- -	- -	- -	- -	- -	Nov. 29, 8 18 p.m.
	5 5 p.m.	1·085	- -	- -	- -	- -	- -	- -		
	5 35 –	1·020	- -	- -	- -	- -	- -	- -	0·059	
	7 20 –	·955	- -	- -	- -	- -	- -	- -		
	11 15 –	·975	- -	- -	- -	- -	- -	- -		
– 30	6 5 a.m.	·500	- -	- -	- -	- -	- -	- -	- -	Nov. 30, 8 41 a.m.
Carried forward -										

DATE.	TIME.	4th Hour.	HEIGHT ON GAUGE: Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
									Inches.	
Brought forward -										
1853:										
Nov. 30	6 35 a.m.	·435	- -	- -	- -	- -	- -	- -	- -	Nov. 30, 8 41 a.m.
	7 0 –	·490	- -	- -	- -	- -	- -	- -	0·059	
	7 40 –	·550	- -	- -	- -	- -	- -	- -		
	8 20 –	·585	- -	- -	- -	- -	- -	- -		
	11 20 –	·670	- -	- -	- -	- -	- -	- -	- -	Nov. 30, 9 4 p.m.
	5 50 p.m.	·790	- -	- -	- -	- -	- -	- -		
	6 37 –	·595	- -	- -	- -	- -	- -	- -		
	7 45 –	·565	- -	- -	- -	- -	- -	- -	0·000	
	11 30 –	·670	- -	- -	- -	- -	- -	- -		
Dec. 1	6 40 a.m.	·520	- -	- -	- -	- -	- -	- -	- -	Dec. 1, 9 26 a.m.
	8 0 –	·480	- -	- -	- -	- -	- -	- -		
	8 50 –	·415	- -	- -	- -	- -	- -	- -		
	11 50 –	·585	- -	- -	- -	- -	- -	- -	- -	Dec. 1, 9 49 p.m.
	6 30 p.m.	·670	- -	- -	- -	- -	- -	- -		
	7 15 –	·605	- -	- -	- -	- -	- -	- -		
	8 35 –	·585	- -	- -	- -	- -	- -	- -	0·000	
	11 50 –	·565	- -	- -	- -	- -	- -	- -		
– 2	7 5 a.m.	·405	- -	- -	- -	- -	- -	- -	- -	Dec. 2, 10 14 a.m.
	8 15 –	·455	- -	- -	- -	- -	- -	- -		
	9 55 –	·575	- -	- -	- -	- -	- -	- -		
	12 50 p.m.	·710	- -	- -	- -	- -	- -	- -	- -	Dec. 2, 10 39 p.m.
	8 7 –	·690	- -	- -	- -	- -	- -	- -		
	9 0 –	·585	- -	- -	- -	- -	- -	- -	0·000	
	10 20 –	·540	- -	- -	- -	- -	- -	- -		
– 3	1 0 a.m.	·440	- -	- -	- -	- -	- -	- -	- -	Dec. 3, 11 2 a.m.
	7 25 –	·500	- -	- -	- -	- -	- -	- -		
	8 20 –	·460	- -	- -	- -	- -	- -	- -		
	10 24 –	·510	- -	- -	- -	- -	- -	- -	- -	Dec. 3, 11 24 p.m.
	11 25 –	·690	- -	- -	- -	- -	- -	- -		
	1 30 p.m.	·750	- -	- -	- -	- -	- -	- -	0·000	
	9 20 –	·480	- -	- -	- -	- -	- -	- -		
	10 50 –	·490	- -	- -	- -	- -	- -	- -		
– 4	12 25 a.m.	·500	- -	- -	- -	- -	- -	- -	- -	Dec. 4, 11 48 a.m.
	1 55 –	·460	- -	- -	- -	- -	- -	- -		
	8 45 –	·440	- -	- -	- -	- -	- -	- -		
	9 40 –	·405	- -	- -	- -	- -	- -	- -		
	10 39 –	·395	- -	- -	- -	- -	- -	- -		
	11 43 –	·415	- -	- -	- -	- -	- -	- -		
	12 40 p.m.	·460	- -	- -	- -	- -	- -	- -	- -	Dec. 4, p.m.
	2 35 –	·395	- -	- -	- -	- -	- -	- -		
	9 0 –	·585	- -	- -	- -	- -	- -	- -	0·000	
	9 50 –	·510	- -	- -	- -	- -	- -	- -		
	11 15 –	·500	- -	- -	- -	- -	- -	- -		
– 5	2 30 a.m.	·625	- -	- -	- -	- -	- -	- -	- -	Dec. 5, 12 14 a.m.
	8 20 –	·540	- -	- -	- -	- -	- -	- -		
	10 31 –	·770	- -	- -	- -	- -	- -	- -		
	11 15 –	·960	- -	- -	- -	- -	- -	- -		
	11 40 –	1·085	- -	- -	- -	- -	- -	- -		
	12 48 p.m.	1·185	- -	- -	- -	- -	- -	- -	- -	Dec. 5, 12 41 p.m.
	3 30 –	1·250	- -	- -	- -	- -	- -	- -		
	9 50 –	·520	- -	- -	- -	- -	- -	- -	0·000	
	11 10 –	·480	- -	- -	- -	- -	- -	- -		
– 6	12 10 a.m.	·470	- -	- -	- -	- -	- -	- -	- -	Dec. 6, 1 7 a.m.
	1 15 –	·500	- -	- -	- -	- -	- -	- -		
	3 25 –	·540	- -	- -	- -	- -	- -	- -		
	10 0 –	·480	- -	- -	- -	- -	- -	- -		
	10 40 –	·520	- -	- -	- -	- -	- -	- -	- -	Dec. 6, 1 35 p.m.
	11 32 –	·645	- -	- -	- -	- -	- -	- -		
	12 51 p.m.	·750	- -	- -	- -	- -	- -	- -		
	1 55 –	·730	- -	- -	- -	- -	- -	- -		
Carried forward -										

DATE.	TIME.	4th Hour.	HEIGHT ON GAUGE: Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
									Inches.	
Brought forward -										
1853:										
Dec. 6	4 20 p.m.	·680	- -	- -	- -	- -	- -	- -	- -	Dec. 6, 1 35 p.m.
	10 55 –	·490	- -	- -	- -	- -	- -	- -		
	11 40 –	·415	- -	- -	- -	- -	- -	- -	0·000	
– 7	12 42 a.m.	·375	- -	- -	- -	- -	- -	- -	- -	Dec. 7, 2 1 a.m.
	1 50 –	·405	- -	- -	- -	- -	- -	- -		
	4 5 –	·395	- -	- -	- -	- -	- -	- -		
	11 5 –	·645	- -	- -	- -	- -	- -	- -		
	12 10 p.m.	·710	- -	- -	- -	- -	- -	- -	- -	Dec. 7, 2 30 p.m.
	1 14 –	·760	- -	- -	- -	- -	- -	- -		
	2 27 –	·825	- -	- -	- -	- -	- -	- -		
	3 34 –	·795	- -	- -	- -	- -	- -	- -		
	5 5 –	·730	- -	- -	- -	- -	- -	- -	0·000	
	11 40 –	·520	- -	- -	- -	- -	- -	- -		
– 8	12 32 a.m.	·460	- -	- -	- -	- -	- -	- -	- -	Dec. 8, 3 1 a.m.
	2 5 –	·405	- -	- -	- -	- -	- -	- -		
	3 40 –	·395	- -	- -	- -	- -	- -	- -		
	5 25 –	·415	- -	- -	- -	- -	- -	- -		
	11 15 –	·585	- -	- -	- -	- -	- -	- -		
	12 28 p.m.	·625	- -	- -	- -	- -	- -	- -	- -	Dec. 8, 3 33 p.m.
	1 30 –	·670	- -	- -	- -	- -	- -	- -		
	3 28 –	·730	- -	- -	- -	- -	- -	- -		
	5 45 –	·710	- -	- -	- -	- -	- -	- -	0·050	
– 9	12 50 a.m.	·440	- -	- -	- -	- -	- -	- -	- -	Dec. 9, 4 8 a.m.
	1 55 –	·415	- -	- -	- -	- -	- -	- -		
	3 0 –	·460	- -	- -	- -	- -	- -	- -		
	4 50 –	·480	- -	- -	- -	- -	- -	- -		
	6 0 –	·480	- -	- -	- -	- -	- -	- -		
	11 12 –	·585	- -	- -	- -	- -	- -	- -		
	12 7 p.m.	·605	- -	- -	- -	- -	- -	- -	- -	Dec. 9, 4 45 p.m.
	1 55 –	·620	- -	- -	- -	- -	- -	- -		
	3 20 –	·670	- -	- -	- -	- -	- -	- -		
	5 35 –	·730	- -	- -	- -	- -	- -	- -	0·030	
– 10	1 30 a.m.	·405	- -	- -	- -	- -	- -	- -	- -	Dec. 10, 5 19 a.m.
	2 25 –	·395	- -	- -	- -	- -	- -	- -		
	3 42 –	·355	- -	- -	- -	- -	- -	- -		
	5 10 –	·355	- -	- -	- -	- -	- -	- -		
	6 35 –	·415	- -	- -	- -	- -	- -	- -		
	2 20 p.m.	·625	- -	- -	- -	- -	- -	- -	- -	Dec. 10, 5 52 p.m.
	3 5 –	·585	- -	- -	- -	- -	- -	- -		
	4 20 –	·730	- -	- -	- -	- -	- -	- -		
	5 12 –	·500	- -	- -	- -	- -	- -	- -		
	6 55 –	·435	- -	- -	- -	- -	- -	- -	0·000	
– 11	2 55 a.m.	·395	- -	- -	- -	- -	- -	- -	- -	Dec. 11, 6 25 a.m.
	3 50 –	·335	- -	- -	- -	- -	- -	- -		
	4 40 –	·315	- -	- -	- -	- -	- -	- -		
	5 37 –	·290	- -	- -	- -	- -	- -	- -		
	7 25 –	·290	- -	- -	- -	- -	- -	- -		
	2 45 p.m.	·290	- -	- -	- -	- -	- -	- -	- -	Dec. 11, 6 58 p.m.
	4 15 –	·270	- -	- -	- -	- -	- -	- -		
	5 5 –	·270	- -	- -	- -	- -	- -	- -		
	6 0 –	·260	- -	- -	- -	- -	- -	- -		
	7 45 –	·260	- -	- -	- -	- -	- -	- -	0·000	
– 12	4 15 a.m.	·335	- -	- -	- -	- -	- -	- -	- -	Dec. 12, 7 25 a.m.
	5 35 –	·325	- -	- -	- -	- -	- -	- -		
	7 37 –	·315	- -	- -	- -	- -	- -	- -		
	9 15 –	·290	- -	- -	- -	- -	- -	- -		
	10 36 –	·415	- -	- -	- -	- -	- -	- -		
	3 55 p.m.	·910	- -	- -	- -	- -	- -	- -	- -	Dec. 12, 7 45 p.m.
	4 38 –	·835	- -	- -	- -	- -	- -	- -		
	6 0 –	·690	- -	- -	- -	- -	- -	- -		
Carried forward -										

DATE.	TIME.	4th Hour.	HEIGHT ON GAUGE: Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
									Inches.	
Brought forward -										
1853:										
Dec. 12	7 37 p.m.	·585	- -	- -	- -	- -	- -	- -	- -	Dec. 12, 7 45 p.m.
	9 15 –	·435	- -	- -	- -	- -	- -	- -		
	10 10 –	·405	- -	- -	- -	- -	- -	- -		
– 13	4 25 a.m.	·670	- -	- -	- -	- -	- -	- -	0·000	Dec. 13, 8 12 a.m.
	5 10 –	·625	- -	- -	- -	- -	- -	- -		
	6 20 –	·595	- -	- -	- -	- -	- -	- -		
	8 7 –	·520	- -	- -	- -	- -	- -	- -		
	10 35 –	·425	- -	- -	- -	- -	- -	- -		
	3 45 p.m.	·855	- -	- -	- -	- -	- -	- -	- -	Dec. 13, 8 31 p.m.
	5 10 –	·900	- -	- -	- -	- -	- -	- -		
	6 55 –	·670	- -	- -	- -	- -	- -	- -		
	8 40 –	·540	- -	- -	- -	- -	- -	- -	0·000	
	10 5 –	·425	- -	- -	- -	- -	- -	- -		
– 14	5 25 a.m.	·650	- -	- -	- -	- -	- -	- -	- -	Dec. 14, 8 53 a.m.
	6 30 –	·585	- -	- -	- -	- -	- -	- -		
	8 45 –	·435	- -	- -	- -	- -	- -	- -		
	10 55 –	·395	- -	- -	- -	- -	- -	- -		
	4 10 p.m.	·680	- -	- -	- -	- -	- -	- -	- -	Dec. 14, 9 12 p.m.
	6 5 –	·710	- -	- -	- -	- -	- -	- -		
	7 10 –	·670	- -	- -	- -	- -	- -	- -		
	8 40 –	·605	- -	- -	- -	- -	- -	- -	0·000	
	10 55 –	·540	- -	- -	- -	- -	- -	- -		
– 15	6 35 a.m.	·435	- -	- -	- -	- -	- -	- -	- -	Dec. 15, 9 32 a.m. Water frozen in gauge.
	8 37 –	·375	- -	- -	- -	- -	- -	- -		
	10 0 –	·325	- -	- -	- -	- -	- -	- -		
	11 8 –	·520	- -	- -	- -	- -	- -	- -		
	11 55 –	·595	- -	- -	- -	- -	- -	- -		
	6 37 p.m.	·490	- -	- -	- -	- -	- -	- -	- -	Dec. 15, 9 48 p.m.
	7 20 –	·480	- -	- -	- -	- -	- -	- -		
	8 25 –	·385	- -	- -	- -	- -	- -	- -		
	9 15 –	·405	- -	- -	- -	- -	- -	- -	0·040	2¾″ snow on platform of gauge.
	10 35 –	·460	- -	- -	- -	- -	- -	- -		
– 16	12 20 a.m.	·500	- -	- -	- -	- -	- -	- -	- -	Dec. 16, 10 7 a.m.
	7 5 –	·460	- -	- -	- -	- -	- -	- -		
	7 50 –	·425	- -	- -	- -	- -	- -	- -		
	9 25 –	·375	- -	- -	- -	- -	- -	- -		
	10 25 –	·565	- -	- -	- -	- -	- -	- -		
	11 50 –	·605	- -	- -	- -	- -	- -	- -		
	12 45 p.m.	·650	- -	- -	- -	- -	- -	- -	0·000	Dec. 16, 10 24 p.m.
– 17	7 5 a.m.	·335	- -	- -	- -	- -	- -	- -	- -	Dec. 17, 10 42 a.m.
	8 27 –	·395	- -	- -	- -	- -	- -	- -		
	10 5 –	·415	- -	- -	- -	- -	- -	- -		
	11 10 –	·510	- -	- -	- -	- -	- -	- -		
	11 45 –	·575	- -	- -	- -	- -	- -	- -		
	7 45 p.m.	·585	- -	- -	- -	- -	- -	- -	- -	Dec. 17, 10 58 p.m.
	9 16 –	·545	- -	- -	- -	- -	- -	- -	0·000	
	11 0 –	·520	- -	- -	- -	- -	- -	- -		
– 18	12 35 –	·450	- -	- -	- -	- -	- -	- -	- -	Dec. 18, 11 14 a.m.
	8 5 –	·385	- -	- -	- -	- -	- -	- -		
	9 30 –	·335	- -	- -	- -	- -	- -	- -		
	10 40 –	·315	- -	- -	- -	- -	- -	- -		
	11 42 –	·305	- -	- -	- -	- -	- -	- -		
	12 45 –	·270	- -	- -	- -	- -	- -	- -	- -	Dec. 18, 11 32 p.m.
	8 15 –	·415	- -	- -	- -	- -	- -	- -		
	9 20 –	·385	- -	- -	- -	- -	- -	- -	0·000	
	10 43 –	·375	- -	- -	- -	- -	- -	- -		
– 19	12 5 a.m.	·325	- -	- -	- -	- -	- -	- -	- -	Dec. 19, 11 51 a.m.
	1 38 –	·315	- -	- -	- -	- -	- -	- -		
	9 5 –	·335	- -	- -	- -	- -	- -	- -		
	10 45 –	·375	- -	- -	- -	- -	- -	- -		
Carried forward -										

DATE.	TIME.	4th Hour.	HEIGHT ON GAUGE: Before Low Water. 3d Hour.	2d Hour.	1st Hour.	After Low Water. 1st Hour.	2d Hour.	3d Hour.	Amount of Rainfall.	TIME of LOW WATER.
									Inches.	
Brought forward -										
1853:										
Dec. 19	11 35 a.m.	·425	- -	- -	- -	- -	- -	- -	- -	Dec. 19, 11 51 a.m.
	12 27 p.m.	·520	- -	- -	- -	- -	- -	- -	- -	Dec. 19, 11 51 p.m.
	2 0 –	·460	- -	- -	- -	- -	- -	- -		
	9 40 –	·415	- -	- -	- -	- -	- -	- -	0·040	Previous snow melted.
	11 5 –	·530	- -	- -	- -	- -	- -	- -		
– 20	12 45 a.m.	·625	- -	- -	- -	- -	- -	- -	- -	Dec. 20, 12 6 a.m.
	2 25 –	·690	- -	- -	- -	- -	- -	- -		
	10 10 –	·520	- -	- -	- -	- -	- -	- -		
	11 5 –	·585	- -	- -	- -	- -	- -	- -		
	12 30 p.m.	·720	- -	- -	- -	- -	- -	- -	- -	Dec. 20, 12 24 p.m.
	1 40 –	·770	- -	- -	- -	- -	- -	- -		
	2 45 –	·825	- -	- -	- -	- -	- -	- -		
	10 20 –	·405	- -	- -	- -	- -	- -	- -	0·025	
	11 15 –	·480	- -	- -	- -	- -	- -	- -		
– 21	12 50 a.m.	·460	- -	- -	- -	- -	- -	- -	- -	Dec. 21, 12 46 a.m.
	1 45 –	·395	- -	- -	- -	- -	- -	- -		
	3 0 –	·395	- -	- -	- -	- -	- -	- -		
	10 25 –	·710	- -	- -	- -	- -	- -	- -		
	11 14 –	·770	- -	- -	- -	- -	- -	- -		
	12 15 p.m.	·915	- -	- -	- -	- -	- -	- -	- -	Dec. 21, 1 5 p.m.
	1 10 –	·980	- -	- -	- -	- -	- -	- -		
	2 30 –	1·075	- -	- -	- -	- -	- -	- -		
	3 35 –	1·125	- -	- -	- -	- -	- -	- -	0·010	
	10 20 –	·520	- -	- -	- -	- -	- -	- -		
	11 5 –	·480	- -	- -	- -	- -	- -	- -		
– 22	1 25 a.m.	·375	- -	- -	- -	- -	- -	- -	- -	Dec. 22, 1 25 a.m.
	3 50 –	·375	- -	- -	- -	- -	- -	- -		
	10 40 –	·585	- -	- -	- -	- -	- -	- -		
	11 20 –	·625	- -	- -	- -	- -	- -	- -		
	12 13 p.m.	·710	- -	- -	- -	- -	- -	- -	- -	Dec. 22, 1 46 p.m.
	2 10 –	·750	- -	- -	- -	- -	- -	- -		
	3 55 –	·815	- -	- -	- -	- -	- -	- -	0·003	
	11 5 –	·440	- -	- -	- -	- -	- -	- -		
– 23	12 25 a.m.	·405	- -	- -	- -	- -	- -	- -	- -	Dec. 23, 2 10 a.m.
	1 32 –	·395	- -	- -	- -	- -	- -	- -		
	4 0 –	·460	- -	- -	- -	- -	- -	- -		

Greatest height - - - - -	1·500
Least ditto - - - - - -	0·260
Mean height of all the observations	* 0·556

* The Referees have to observe upon these gaugings, that assuming that the results stated in the general Table of Quantities, at p. 194, for these two sewers, are derived from the above gaugings, the total quantities appear to be greatly underrated.

King's Scholars' Pond Sewer.

The arithmetical mean depth of all the observations is ·419 feet, but, excluding those which appear to contain rain, the mean would be ·406 feet; and if this depth be taken for a weir 10 feet wide, the ordinary formula for the flow of water over weirs gives 557 cubic feet per minute, or about 802,000 cubic feet in 24 hours, the amount in the Table being only 668,000 cubic feet per day; but the arithmetical mean of all the observed depths would not furnish a correct result, because each observation should be worked out according to its depth, and the result should be the mean of the quantities thus arrived at. Pursuing this process, and working out every observation in the above gaugings (excluding, as before, those containing rain), the mean quantity is

Appendix VI.

Information furnished by Mr. Bazalgette.

Miscellaneous Papers.

is 576 cubic feet per minute, or 829,400 cubic feet per day, showing that the quantity in the Table (668,000 cubic feet) is 24 per cent. less than the actual quantity.

Ranelagh Sewer.

The arithmetical mean depth of the gaugings is ·556 feet; but excluding, as before, those containing rain, the mean would be ·524 feet, giving for the weir 8 feet wide 551 cubic feet per second, or about 794,000 cubic feet per day, while the Table shows only 614,971 cubic feet per day. When each observation is worked out as before stated, the mean quantity becomes 688 cubic feet per minute, or 990,000 cubic feet per day, showing that the quantity in the Table is 61 per cent. less than the actual quantity.

It must, however, be further explained, that the quantities of sewage due to the depths given in these gaugings would be even greater than those above stated (829,400 for the King's Scholars' Pond and 990,000 for the Ranelagh), as there would no doubt be some initial velocity in the stream approaching the weir, which velocity appears to have been altogether overlooked; and when an addition is made for this, and the results worked out, the totals become,—

For the King's Scholars' Pond sewer - - - 921,000 cubic feet per day,
For the Ranelagh sewer - - - - - 1,063,000 cubic feet per day,

showing that the quantities as given in the Table are, respectively, 38 and 72 per cent. under the results as ascertained from the experiments.

Mr. Bazalgette has informed the Referees that he has not been able to refer to the original calculations made by Mr. Smith, the surveyor, that officer having left the service of the Commissioners; but he stated that he believed that some of the observations were rejected, on account of their having been considered to be subject to tidal influence, of which no record appears in the Tables.

(iii.) Comparison of Diameter of Pipes and Sewers in Inches, by Mr. *Roe's* Experiments in 1852, and as calculated by Mr. *Hawksley's* Formula.

Diameter of Sewers by Mr. Roe -	24	30	36	48	60	72	84	96	108	120	132	144
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Level - - - -	38½	67½	120	277	570	1,020	1,725	2,850	4,125	5,825	7,800	10,100
¼ inch in 10 feet, or 1 in 480 - - -	43 *27*	75 *32*	135 *38*	308 *49*	630 *61*	1,117 *72*	1,925 *85*	3,025 *98*	4,425 *110*	6,250 *122*	8,300 *133*	10,750 *143*
½ inch in 10 feet, or 1 in 240 - - -	50 *26*	87 *31*	155 *37*	355 *48*	735 *59*	1,318 *71*	2,225 *83*	3,500 *95*	5,100 *107*	7,175 *119*	9,550 *130*	12,400 *140*
¾ inch in 10 feet, or 1 in 160 - - -	63 *27*	113 *32*	203 *39*	460 *50*	950 *62*	1,692 *73*	2,875 *86*	4,500 *99*	6,575 *111*	9,250 *124*	12,300 *134*	15,950 *145*
1 inch in 10 feet, or 1 in 120 - - -	78 *28*	143 *34*	257 *40*	590 *52*	1,200 *64*	2,160 *77*	3,700 *90*	5,825 *104*	7,850 *114*	11,050 *126*	14,700 *137*	19,085 *148*
1½ inch in 10 feet, or 1 in 80 - - -	90 *26*	165 *34*	295 *40*	670 *52*	1,385 *64*	2,486 *77*	4,225 *90*	6,625 *103*				
2 inches in 10 feet, or 1 in 60 - - -	115 *29*	182 *34*	318 *40*	730 *52*	1,500 *65*	2,675 *76*	4,550 *90*	7,125 *103*				

The italic figures show the diameter of sewers required at the given inclinations to drain the adjoining number of Acres, as calculated by Mr. Hawksley's formula.

J. W. B., 17th January 1857.

(iv.) Table showing approximately the Difference between the Ordinary Flow in the Sewers in Dry Weather and during Heavy Storms. *See* Plate 2, App. VI.

Number of Section.	Points at which Observations were taken.	Dimensions of Sewer at the Point.	Approximate Inclination.	Depth of Flow during Dry Weather.	Depth of Flow during Storms.	Relative Proportions of Ordinary Flow to Storm Discharge.	Remarks.
			1 in	*Ft. In.*	*Ft. In.*	1 in	
1	Ranelagh Sewer, Gloucester Road.	8·6 × 10·6	563	1 1½	7 6	21·5	
2	Fleet Sewer, Kentish Town Road.	6·6 × 6·0	316	– 9	5 1½	26	
3	Hackney Brook Sewer, Dalston Land.	5·0 diam.	350	– 6½	2 9	19	
4	Sewer at intersection of New North Road and Murray Street.	5·0 × 3·6	350	– 9	5 0	17	This sewer is often discharging under pressure.
5	Cockspur Street (Northumberland Street Sewer).	5·6 × 3·0	108	– 8¾	4 0	10·5	
6	Bow Street, Covent Garden	5·6 × 3·0	193	– 6½	4 7	21	
7	Green Park (Pall Mall Sewer).	6·0 × 4·0	503	– 9¼	4 0	11	
8	Effra Sewer, Vassal Road, Brixton.	9·2 × 11·0	302	– 7	4 6	24	

20 February 1857. (signed) *J. W. Bazalgette.*

Appendix VI.

Information furnished by Mr. Bazalgette.

Evidence, Jan. 17.

4.—MINUTES of Evidence given by *I. W. Bazalgette*, Esq.

Meeting of Referees, 29, Great George-street, Saturday, January 17th, 1857.

Mr. *Bazalgette* again attended by appointment.

Mr. Bazalgette put in written answers to the questions placed in his hands at the last meeting.

Mr. Bazalgette handed in—

(1.) "A List of all the Sewers which can be identified by name."

(2.) "Sections of all the main Sewers."

(3.) "Gaugings of Westminster Sewers by Hawkins."

(4.) "Two Formulæ for ascertaining the discharging power of intercepting sewers, and for determining the size of drainage outfall sewers; with proof of the latter (Mr. Hawksley's), after experiments by Mr. Bazalgette.

(5.) "A Statement explaining the alleged discrepancy between different statements of Mr. Bazalgette, concerning amount of sewage to be provided for."

For (3), (4) and (5) *see* pages 186 and 193.

Mr. Bazalgette then gave the following information in answer to questions put by the Referees.

Stated that he proposed to construct his sewers in a slightly elliptical form, so as to make allowance for settling.

Mr. Bazalgette promised to supply the data on which the estimate of the cost of deodorising works was founded. (*See* Mr. Wicksteed's letter, Appendix I.)

Stated that he believed the amount of fluid sewage per head in Leicester was less than that provided for by himself in London: viz., 30 gallons.

Explained the way in which he estimates the prospective population of London. He divides London into its natural drainage areas; and, having ascertained by the census of 1851 that an area built upon, according to modern improvements, when covered, contains about 30,000 per square mile, he raises all the suburban areas to that maximum population (with some few exceptions of suburban districts, which he raises only to 20,000 per square mile), and thus makes an allowance equal to 50 per cent. on the present population, the increased drainage being provided for at those points in the sewers from whence it is likely to arise.

Stated, in giving in sections of all the main sewers, as defined by Schedule (A.) of the Metropolis Local Management Act, that these were required to be improved, and connected with the main intercepting sewers; but that cost of this work was not included in the estimate for the main intercepting sewers themselves. The plans for these works, in connexion with the intercepting scheme approved by the Metropolitan Board of Works, were now in progress, and he hoped to have them and the estimates ready to lay before that Board shortly.

They would be of two classes:

1st. Those which might be proceeded with previous to the construction of the main intercepting sewers.

2d. Those which must wait to be done till the main intercepting sewers were executed.

Of this latter class are nearly all the main sewers on the south side, and in the low districts on the north side.

Mr. Bazalgette explained how the waters from the upland districts injured the low-level sewers by flowing into them, and thus interfering with the discharge of sewage, and by overcharging them in rainy weather.

Stated that there was no possibility of getting water from the higher lands effectually to flush the low-level sewers in dry weather, as was generally supposed.

Stated that he proposed to make it possible to flush and cleanse the sewers with water from the Thames, and that the cost of pumping at Deptford Creek would be almost entirely paid for by the saving in cost of cleansing the sewers.

As to the amount of water estimated for, Mr. Bazalgette stated that he took it at double the maximum of the daily supply of the water companies, and the amount pumped into the metropolis. The estimated supply from wells and other sources (from 10,000,000 to 12,000,000 gallons daily), Mr. Bazalgette considered was compensated for by the amount of evaporation daily taking place from boiling the water and other causes of waste.

Explained, briefly, the way in which the estimate of the annual cost of pumping, &c. was estimated (*see* page 3 of Report as to "Data employed," &c.)

Believed the present cost of flushing and cleansing the sewers on the south side to be 11,000 *l.* per annum, but promised further particulars.

Stated, in answer to question, that he proposed to have a separate outlet for high and low level sewers.

The overflow during storms will be at several outlets, not only at the outlet of the main intercepting sewer.

Mr. Bazalgette left a letter from Mr. Wicksteed, of Leicester, estimating the cost of deodorising the sewage of London.

Mr.

Appendix VI.

Information furnished by Mr. Bazalgette.

Evidence, Jan. 17.

Mr. Bazalgette stated, that the rate raised by the late Commission of Sewers was 6*d.* in the pound, and that they had at times raised, on the security of these rates, 400,000 *l.*, at 4½ per cent., involving an annual payment for interest of 18,000 *l.*

The cost of extending the intercepting sewer to B*, would be much the same as that of erecting deodorising works at various points (Abbey Mills and Deptford Creek) on the B. plan.

The great majority of the sewers discharge their matter in an advanced state of decomposition, so that it can never be received in such a state as would allow of its being utilised.

Had seen experiments performed to deodorise sewage. The solid matter was rapidly deposited, and the supernatant water was clear and free from smell; it had been, however, stated to Mr. Bazalgette that, if bottled up for a length of time, it became offensive.

With regard to ventilation of sewers, Mr. Bazalgette stated that no artificial mode had ever been found satisfactory, but that an ample supply of water fully answered all purposes.

Mr. Bazalgette could at present give no opinion upon the feasibility of deodorising the sewage as it passes through the sewers.

Mr. Bazalgette promised all the borings he had made himself, and those made for Phillips's plan.

Mr. Bazalgette stated that he did not anticipate any difficulties from the sandy soil under St. Paul's, greater than those met with and overcome under the foundations of the Horse Guards, which is built on similar soil.

Allowance is made in estimate for probable compensation necessary from settlement of works, &c.

Almost all the northern high level sewers might be flushed from the Paddington Canal, the low level by water from the Thames at high-water.

Mr. Bazalgette left a complete set of the estimates for Plan B*, and also an estimate of the cost of deodorising works.

5.—MINUTES of Evidence of *I. W. Bazalgette*, Esq.

Meeting of Referees, 29, Great George-street, Saturday, July 25.

Mr. *Bazalgette* attended by appointment.

Mr. Bazalgette said, in answer to a question, that the statement of Mr. Roe, that 4 inches of rain fell in an hour during the famous storm of 1st August 1846, had been disputed. Mr. Mylne had informed him (Mr. Bazalgette) that the total quantity of rain which fell into their reservoir at Highgate, during the storm, which lasted considerably more than an hour, was 3½ inches. Mr. Hawksley received from Mr. John Thomas Cooper, the eminent analytical chemist, his register of that storm, in the same locality, which showed that 3·3 inches fell in two hours and 20 minutes; whilst Mr. Glaisher's tables showed that the whole fall on that day, at Greenwich, amounted only to 0·95, and to 4 inches during the whole month of August.

Evidence, July 25.

In answer to a question from Mr. Simpson, as to the levels of the Aldgate branch, Mr. Bazalgette said that the Ratcliffe Highway sewer, which is the valley line, discharging into the Aldgate branch, fell towards it at an inclination of 1 in 500, and that this sewer was so deep that the districts intercepted by it would not, under any circumstances, be flooded when the middle-level sewer was running full. The crown of the branch sewer at the upper end being 3½ feet below that of the middle-level sewer, this branch would discharge into it until the main line was about two-thirds full, which would be the case probably for more than 10 months in the year, after which the surplus waters would overflow to the low-level sewer, and, by a flap at the mouth of this sewer, the level and period of overflow could be adjusted with great precision.

Mr. Bazalgette produced the contract drawings of the portion of the main high-level sewer, which was constructed some time ago, under Sir George Duckett's canal, intended as a part of the intercepting system of sewers now proposed.

Mr. Bazalgette said that the lower end of the Isle of Dogs branch sewer would act as syphon only when the main low-level sewer was full.

With regard to the overflow at the Roding, Mr. Bazalgette said that it would act as a storm overflow probably for a month or six weeks in the year; but this river being from 11 to 12 miles below London Bridge, the waters were on those days permitted to pass off in a less diluted state than from the overflows near to London.

With regard to the portion of sewer between the junction of the high and middle-level sewers and the pumping station at Abbey Mills, Mr. Bazalgette said that there was about 7,000 feet run there, practically level; and it would require a head of 1½ feet to enable it to discharge the quantity conveyed into it by the high and middle-level sewers. This pressure would be produced as soon as the waters reached the crowns of the high and middle-level sewers.

Appendix VI.

Information furnished by Mr. Bazalgette.

Evidence, July 25.

The aqueduct between the East and West India Docks Junction and Abbey Mills, excepting the crossing of the River Lea, was estimated to be of cast iron like the other aqueducts on the line proposed, and not of wrought iron.

Mr. Bazalgette produced a drawing showing the mode of lowering the Stratford road at the point where it is crossed by the sewer.

Mr. Bazalgette explained the way in which he proposed to work the junction of the high and low level sewers on the south side of the Ravensbourne; and stated, that on the section was shown a single connecting sewer of four feet in diameter for a length of 2,260 feet, but that he proposed to construct a double sewer of this size, so that to produce the required maximum discharge to be intercepted, it would be necessary that the level of the water in the high level sewer should be two feet higher than that in the extension sewer. From the relative levels of the high-level and extension sewers it would therefore be observed, that when the latter was full the water would stand within about 2½ feet of the top of the former, and its overflow weir into Deptford Creek being placed a little below this level it would then be discharging its proper proportion into the extension sewer, and the surplus flood-waters into the Creek.

Mr. Bazalgette, in answer to a question, said, that the borings which he had handed in to the Referees had been made at various times, and by different people; he did not think it would be necessary to make further borings before proceeding to work with the proposed sewers, unless in some exceptional points.

Mr. Bazalgette, in answer to Mr. Simpson, said that he thought there must have been some peculiar circumstances in the case of the specimens of sewage water taken during a second heavy fall of rain in June 1857, which were found to be even more polluted than those of the first rain the preceding day. As a rule, he believes that the first rain-fall after dry weather would remove the larger amount of deposit, unless it was a light rain-fall, or of short duration.

Mr. Bazalgette thought the sedimentary matter which was removed by a heavy rain would be at the bottom of the flow, and would therefore be carried off in the intercepting sewer; instead of flowing at the surface, and thus passing by the overflow into the river.

In answer to a question, Mr. Bazalgette said that he thought the estimate of 10 *l.* a house, for the alteration of house drains, which would become necessary if a separate system were to be adopted, was not too large for London; and had at one time estimated the cost of draining London in this way at 10 millions of money.

Mr. Bazalgette alluded to the deleterious effects of the sewage deposited on the pavements, as shown in the case of the silversmiths' shops in Regent-street, at the time the wood pavement was used there; the sulphuretted hydrogen and ammonia from the road-refuse getting absorbed in the wood, and exhalations arising in consequence, which did considerable damage to the silver with which they came in contact.

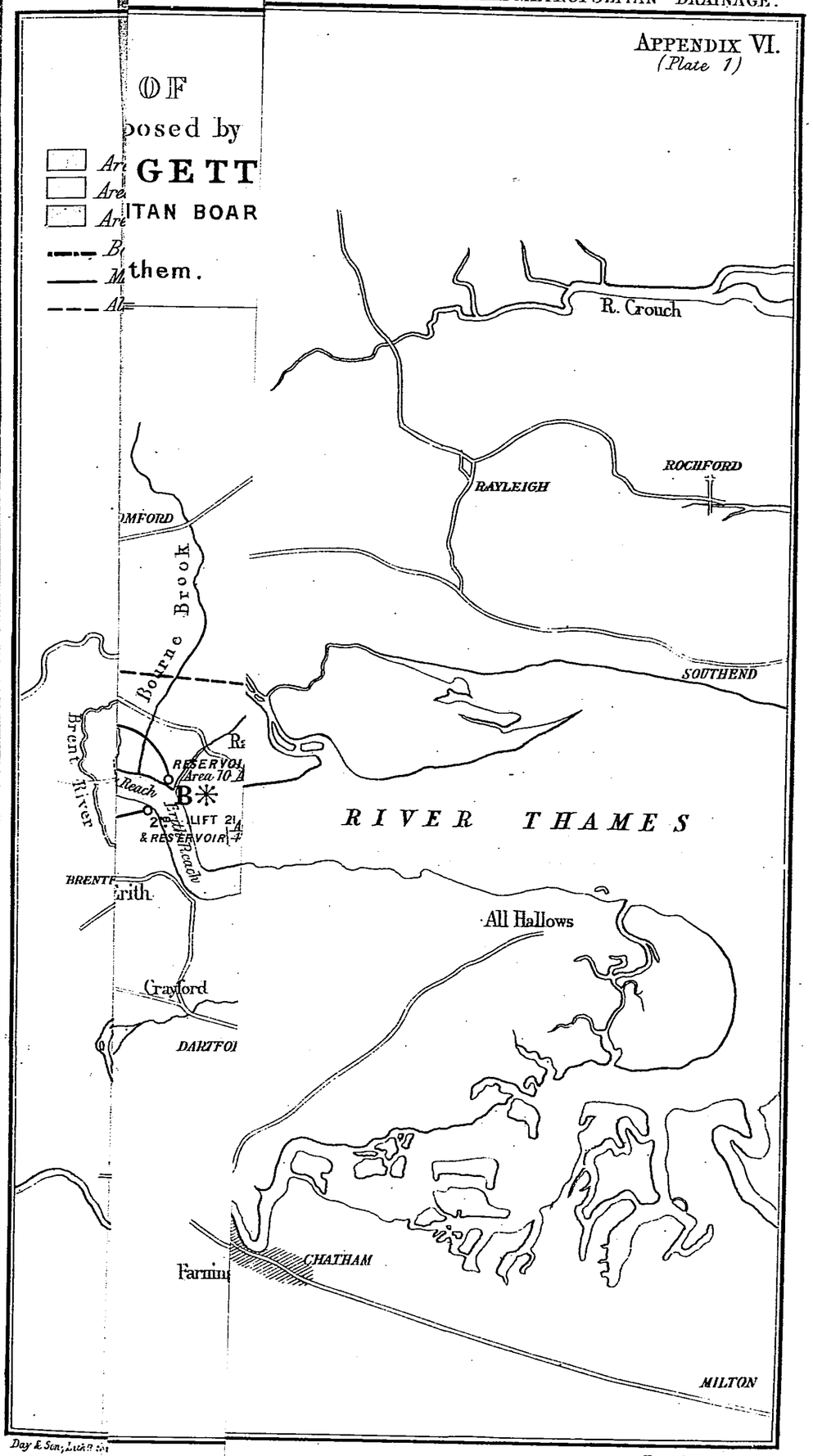
LIST of PLATES to APPENDIX VI.

Plate 1. Map, showing the Scheme of Drainage proposed by Mr. Bazalgette, Engineer to the Metropolitan Board of Works.

„ 2. Sections of Sewers, showing the Flow in Dry Weather compared with that during heavy Storms.

„ 3. Elevations of the Exits of Sewers under the late Commissioners of Sewers for Westminster, and Part of Middlesex.

APPENDIX VI.
(Plate 1)



Day & Son, Lith.

Henry Hansard, Printer

House of Commons, to be Printed, 3rd August, 1857.

PLAN OF
Drainage proposed by
Mr. BAZELGETTE,
ENGINEER TO THE METROPOLITAN BOARD OF WORKS,
AND
Adopted by them.

REFERENCE.

- *Area to be drained by Gravitation*
- *Area to be drained by Artificial power, with One Lift*
- *Area to be drained by Artificial power, with Two Lifts*
- *Boundary of the Metropolitan Districts*
- *Main Lines of Sewers.*
- *Alternative Lines to Sea Reach.*

INGATESTONE
BALLERICA
BRENTWOOD
R. Roding
ROMFORD
Bourne Brook
Ingrebura Brook
Laugdon Hil
Hornsey
Highgate
Stamford Hill
Stoke Newington
Hampstead
HIGH LEVEL SEWER
Paddington
Wilsdon
Canal
Kilburn
27·32 SQRE MILES
Islington
Kingsland
Hackney
Stratford
2nd LIFT 57 FEET
Extension to Barking Creek
BARKING
ALTERNATIVE LINE TO SEA REACH
Bow
Paddington
PARK
Stepney
10·8 SQRE MILES
MIDDLE LEVEL SEWER
HYDE PARK
Plaistow
ALTERNATIVE LINE
Rainham
Halfway Reach
RESERVOIR Area 10 Acres
B*
Blackwall
Front River
Acton
Ealing
21·45 SQRE MILES
Kensington
ISLE OF DOGS
Bermondsey
Rotherhithe
Extension to North Reach
WOOLWICH
Stifford
Hammersmith
Chiswick
Chelsea SEWER
1st LIFT 20·5 FEET
Lambeth
Peckham
Deptford
2nd LIFT 20·5 FEET GREENWICH
Erith
Purfleet
West Tilbury
Barnes
LOW LEVEL SEWER
Fulham
Battersea
Camberwell
HIGH LEVEL SEWER
Long Reach
Grays Thurrock
West Thurrock
East Tilbury
Mortlake
Clapham
Brixton
Tilbury Fort
Richmond
Putney
Wandsworth
22 SQRE MILES
Dulwich
19·75 SQRE MILES
Lewisham
Eltham
Grayford
Gravesend Reach
Stone
North Fleet
RICHMOND PARK
Ham
DARTFORD
GRAVESEND
E. Norwood
Sydenham
River Ravensbourne
Tooting
Wimbledon
Up. Norwood
Chiselhurst
River Cray
KINGSTON
Hogs Mill River
R. Wandle
Beckenham
BROMLEY
R. Darent
Farningham
CROYDON

SCALE.

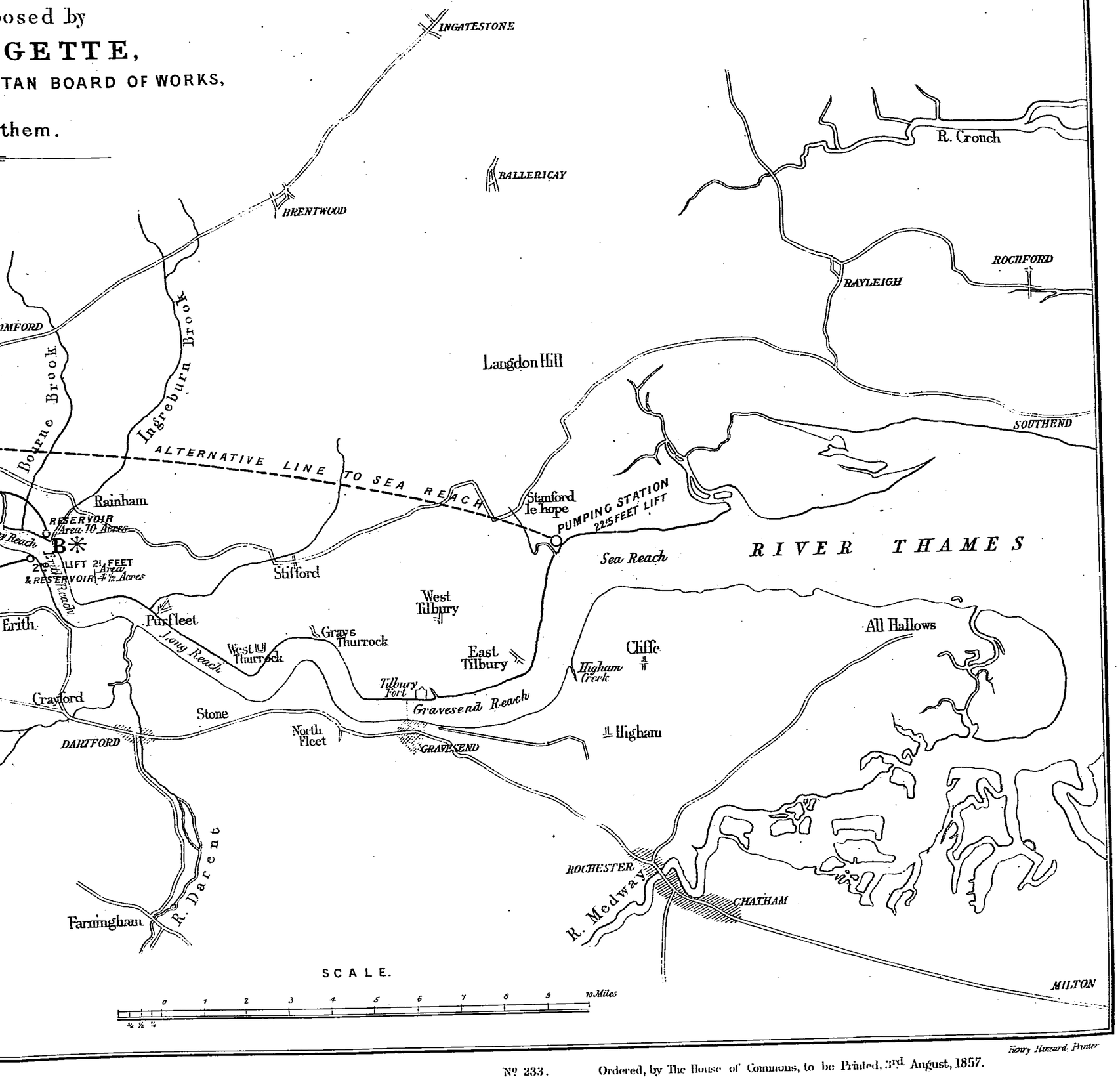
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Day & Son, Lith.rs to the Queen

No 233.

APPENDIX VI.
(Plate 1)

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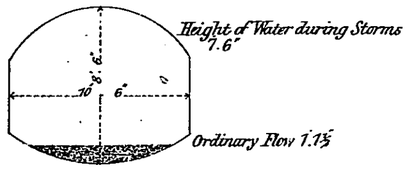
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APPENDIX, VI.
(Plate. 2.)

SECTION OF RANELAGH SEWER, GLOUCESTER ROAD.

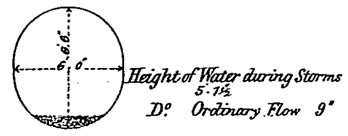
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Inclination, 1 in 563.

FLEET SEWER, KENTISH TOWN ROAD.

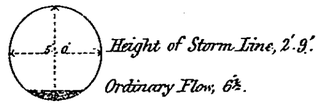
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Inclination, 1 in 316.

HACKNEY BROOK SEWER, DALSTON LANE.

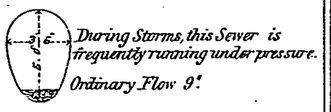
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Inclination, 1 in 350.

NEW NORTH ROAD SEWER.

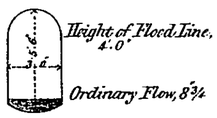
Nº 4.



Inclination, 1 in 350.

COCKSPUR STREET SEWER.

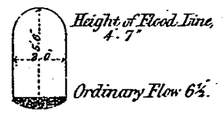
Nº 5.



Inclination, 1 in 108.

BOW STREET SEWER

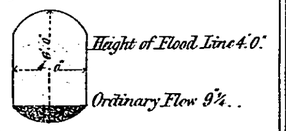
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Inclination, 1 in 193.

GREEN PARK SEWER.

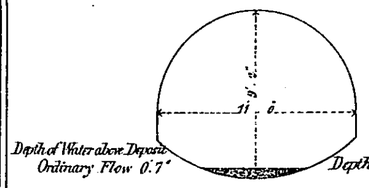
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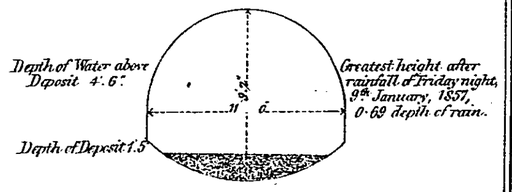
Inclination, 1 in 503.

EFFRA SEWER, BRIXTON ROAD AT VASSAL ROAD.

Nº 8.



Nº 8ª



Rate of Inclination 1 in 1071 above this point
" " 1 in 302 below.

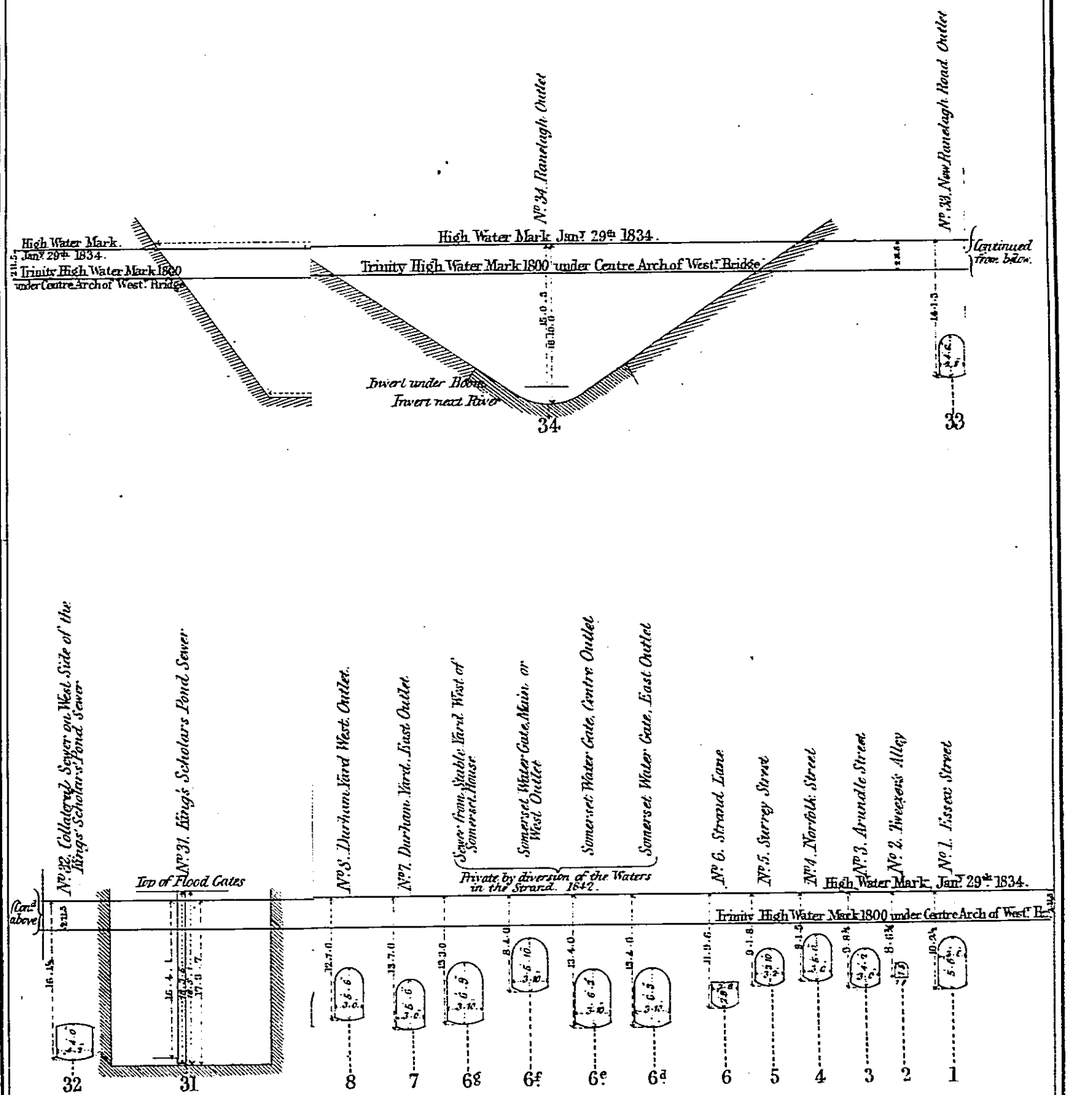
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APPENDIX VI.
(Plate, 3.)

S,
MIDDLESEX,

w. 18th June, 1841.)



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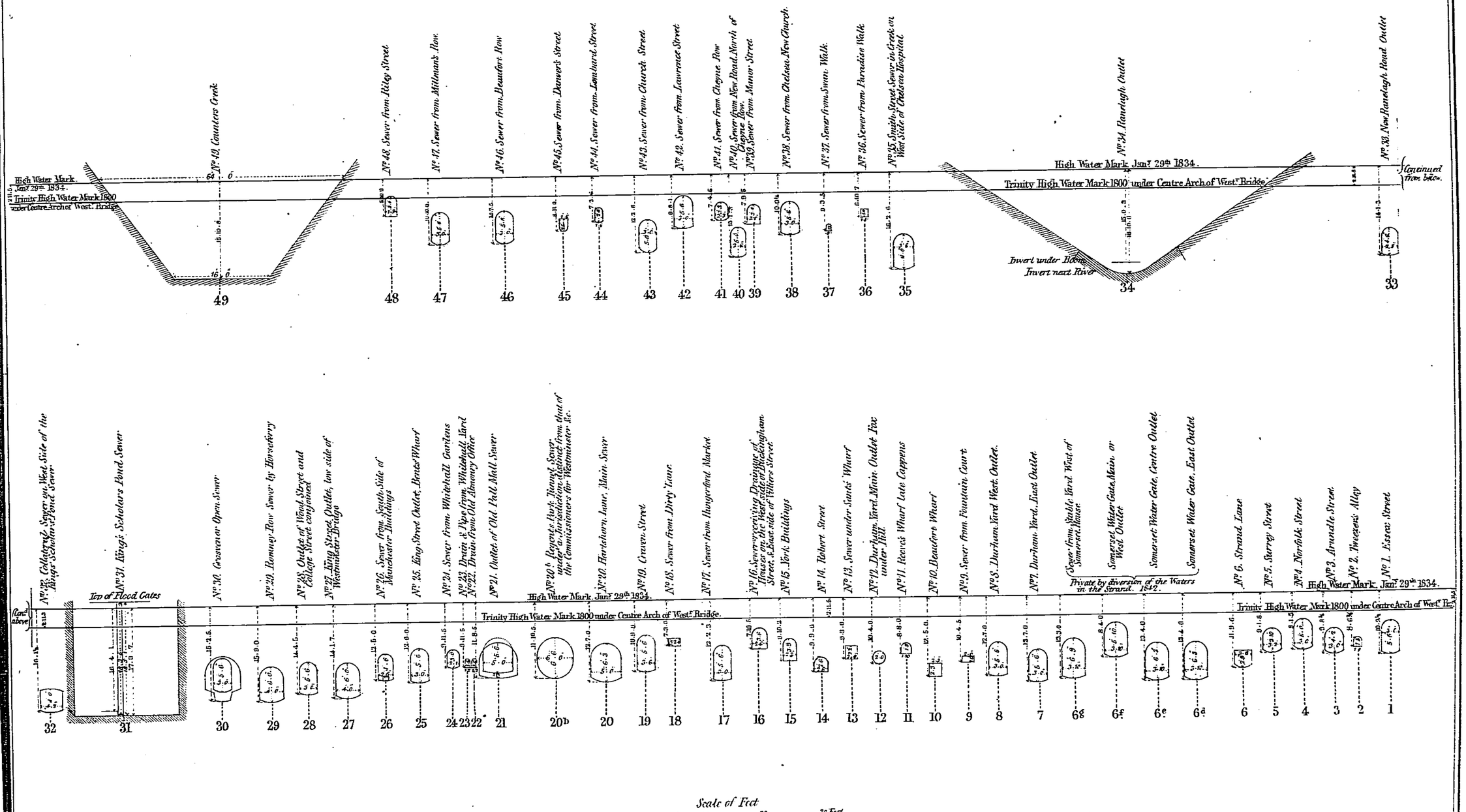
APPENDIX VI.
(Plate, 3.)

ELEVATION OF THE EXITS OF SEWERS,

UNDER THE JURISDICTION OF THE COMMISSIONERS OF WESTMINSTER AND PART OF MIDDLESEX,
Shewing their Height, Width, and Levels, with regard to High Water in the

RIVER THAMES.

(See the Minutes of the Committee on View, 18th June, 1841.)



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APPENDIX VII.

INFORMATION UPON LOCAL DRAINAGE,

Obtained from the District Surveyors and others.

APPENDIX VII. - - - - - - - -

1.—ANALYSIS of ANSWERS received from the DISTRICT

NAME of DISTRICT.	NAME of SURVEYOR.	Length of Sewer under Metropolitan Board of Works.	UNDER DISTRICT BOARD. Length of Sewer. Covered.	Uncovered.	Length of Street Unsewered, which at present requires New Sewers.	Cost of Necessary New Works.
1.—Bermondsey -	Geo. Elkington	- - -	*miles. yds.* Brick sewers, 7 1,460 Pipe ditto - 7 450 Total - 15 150	*miles. yds.* 4 1,240 of which only 180 yards are in inhabited districts.	Does not state -	- - No estimate has been prepared.
2.—Bethnal-green	Thos. H. Bainbridge.	Declined to give information, from want of time.			—	—
3.—Camberwell -	J. C. Reynolds	- - -	Low level brick & pipe sewers, *mls. yds.* 3 0 High level ditto, 15 880 Total - 18 880	10 miles - -	- - -	Does not state - -
4.—Chelsea -	J. Pattisson -	- - -	25 miles 660 yards -	883 yards -	1 mile 448 yards	Covering £. s. d. open sewers, 364 7 6 New sewers, 3,341 13 - Total, £.3,707 - 6
5.—Clerkenwell -	Sanders Bevan	- - -	- - 11 miles 132 yards; there may, however, be more, not marked on the plans in possession of the vestry.	None - -	- - No accurate information can be given.	- - - - -
6.—Fulham -	A. C. Bean -	- - -	No accurate information given - - - - - - -

Appendix VII.—*continued.*

NAME of DISTRICT.	NAME of SURVEYOR.	Length of Sewer under Metropolitan Board of Works.	UNDER DISTRICT BOARD. Length of Sewer. Covered.	Uncovered.	Length of Street Unsewered, which at present requires New Sewers.	Cost of Necessary New Works.
7.—Greenwich	J. Nidd Smith		16 miles 1,405 yards	7 miles 363 yards	27 miles 890 yds.	£. Covering open sewers 13,817; Making new ditto 64,436; £. 78,253
8.—Hackney	S. Lovegrove		16 miles	-- 7 miles, including Hackney Brook.	13 miles 880 yds.	£. s. d. 24,359 8 4
9.—Hampstead	John Douglas	3½ miles	6 miles	14 miles	7½ miles	£. Covering sewers 55,300; New ditto 21,000; £. 76,300
10.—Holborn	L. H. Isaacs		9 miles 1,364 yards	None	1 mile 1,182 yds.	-- £. 5,600. Does not include the whole amount required to put the sewerage in order.
11.—Islington	C. Higgins		45 miles 1,343 yards	-- 6 miles 1,106 yards. Of this, 2 miles 1,176 yds. will require to be covered.	-- 13 miles 1,063 yards.	£. Covering open sewers 3,683; New sewers 31,143; Total £. 34,826
12.—Kensington	James Broadbridge.		Brick sewer 27 miles 1,523 yds.; Pipe ditto 7 miles 293 yds.; Total 35 miles 56 yds.		1 mile 1,063 yds.	2 miles 196 yards. £. s. d. 4,743 16 –

Appendix VII.—*continued.*

OBSERVATIONS ON PLAN of METROPOLITAN BOARD OF WORKS.	REMARKS AS TO FLOODS.	MISCELLANEOUS INFORMATION, &c.
-- The works proposed by Mr. Bazalgette will be sufficient for the drainage of this district, so far as the levels are given. The reversal of existing sewers, to fall into the low-level intercepting sewer, will cost about— £. 3,261; The reversal of those which are to be received in the high-level sewer will cost about 5,218; Total £. 8,479	-- States that portions of the district, especially East-lane, Church-street, and Horse-ferry-road, suffer greatly from floodings. These are attributable to the upland waters flowing down into the low-level sewers, which are tide-locked for nearly 18 hours out of every 24;—states that these floodings, which injure the basements of the houses, at the same time breed disease and pestilence.	-- *See* also Letters from Mr. James and Mr. Pink, Appendix VII., Page 258.
-- Approves of the principle of interception generally, but objects to the large amount of mechanical power proposed by Mr. Bazalgette to be applied, on account of the derangements likely to ensue from such a complication of works. Does not believe the scheme as effectually relieves Hackney of its local drainage as might be done. Considers that the area of low-level drainage should be diminished, by constructing the high-level intercepting sewer at greater depth than is proposed. *See* Printed Report by Surveyor, dated 9th April 1857. Appendix VII., Page 270.	- - - - - - - - - -	-- Printed Report by Surveyor received. *See* Appendix VII., Page 270.
-- Believes Mr. Bazalgette's intercepting sewer will be perfectly effective in draining the district.	-- Floodings occurred previous to the construction of the main sewer from Flash-walk to Gospel Oak Fields, commonly called the Fleet sewer.	—
-- Fears that the Piccadilly branch, designed to traverse a portion of this district, will prove insufficient as to size; and as it is intended to pass through a densely populated neighbourhood, any flooding that might occur would produce very serious mischief. Does not see how the Fleet, at the bottom of Back-hill, can be intercepted, as the proposed sewer at that point will be some feet above the invert of the Fleet in Warner-street, unless a considerable length of branch sewer be constructed by its side, until the difference of level is overcome. Great caution should be used in the consideration of the plan, as it affects adjoining districts, and London generally, since it might be found that additional modifications would still be needed to ensure a perfect system of intercepting drainage.	-- Along the valley of the Fleet, which is the outfall of the greater part of the drainage of this and adjoining districts, several floods have taken place; and in August 1846, a serious one was experienced, causing large loss of property; it is to be attributed to the many obstructions at that time in the Fleet river to the volume of storm water committed to it, and the circuitous route it then took; but the alterations made will prevent any flooding for the future.	-- For general information, &c., *see* Minutes of Mr. Isaacs' Evidence. Appendix VII., Page 275.
-- Suggests that it would be more advantageous to divert nearly the whole of the Islington waters into the northern high-level sewer; draws attention to the large annual expenditure which will be incurred by working and keeping in repair the main drainage works, and proposes, as a method of reducing the cost, that an undershot water-wheel should be fixed, and such arrangements made, that the water of the high-level sewer should lift the water from the low-level sewers, and steam power be used only as an auxiliary to the water-wheel.	-- The high-level sewer proposed, will, he thinks, be sufficient for this parish, and will provide an efficient outlet for the northern or Holloway district, where floodings are of frequent occurrence. On 9th January last, the water was two feet above the top of the culvert under the Great Northern Railway near the Hornsey-road.	—
- - - - - - - - - -	-- Only one flooding has occurred since the beginning of 1856, which happened on the 17th August. This arose from some 18-inch stoneware pipes, put down in continuation of the eastern branch of the Counters Creek sewer, at the Kensington Workhouse, where its dimensions are 5 feet 6 inches by 3 feet 6 inches, being insufficient to carry off the Stormwaters, which thus flooded Kensington New Town. The defect is being remedied by the Metropolitan Board of Works, who are having the portion of the sewer from the workhouse to the outlet in Warwick-road reconstructed.	-- *N.B.*—A letter was also received from Mr. Green, vestry-clerk of Kensington, written by order of the Board, and accompanying a copy of a letter addressed to the Metropolitan Board of Works, urging them to offer a reward for the discovery of an inexpensive method of utilising sewage; and also sending copies of resolutions of the vestry to the same effect, and objecting to the reservoir proposed to be constructed in Fulham fields, as well as to the outlet at Barking, on account of its proximity to London. *See* Appendix VII., Page 259. (*continued*)

Appendix VII.—*continued.*

NAME of DISTRICT.	NAME of SURVEYOR.	Length of Sewer under Metropolitan Board of Works.	UNDER DISTRICT BOARD. Length of Sewer. Covered.	Unsewered.	Length of Street Unsewered, which at present requires New Sewers.	Cost of necessary New Works.
13.—Lambeth	H. M'Intosh		37 miles 880 yards	1,600 yards	47 miles 80 yards	Covering open sewer £. 1,450 New sewers 94,000 TOTAL £. 95,450
14.—Lewisham	H. Treverton		10 miles 257 yards	Does not state	Sewers at present required *miles.* 3 *yds.* 1,491 Ditto likely to be required 18 1,353 22 1,084	Cost of sewers now required £. 7,029 Cost of ditto likely to be required 50,397 £. 57,426
15.—Limehouse	Chas. Dunch		11 miles 871 yards	133 yards	6 miles 308 yards	
16.—Mile End Old Town	Robt. Lemon		8 miles 635 yards	600 yards	7 miles 1,026 yards	Covering open sewers £. 500 New sewers 16,000 Proposed sewering of Bow Common 3,500 TOTAL £. 20,000
17.—Newington	H. Jarvis		18 miles 803 yards	1 mile 458 yards	15 miles 763 yards	Covering open Sewers £. 4,000 New sewers 19,000 TOTAL £. 23,000
18.—Paddington	W. Merry		28 miles		Does not state	

Appendix VII.—*continued.*

OBSERVATIONS ON PLAN of METROPOLITAN BOARD OF WORKS.	REMARKS AS TO FLOODS.	MISCELLANEOUS INFORMATION, &c.
Suggests an improvement on the route of the low-level line from Battersea Fields to the Camberwell New-road, by carrying it along the Battersea-road to Nine Elms, the Wandsworth-road to Vauxhall Cross, along New Bridge-street, Harleyford-road, Kennington Oval, Harleyford-street, Camberwell New-road to Vassall-road, there to resume the proposed line onwards. In this part of the parish the Wandsworth, Clapham, and Brixton roads may be regarded as three terrace lines, all converging to where it is proposed by this alteration to carry the main sewer; the subsidiary sewers can be constructed to incline with the natural fall of the surface, which will economise their cost, and dispense with the expensive reconstruction of the Effra from Vassall-street to the outlet. It is a serious error to use as an argument in justification of the proposed line, that the cost of covering the existing sewers will be saved, since, were the whole scheme completed, it would only be more urgent that they should be covered; it is made a great point in the design to show where the Effra is intercepted, and the provision made for diverting its ordinary flow into the deep line; this is inconsistent with the abandonment of that sewer. He calls attention to the error of providing *now*, for a district such as Dulwich, what may not be required for the next 50 years, considering that the proposed outlay of 200,000*l.* would, in 52 years, amount to 3,200,000*l.*; condemns the construction of sewers upon the principle of providing in them reservoir room for floods, and maintains that if it is necessary to hold back the drainage of a district, proper receptacles may be constructed, at far less cost, from which it may be discharged by sewers specially adapted for its conveyance. That, as it is not intended to provide for carrying into the extension line below Deptford more than what a 4-feet barrel will convey from the double 10-feet 6-inch barrel, while the superabundant contents are to be discharged by an overflow into Deptford Creek at low water, it is clear this sewer will not be free from the objection arising from the present system of intermittent discharge by a tide-locked outlet. Raises the question whether there is really any necessity for the construction of the intercepting sewer, liable as it is to the objections which exist against tide-locked sewers, while they might be avoided by the construction of a reservoir, and the sizes of the sewers be then materially reduced; and, further, whether it is worth an outlay of 200,000*l.* to be able to discharge the overflow into Deptford Creek, when in about three hours' of rising tide it would be carried to Vauxhall, whereas, if it had been first discharged here, though carried higher up, it would cause no inconvenience, as sewage in time of floods is not offensive.		
Believes Mr. Bazalgette's proposed works will be quite sufficient for the district.	The last floodings occurred five or six years ago, from the sewers not being large enough to receive the waters from the river, which is usually carefully preserved for the mills. Works to remedy this defect have since been carried out.	—
The intercepting sewer proposed by Mr. Bazalgette will be sufficient for the drainage of the greater portion of the district; but the plans published not showing the branches requisite to convey the sewage south of the London Docks into the intercepting sewer, no opinion can be given as to the drainage of those parts of Wapping and Shadwell.	No floodings occurred in this district in 1856	—
		Report by Medical Officer of health received; dated June 1856. *See* also Letter from Mr. Lemon, Appendix VII., Page 260.
In giving an unqualified approval he suggests the application of sewage to agricultural purposes, rather than that it should be discharged into the river, and that an inquiry into this would not delay the carrying out so much of the proposed plan as relates to the construction of the sewers, as most probably the proposed reservoir would be required in either case. *See* Report by Surveyor upon Mr. Bazalgette's proposed Plan of Intercepting Drainage, Appendix VII., Page 279.	With reference to the state of drainage generally, the greatest evil arises from floodings where the storm water falls at the time the sewers are pent up by the back tidal-water, and that the injury from this cause, he thinks, is most severely felt in the Trinity District, viz., in St. George's-road, St. Andrew's-road, Devonshire-street, William-street, and even in the cellars of the houses in Newington Causeway, which are seldom free from water.	Report by Surveyor received; dated April 1856. *See* Appendix VII., Page 279.
Considers that a branch sewer should be carried along the Edgware road from Oxford-street to Kilburn Gate, to intercept the Grove End-road sewer at the New-road, and the Ranelagh sewer at Kilburn, in order to relieve the lower part of Paddington of 1,300 acres of flood waters. When the whole parish is covered with houses, the existing main line in the Gloucester-road will be only large enough to take off the storm-waters, and therefore the sewer proposed to be carried along the Uxbridge-road to intercept the Ranelagh and part of the Counters Creek districts should not be less than eight feet in diameter.	In heavy rain the lower part of Paddington is inundated with back-water from the Ranelagh sewer, owing to the inefficient capacity of that sewer in the Uxbridge-road, between the Serpentine and Albion-street. On the 17th August 1856, the houses in the Bishop's-road and Westbourne-grove were inundated with two feet of foul sewage water.	Printed Report, by Surveyor, received; dated January 1857. *See* Appendix VII., Page 280. *See* also Letter from Mr. Aveling, Appendix VII., Page 261.

(*continued*)

Appendix VII.—*continued.*

NAME of DISTRICT.	NAME of SURVEYOR.	Length of Sewer under Metropolitan Board of Works.	UNDER DISTRICT BOARD. Length of Sewer. Covered.	Uncovered.	Length of Street Unsewered, which at present requires New Sewers.	Cost of Necessary New Works.
19.—Plumstead *N.B.*—Plumstead District is divided into four sub-districts, each having a separate surveyor.	(1.) H. A. Fisher (Surveyor of Plumstead Sub-district.)		No accurate information given.			
	(2.) James Collis (Surveyor of Charlton Sub-district.)		400 yards. This does not include a temporary barrel drain in the Lea-road.	-- None, except tidal ditches, of which there are several miles in the marshes.	1 mile 740 yards	£. 5,500.
	(3.) F. F. Thorne (Surveyor of Lee and Kidbroke Sub-district.)	1 mile 220 yards	4 miles 1,540 yds.	-- 9 miles 440 yards, including Quaggy River and Kidbrooke Streams.	1 mile 1,100 yds.	£. 5,000. Only 2,000 *l.* is required to be immediately incurred.
	(4.) No information received from the Eltham Sub-District.					
20.—Poplar	R. Parker					
21.—Rotherhithe	G. Legg		-- 1 mile 1,240 yards, covered in 1856.		About 2 miles	No estimate
22.—St. George the Martyr, Southwark.	J. Smith		-- Low level, brick and pipe, about 10 miles 880 yards; high level, ditto, 10 miles 440 yards; and 6 miles 440 yards of brick and pipe sewers laid in boundary. *miles. yds.* Total - 26 1,320	Nil	6 miles	About 10,000 *l.*
23.—St. George, Hanover-square.	E. C. Richman		30 miles	None	250 yards	475 *l.*

Appendix VII.—*continued.*

OBSERVATIONS ON PLAN of METROPOLITAN BOARD OF WORKS.	REMARKS AS TO FLOODS.	MISCELLANEOUS INFORMATION, &c.
		-- General Information from Mr. H. A. Fisher.—This parish has increased greatly since 1848, when the North Kent Railway was constructed. There are two estates known as the "Burrage" and "Park" Estates, on which building increases rapidly. In the former, though there are drains, they are mostly so small, and at so high a level, as to be insufficient for any general system of drainage. The "Park" Estate, lying to the east of the "Burrage," has three drains leading to the railway cutting, from which point the sewage is conveyed in open ditches. The large spread of Government works has necessitated a corresponding increase of house accommodation. There are a large number of cesspools in the district. *See* Appendix VII., Page 244.
-- On application to Mr. Bazalgette, has received information that the proposed sewer will be sufficiently low to drain all houses likely to be built on the marsh land, and therefore concludes that it will be available for the drainage of the principal portion of the parish.		
-- Thinks Mr. Bazalgette's proposed sewers very well adapted for the drainage of the Lee and Kidbrooke sub-district, which is altogether well situated for drainage purposes generally, from its height above the level of the river.	-- States that he believes no floodings have occurred in the sub-district of Lee and Kidbrooke.	
	A Letter from Mr. Smith, vestry clerk to the Plumstead District Board, states that a great portion of the Charlton parish and all Plumstead parish proper, is without a main sewer, and that, in consequence, the drainage is carried off by open ditches into the marshes, where there are no cesspools. There are great objections to this mode of drainage, in consequence of its rendering the ditches offensive as permanent boundaries between the fields, and for other reasons. It is only quite lately that the lower portion of the parish of Lee, and parts of Kidbrooke, Eltham, and Charlton have had the advantage of a main sewer emptying itself into the Ravensbourne, at Deptford Creek. *See* Appendix VII., Page 246.	
-- The lines of the high level, middle level, and low level sewers, where they pass through this district, are well adapted for receiving all its sewage. With regard to the proposed line of the Isle of Dogs branch, all the existing sewers will have to be reversed, if it is carried out according to Mr. Bazalgette's plans. The better route would be along East Ferry-road, Preston's-road, Bedford-street, Brunswick-street, Robinhood lane, East India Dock-road, St. Leonard's-road, beneath the Lea cut, and from thence to join the main sewer in Brickfield-lane. If this line were to be taken, great expense would be saved.		-- *See* Letter from Mr. Marchant and Correspondence enclosed, Appendix VII., Page 261.
-- The proposed north or Bermondsey branch intercepting sewer is not of sufficient area to receive the sewage from the district where the largest manufactories are carried on, using immense quantities of water; and about 1½ mile of parish could not, he thinks, be drained by the proposed plan, without a branch under the lock of the Surrey canal or the Commercial Docks; but, in either case, the main sewer must be at a lower level.	-- There have been three floodings in 10 years, and most of the district being about six feet below Trinity high water standard, many houses, streets, and turnpike-roads were injured, the water flowing up the sewers and gulleys, leaving a large deposit on the surface. Is of opinion that the additional sewage proposed to be carried through Rotherhithe from all the present outlets into the river, east of London Bridge, will be three times as much as that of the Earl, which overflows its banks at times, and even with the constant lifts, would require a main of 9 ft. in diameter (as suggested in Mr. Forster's report).	-- Three printed Reports received: 1. Report, by Medical Officer of Health, Dr. Sutherland; dated September 1852. 2. Reports by Dr. Murdoch and Mr. Legg; dated February 1856. (For Surveyor's Report, *see* Appendix VII., Page 282.) 3. Report, by Dr. Murdoch, Medical Officer of Health; dated April 1856. *See* also Letter from Mr. Hawks, Clerk to the Vestry, with Enclosure, Appendix VII., Page 262.
-- The proposed plan will relieve the sewers of this parish to a certain extent, but it will eventually be necessary to prolong the proposed deep level sewers into various parts of this and adjoining parishes.	-- In consequence of increased stowage room for sewage obtained by the old high level sewers, combined with the new low level sewers, no serious floodings have of late years occurred in this parish.	—
-- States that an opinion on this subject, to be of any value, could only be arrived at after a careful investigation, but from an examination of the section of the penitentiary branch of the northern low level intercepting sewer, it would appear that the sewers of Lupus-street, and one or two other places south of it, are at a lower level than the proposed sewer of interception, but that possibly some alterations may be contemplated, which would render these places capable of efficient drainage.	—	—

(*continued*)

Appendix VII.—*continued.*

NAME of DISTRICT.	NAME of SURVEYOR.	Length of Sewer under Metropolitan Board of Works.	UNDER DISTRICT BOARD. Length of Sewer. Covered.	Uncovered.	Length of Street Unsewered, which at present requires New Sewers.	Cost of Necessary New Works.
24.—St. George in the East.	Andrew Wilson	- - -	4 miles, 156 yards -	None	6 miles 1,510 yards -	- - Combined cost of reconstructing old, and making new sewers, 12,300 *l.*
25.—St. Giles - -	W. J. Tremaine	- - -	12 miles, 1,320 yards -	None	1 mile, 1,300 yards -	5,000 *l.* - -
26.—St. James, Westminster.	A. P. Howell	- - -	8 miles, 646 yards -	None	None - - -	- - For repairing old sewers, about 1,000 *l.*
27.—St. Luke's, Middlesex.	W. Christie* -	- - -	- - - - -	None	- - - - -	- - No estimate of necessary works made.
28.—St. Martin-in-the-Fields.	R. K. Burstall	2 miles 924 yds.	*miles. yds.* Brick - - 5 1,026 Pipe - - 0 913 TOTAL - 6 179	- - -	1 mile 906 yards -	About 4,000 *l.* -
29.—St. Marylebone -	Robert Scace	- - -	*miles. yds.* Brick sewers 39 576 Pipe ditto - 6 450 Barrel drains 1 334 TOTAL - 46 1,360	None	*miles. yds.* Requiring sewers - - 5 630 Do. pipe drains 1 227 TOTAL - - 6 857	- - New sewers, 23,005 *l.*
30.—St. Olave, Southwark.	A. J. Newman	2 miles - -	*miles.* Brick sewers about - 4 Pipe sewers, about - 2 TOTAL - 6	None	- - - - -	- - - -
31.—St. Pancras -	W. B. Scott -	- - States that there is no information in possession of District Board of Works.				—
32.—St. Saviour's, Southwark.	John Howe -	- - -	*miles. yds.* Brick sewer - 6 606 Pipe ditto - 2 1,748 TOTAL - 9 594	None	1 mile 1,569 yards -	3,231 *l.* 5 *s.* 6 *d.*

* *See* Letter (Page 250), as to part of the information given.

Appendix VII.—*continued.*

OBSERVATIONS ON PLAN of METROPOLITAN BOARD OF WORKS.	REMARKS AS TO FLOODS.	MISCELLANEOUS INFORMATION, &c.
- - The intercepting sewers, proposed by Mr. Bazalgette, will be sufficient for the district, in which there is no sewer at so low a level as not to be efficiently drained.	- - The sewer in St. George's-street is frequently flooded. This arises from heavy rainfalls occurring at the time the floodgates are closed.	- - The existing covered sewers in the district are in good condition.
- - The proposed middle level line of Mr. Bazalgette, is amply deep enough to intercept all the sewers of the district.	—	—
- - The Piccadilly branch will take all the sewage of the parts situate north of it.	- - All the main sewers are large enough to carry off storm waters, though some of three feet nine inches, by two feet six inches, were nearly full on the occasion of the thunderstorm, June 19–20, 1857. Some of the small local sewers were completely filled from the sudden accumulation of water.	—
- - The proposed intercepting sewer will effectually drain the lowest levels.	No floodings have occurred in this parish.	—
- - With respect to the main sewer which is proposed to be constructed along the Strand, there is an alternative plan to construct the same upon the north side of the river, from Hungerford Market Bridge. This latter plan would drain the district south of the Strand, such as the Adelphi, &c., without incurring the expense of reconstructing and reversing the present system of district sewers. In this parish, at or near Scotland-yard, three of the main sewers (Victoria-street, Regent-street, and Northumberland-street sewers) have their outlets into the river; at the present time, two of these main sewers are tide-locked, and consequently the accumulated sewage, &c. has to remain until the recession of the next tide.	- - - - - - - - - -	- - Printed report received, dated 3 April 1856. *See* Appendix VII., Page 284.
- - The proposed main intercepting sewer will provide fully for the wants of the district, being at the same level with the Regent-street sewer, which is 54 feet below the surface of the ground at Regent Circus, or 20 feet lower than any other sewer in St. Marylebone district.	- - There have been no floodings for 50 years in St. Marylebone.	- - General Information.—Attention is called to the state of the K. S. Pond sewer, at the point where it crosses the Regent's Canal. Northwards of this point its dimensions are 7 feet by 3 feet, but in order to allow it to cross beneath the roadway of the canal bridge, it is here contracted into a trough 3 ft. 10 in. by 2 ft. The consequence of this, and of a wrong inclination in parts of the sewer, is that above the bridge the contents of the sewer stagnate for long periods. South of the bridge the sewer runs at so high a level, that a great part of the Alpha-road and the adjacent parts cannot be efficiently drained. With regard to existing sewers generally, many of them are so bad, in point of levels, form, and materials, that very extensive alterations will be necessary. *See* also Mr. Truth's Letter and Evidence, Pages 263 and 307.
- - - - - - - - - -	- - A very large portion of the district is below Trinity high-water mark, and there is scarcely a year on which this part would not be flooded on the occasion of high tides if the bank of the river was not carefully maintained. A description of this and the adjoining district is given, extracted from Mr. P'Anson's Report to the Commissioners of Surrey Sewers, dated February 1843. *See* Appendix VII., Page 252, and Appendix VIII., Page 317.	- - The drainage of the district is, generally speaking, very good; though, owing to the low levels of the district, the sewers are tide-locked for 18 out of every 24 hours. There are few streets now requiring to be drained. The owners of private courts are, in many instances, carrying out sewage works in the district. For further information, *see* Letter, Appendix VII., Page 252.
—	—	—
- - Mr. Bazalgette's works will effectually relieve the district of its sewage. The works in existence are in good condition.	No floodings have occurred of late years.	—

Appendix VII.—*continued*

NAME of DISTRICT.	NAME of SURVEYOR.	Length of Sewer under Metropolitan Board of Works.	UNDER DISTRICT BOARD. Length of Sewer. Covered.	Uncovered.	Length of Street Unsewered, which at present requires New Sewers.	Cost of Necessary New Works.
33.—Shoreditch	W. Y. Freebody	Declined to give information, from want of time				
34.—Strand	Geo. Fred. Fry	11 miles 1,390 yards	None		1 mile 1,100 yards, including sewers requiring reconstruction.	5,091 *l.*
35. Wandsworth	D. W. Young	45 miles 1,320 yards	21 miles		39 miles	£. Covering open sewers 8,237; New sewers 111,840; Total £. 120,077
36.—Westminster	R. R. Arntz	18 miles 1,320 yards			6 miles 1,320 yards	25,000 *l.*
37.—Whitechapel	H. R. Fricker	2 miles 880 yds.	Brick and pipe sewers *miles.* 13 *yds.* 440			
38.—Woolwich	J. Barnett	17 miles	None		None	
39. City of London	W. Haywood (Engineer to the City Commission).	48 miles 880 yards	None		None	

Appendix VII.—*continued.*

OBSERVATIONS ON PLAN of METROPOLITAN BOARD OF WORKS.	REMARKS AS TO FLOODS.	MISCELLANEOUS INFORMATION, &c.
		Two printed reports received: one from Surveyor, dated December 1856; one from Dr. Barnes, Medical Officer of Health, dated 27 December 1856. For Surveyor's Report, *see* Appendix VII., Page 291.
Mr. Bazalgette's proposed intercepting sewers will be quite sufficient for the drainage of the district, if it is intended that the St. Martin's-lane sewer should be intercepted by the main middle level sewer, and not by the Piccadilly branch, which would be of insufficient capacity for the purpose.	This district has not suffered from floods, so far as is known, for the last eight years.	—
Thinks that the low level sewer ought to be deeper at its commencement at High-street, Putney, so as to intercept any new sewer that may be built along the Lower Richmond-road, and proposes that the level of this new sewer when built should be 7 feet above Ordnance datum, or nearly 2 feet lower than the proposed main low level sewer.	In heavy rains floodings take place along each of the principal main lines of sewers in this district; along the valley of the River Wandle floodings arise from the numerous obstructions by the mills, the level of the water, in dry weather, being some feet above the level of the adjoining land. Along the Falcon Brook are various ponds, originally ornamental pieces of water, but now, in dry weather, little better than foul, open cesspools and obstructions to the drainage. The Heathwall open sewer, along Battersea Fields, is in a very bad state, from the increasing quantity of soil drainage discharged into it.	Printed Report by Surveyor received, dated 10 December 1856; *see* Appendix VII., Page 297. For general information, &c., *see* Minutes of Evidence, Appendix VII., Page 297.
States that according to the plan proposed, the depth of the sewer at Great Peter-street by St. Ann-street, would require that the basement floor of a building, taking 4 feet as a minimum level at which it should be laid above the sewer, must be, in this instance, laid 5·41 feet only below the surface of the street, and that, in consequence, to obtain a basement story of the minimum clear height of 7 feet (as required by the Metropolitan Buildings Act) the ground floor must be laid at a height of 2 59 feet above the level of the street.	Floodings have occurred several times during the last year in the Vauxhall Bridge-road, and in each case from the great depth of water ponded, during heavy rains, in the King's Scholars pond sewer.	For general information, &c., *see* Minutes of Evidence, Appendix VII., Page 302.
The proposed sewers will be at quite sufficient depth to receive the drainage of every part of the district. The sewers south of the intercepting line, will have to be reconstructed that their inclination may be reversed, and new connections with the existing house-drains made.	The only floodings which have lately occurred in the district were on the 17th of June and on the 1st of July in this year, when the sewage was ponded back up the drains, after the heavy rain which fell on those days, and for a period of eight or ten hours caused great inconvenience, by flooding the cellars of houses in various parts of the district.	—
Is of opinion that the plan alluded to will be sufficient, and that there is no sewer at so low a level but may be drained by it; but the whole of the outlets will require to be brought up to the proposed sewer, at a very considerable cost.	—	—
States that he has not gone accurately into the scheme as it now stands, but believes that in principle it coincides with the plan prepared by himself and Mr. Foster in 1850, as well as with that brought forward by Mr. Bazalgette and himself in 1854, and still believes in the correctness of those general principles.		For general information, &c., *see* Letter containing answers to questions put by Referees, Appendix VII., Page 302, and Minutes of Evidence, Appendix VII., Page 304. *See* also Letters, &c. as to certain Floods in the parts near the Fleet Sewer, Appendix VII., Page 263.

Appendix VII.

Information on District Drainage.

2.—TEXT of Answers from the Surveyors of the District Boards of Works to Circular containing request for certain Information.

Copy of Circular.

Copy of Circular.

Sir, 29, Great George-street, March and April 1857.

I am desired by the Referees to request you to have the goodness to furnish them, at your earliest convenience, with the following information:—

1. The length of covered sewers in the district.

2. The length of open sewers in the district, with the estimated cost of re-constructing and covering the same.

3. The length of streets and places (exclusive of uncovered sewers) which require to be drained, with the estimated cost of the sewer-works thereon.

The above information is required, exclusive of the principal lines of sewers which are proposed to be constructed by the Metropolitan Board of Works.

I am further directed to inquire, for the information of the Referees, whether the plan proposed by the Metropolitan Board of Works, as described in Mr. Bazalgette's Reports, dated May 22* and December 1, 1856, will, in your opinion, be sufficient for the district, and whether there will be any sewer in your district at so low a level as not to be susceptible of efficient drainage by the proposed works.

The Referees would also feel obliged by your adding any general information as to the drainage of your district, with a description of any floodings which may have occurred from defects of the main drainage.

I have, &c.

To the Surveyor of the District. (signed) *Herbert C. Saunders.*

Text of Surveyors' Answers to Circular.

(1.) Bermondsey District.

(1.) Bermondsey District.

(i.)

Sir, Maltby-street, Bermondsey, 26 March 1857.

I have to acknowledge the receipt of your communication with respect to the sewers and drainage in this district, and to inform you that the particulars required shall be forwarded with as little delay as possible.

I am, &c.

H. Saunders, Esq. (signed) *Geo. Elkington*, Surveyor.

(ii.)

Sir, Maltby-street, Bermondsey, 12 May 1857.

I beg to transmit the following information in reply to your communication dated 25th March last, with reference to the main drainage of the metropolis.

1. The lengths of covered and open sewers in the Bermondsey district under the control and supervision of the vestry are as follows:—

	Miles.	Yards.
Brick Sewers	7	1,460
Pipe ditto	7	450
Open ditto	4	1,240
Total Length	19	1,390

being exclusive of the main lines vested in the Metropolitan Board of Works.

2. As to the length of streets and places exclusive of uncovered sewers which require to be drained, and the estimated cost of the works thereon, as well as the estimated cost of reconstructing and covering the open sewers, I would observe that the parish of Bermondsey comprises a total area of 620 acres, of which 450 acres are thickly inhabited, and built over with dwelling-houses, extensive manufactories and premises, the remaining area of about 170 acres being at present chiefly occupied for market gardens and meadow land. It is satisfactory to report that within the last few years, especially in 1854 and 1855, a very considerable amount has been expended by the Commissioners for the Surrey and Kent division, as well as the late Commissioners of Sewers in the construction of a series of most important low-level sewers in the leading thoroughfares throughout the parish, the benefits resulting from which have been duly appreciated by owners of property, inasmuch as during the past year the deep sewers of the locality were rendered available for the drainage of upwards of 1,000 houses, either by the construction of new branch drains or the adaptation of original drains to communicate therewith.

With the exception of one part of the district to which I allude hereafter, the existing requirements extend rather to the connexion of proper house drainage with the new sewers thus provided, than to laying down new lines, and I feel justified in stating that in the inhabited area, no special necessity exists for a system of new sewerage.

The district immediately abutting on the Blue Anchor road, however, is rapidly being covered with new buildings, and the land converted for building purposes. It possesses no low-level sewer available for the house drainage, which, pending the execution of the southern main drainage scheme, must temporarily be carried either into the open sewers, which ultimately communicate with the main Duffield or Earl sewers, or must reluctantly perpetuate the obnoxious cesspool accumulations. It is needless to add what a serious evil is in progress of development, and what injury is inflicted on the health of this district in the interim of suspense.

As Mr. Bazalgette's plan proposes to construct the northern branch of the low level intercepting sewer in the immediate vicinity, the vestry have had no alternative but to defer operations until the scheme

* In the Letters to the Surveyors of districts to the south of the Thames, April 3 was inserted, instead of May 22.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(1.) Bermondsey District.

scheme is finally determined, when effectual relief can be afforded and remedial measures adopted. Under these circumstances no estimate has been prepared.

Since the commencement of the Metropolis Local Management Act, the vestry have caused all the open sewers in inhabited districts, excepting for a distance of 180 yards, to be arched over, the remainder of the open sewers before referred to being situate in the uncovered area. The necessity for their continuance in existing situations will mainly depend on the future appropriation and arrangements for building purposes, and as the whole uncovered area from its proximity to the heart of the metropolis is likely to be built upon at no distant period, no adequate results would accrue from arching over the high level open sewers; I have therefore not prepared any estimates for arching them over until the main intercepting line which is intended to cross the district diagonally be resolved.

3. As to your inquiry whether the plan proposed by the Metropolitan Board of Works for main drainage, as described in Mr. Bazalgette's reports, will be sufficient for the Bermondsey district, and whether there will be any sewer in the district at such a low level as not to be susceptible of efficient drainage by the proposed works:

It is important to observe that the whole of Bermondsey is embraced within the low lying district south of the Thames, the minimum surface levels ascertained from the Ordnance maps being four feet, and the maximum 15 feet 9 inches above Ordnance datum, showing that the extreme variation in surface levels throughout the parish scarcely amounts to 12 feet, while the natural surface of the ground is almost entirely below Trinity high-water mark.

I feel it unnecessary to refer to the existing condition of the sewers which for 18 hours daily become tide-locked, and reservoirs of stagnant sewage.

To provide an improved outfall is the obvious leading desideratum, whereby a continual and uninterrupted flow may be maintained, and their contents constantly discharged. Whether in a district which like this possesses no means naturally of drainage by gravitation, the plan propounded by Mr. Bazalgette will accomplish that desirable object, appears the simple question.

The words of his report* are, "Low Level or Bermondsey Branch.—This branch commences at St. James's Church, Bermondsey, at which point it forms a connexion with, and supplies an outfall to the Battle-bridge, the Earl, the Great St. John's, and the Duffield sewers, and thus completes the interception of the sewage from the low district."

The four arterial lines by which this district is now exclusively drained are thus united at one point, viz., St. James's Church, where the invert of the intercepting line is to be 6 ft. 10 in. below Ordnance datum, with a fall from thence towards the pumping station at Deptford Creek at the rate of 1 in 1,214, or 4·35 feet per mile.

I am of opinion that Mr. Bazalgette's plan, so far as it affects the particular locality under my charge, will fulfil the required conditions, and that there will be no sewer in the district at such a low level as not to be susceptible of efficient drainage, conditionally upon the proposed engine power and pumping apparatus proving sufficient to pump up the contents of the sewers at the Deptford and Woolwich stations.

The report does not appear to explain in what manner that portion of the Duffield sewer situate between Saint James's Church and the River Thames is to be adapted, in order that the property which now discharges into it may derive the advantages of the interception.

If it be intended to lay down a false bottom with reversed fall towards St. James's Church, I have no objections to offer; but if, as I understand, these original outlets are also to serve as storm overflows at extraordinary periods, I conceive that the property so situated will be subject to back water as before.

4. As to any general information on the state of the drainage in my district, with a description of any floodings which may have occurred from defects of the main drainage, I feel bound to repeat that the district suffers, not so much from want of sewers to receive the house drainage, as from want of sufficient outlets to discharge their contents.

The floodings which have occasionally occurred in basements and cellars naturally result from the sewers at high water with closed outlets becoming overcharged concurrently with extraordinary storms and rain-fall; the waters which thus rapidly descend from the higher districts under the existing system are unable to find a vent, and thereby inundate a large extent of property.

The experience of such floodings induces me to approve the construction of a high level intercepting sewer for the upland districts in which drainage by gravitation can practically be accomplished; and I have no doubt that in a district like Bermondsey, owing to the peculiar manufacturing processes and the recent enactments enforcing water supply, a very large quantity of waste water must inevitably pass through the sewers; whilst the additional means afforded for flushing the sewers by the numerous tidal culverts in this parish will compensate for insufficiency of fall, and ensure their reasonable freedom from deposit.

I am, &c.

(signed) *Geo. Elkington*,

Herbert C. Saunders, Esq. Surveyor to the Vestry of the Parish of Bermondsey.

29, Great George-street, Westminster.

(2.) Bethnal Green District.

(2.) Bethnal Green District.

(i.)

Sir, Town Hall, Church-row, 6 April 1856.

In reply to your letter of the 25th of March, I beg to say I am unable to furnish the information you require, being at present fully occupied for the vestry, and not having at my command the means of employing persons to take the measure and make the various estimates for which you apply.

I remain, &c.

To Herbert C. Saunders, Esq. (signed) *Thos. H. Bainbridge.*

(ii.)

Sir, Town Hall, Church-row, Bethnal-green, 22 April 1857.

In answer to yours of the 16th instant, I am sorry to say it is not in my power to answer the inquiries in yours on the 25th March; to answer either inquiry would occupy time which I am wholly unable to give.

I am, &c.

To Herbert Saunders, Esq. (signed) *Thos. H. Bainbridge*, Surveyor.

* *Vide* page 18.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(3.) Camberwell District.

(3.) Camberwell District.

Vestry Hall, Camberwell, 7 April 1857.

Gentlemen,

In compliance with your request, I forward the following information as to the drainage of this parish, in reference to the "main drainage of the metropolis."

1. The length of covered sewers in the Camberwell district:—

	Miles.	
* Low Level Brick Sewers	2	
" Pipe "	1	
		3
High Level Brick "	12	
" Pipe "	3½	
		15½
		18½

These "low level" brick and pipe sewers will eventually form portions of the permanent local sewerage, as will also to a small extent some of the high level sewers, by the construction of the proposed intercepting local lines, which will render them permanently available for short lines of drainage; the remainder being for the most part ancient archings of the primary watercourses of the district are, either from their imperfect levels or impaired condition, not suited for an improved system of drainage.

2. The length of open sewers in the Camberwell district and the estimated cost of re-constructing and covering the same.

The length of open sewers, 10 miles.†

As to the expense of covering these open sewers. In but few cases do I propose to incur this cost; the following will explain:—Many of them are situate in a suburban locality, and consequently at present but little fouled by house drainage, which, by the adoption of remedial measures, can be easily removed; they can consequently remain to perform their original functions, viz., the passage of surface water only; others of these open sewers now receiving foul drainage to a somewhat greater extent, it is proposed to maintain (temporarily) pending the execution of local permanent works, and also the anticipated main works of the Metropolitan Board, in as sanatory condition as possible, by means of flushing and cleansing. To arch over these sewers with their present outfalls and defective levels would incur an useless expenditure, without producing a corresponding benefit either to the property now temporarily draining into them or to the locality in the immediate vicinity; for, on the construction of the permanent drainage works, they will in most cases, after having the drainage diverted from them, be no longer required, or, if partially retained, will in their levels and sizes have to be adapted to the new lines of sewers above referred to.

Others of these open sewers, which, from their proximity to house property and consequent foul condition, it is proposed at once to arch over, in order to prevent the inevitable consequences which would ensue, should a cholera visitation take place; these works (and those of a similar description which the vestry executed during the past year to the extent of about two miles) will be so constructed as to become, as far as practicable, eventually useful for ultimate drainage. As I stated in my reply to the query No. 1, the remaining portions not so applicable for ultimate purposes, it is presumed will not have been without their beneficial uses in warding off the results which attend a neglected, foul, and imperfectly drained district.

3. The length of streets and places, exclusive of uncovered sewers which require to be drained, and the estimated cost of sewer works therein.

Availing myself of your permission, I beg to refer you to my printed report, in which, I believe, will be found full information on this head.

4. Whether the plan proposed by the Metropolitan Board of Works for the main drainage, as described in Mr. Bazalgette's reports, dated 3 April and 1 December 1856, will in your opinion be sufficient for the Camberwell district, and whether there will be any sewer at so low a level in the district as not to be susceptible of efficient drainage by the proposed works.

Begging permission again to refer you to my printed report, you will there find that I have, in laying out the proposed drainage of this parish, anticipated the execution of these main works, and consequently have accepted them as regards their projected levels as amply suited for the eventual drainage of the parish under my charge.

I beg to be permitted to qualify my approval of this or any other plan which may be submitted for a like object, and to adopt it solely for the reason that it accomplishes the one thing needful for this parish, and indeed for the whole of the marsh area south of the Thames, viz., an efficient and constant outlet, the necessity of which for the sewage and drainage of this low lying area need not be enlarged upon.

The lower stratum being a porous sand bed, even at a distance from the river Thames, experiences the influence of the pressure of the tide, and is kept constantly saturated, as has been frequently found during the execution of deep excavations, and therefore affords no means of percolation to the soil above it, the effect produced being evaporation instead of percolation, consequently spreading its moisture around to the injury of the health of the inhabitants of the surrounding locality.

This effect, so much to be deplored, will, I anticipate, be removed by the introduction of the deep level sewers, by cutting off the sub-tidal influence below their course, and drawing into such sewers the subsoil drainage of the land above it; and they will remove from this area, upon which house property is now so rapidly extending, one of the greatest evils to which it is subjected, and from which its occupants consequently suffer.

I need not refer to the beneficial effects of deep drainage as regard the removal of sewage matters from crowded localities, which also will be effected by improved sewerage.

In reply to your last request "for any general information as to the state of this district, with a description of any floodings which may have occurred from the defects of the main drainage," I would observe that,—

As to the floodings experienced within this area, I have known many such occur, and have taken much pains to ascertain the causes, which are these. The present sewer outlets, being tide-locked for several hours during each tide, the existing sewers during these intervals, instead of performing the duty of channels for the passage of the sewerage, become mere accumulating reservoirs, and when storms take place they become overgorged, and the consequent backing up of the water occurs in the collateral sewers, which eventually forces itself into the house property through the house drains. The

* This does not include those brick sewers within this parish which are scheduled in the Metropolitan Local Management Act as "main sewers."

† This length does not include those open sewers within this parish scheduled in the Metropolitan Local Management Act as "main sewers."

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(3.) Camberwell District.

The absolute necessity of a remedy to prevent these results was foreseen by the late Surrey and Kent Commissioners of Sewers with whom I was connected, and they had it in contemplation (when that body was superseded by the Metropolitan Commissioners of Sewers) to carry into effect a high level line of drainage, to intercept the hill water, and prevent the flooding referred to. I therefore consider an upper level line of sewerage to effect this result a necessary adjunct to any scheme which may be proposed for like purposes.

I beg to say, although I scarcely venture to assume its necessity, that if the Referees should require any further information as to this particular locality, on the sewerage works of which I have been almost exclusively engaged, I shall be most happy to tender to them the results of my experience during the last 14 years.

Apologising for the length of this communication,

I am, &c.
(signed) *J. C. Reynolds*, Surveyor.

(4.) Chelsea District.

(4.) Chelsea District.

Surveyor's Office, Manor House, May 1857.

Sir,

With reference to your communication dated the 31st day of March last, I have to forward you for the information of the Referees, to which the main drainage of the Metropolis is referred, the several answers to the questions put for their information.

1. The length of the covered sewers in the Chelsea district is 25 miles and 3 furlongs.
2. The length of open sewer in the Chelsea district is 2,650 feet, and the cost of constructing covered sewers in lieu thereof is estimated at 364 *l.* 7 *s.* 6 *d.*, exclusive of the open Counters Creek sewer or Kensington canal.
3. The length of streets and places (irrespective of uncovered sewers) which require to be drained is 6,745 feet, and the estimated cost of the same 3,341 *l.* 13 *s.*

With respect to Mr. Bazalgette's report, dated 22 May, as to whether the contemplated sewer for the drainage of the Chelsea district would be sufficient, I am of opinion that the sewer in question and referred to in such report, would be sufficient, and the sewers as represented on the section accompanying such report are represented at a sufficient level to intercept the lowest sewer in the Chelsea district.

The floodings have occurred at periods in the houses in the proximity of the river in Cheyne Walk, Duke-street, Lombard-street, and Cremorne Road, by the river overflowing its banks during extraordinary spring tides, and not from any defects in the present drainage, the sewage or contents of which does not find its way into the houses even during such spring tides, but the river water only.

The present drainage of Chelsea is, generally speaking, effective, except in some few instances where the sewers are required to be reconstructed at a lower level, and dilapidated sewers reconstructed. A considerable quantity of new sewers have been built within the last few years. The only sewers required at the present time for house drainage in existing thoroughfares are described in the before-mentioned estimate.

I remain, &c.
(signed) *Joseph Pattisson*, Surveyor.

H. C. Saunders, Esq.

(5.) Clerkenwell District.

(5.) Clerkenwell District.

23, Upper Rosoman-street, Clerkenwell, 4 July 1857.

Sir,

In answer to yours of the 26th March last,

1st question. The length of covered sewers in this district, independent of main lines which are under the Metropolitan Board of Works, are as near as I can get them, 62,041 feet. Still I believe there are more, though not shown upon the plans furnished us by the late Metropolitan Commissioners of Sewers.

2d. No open sewers in this district.

3d. I cannot well answer, as many of the streets are apparently well drained on each side, either front or back. Such sewers I have not included in the length above.

I think the plans proposed by the Metropolitan Board of Works, as described in Mr. Bazalgette's reports, to be sufficient for this district.

There is no sewer in this district but would be efficiently drained by such works.

The drainage of the northern portion of this district, generally, is good; the sewers being of modern construction, with good falls.

The drainage of the southern portion, generally, is not good; the sewers principally being old, having upright sides and flat bottoms, with sluggish falls

Floodings there have been none since I have been in the district.

I am, &c.
(signed) *Sanders Bevan*, Surveyor.

Herbert C. Saunders, Esq.

(6.) Fulham District.

(6.) Fulham District.

Broadway House, Hammersmith,
18 July 1857.

Sir,

I beg herewith to enclose the requisite information relative to the sewerage of this district. On further information of the Referees on the main drainage question, I regret that I have not been able to furnish it earlier, but have been very much engaged.

I am, &c.
(signed) *Alf. C. Bean.*

H. Saunders, Esq.

To the Referees appointed by Her Majesty's Commissioners of Public Works to report on the Metropolitan Main Drainage.

Broadway House, Hammersmith,
14 July 1857.

Gentlemen,

I beg herewith to transmit you some information with respect to "the present state of the drainage of the Fulham district," and some suggestions thereon as to what in my judgment is requisite and necessary to improve it.

This information, although not strictly in direct answer to the question transmitted by you, will nevertheless, I trust, fulfil the end you have in view.

Without

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(6.) Fulham District.

Without taking up your time by entering on a description of the levels of this district, and with which I feel assured you are fully acquainted, I will at once proceed to describe the principal streets and thoroughfares, and the present provisions for drainage, and will introduce such suggestions for their improvement as I conceive to be necessary.

Commencing at the north-east end of Hammersmith parish, I find that the Latymer-road is drained by the west branch of the Counters Creek sewer.

Into this the adjoining streets are, I believe, well drained by 4 ft. × 2 ft. 6 in. brick sewer. The names of these streets, with the length of sewer to each, I herewith annex.

Clifton-street, 400 feet; St. George's-road, 500 feet; Devonshire-street, 480 feet; Queen's-road, 350 feet; Beaumont-street, 250 feet; Norland-road, 150 feet. Wood-lane is drained by an open ditch called the Brook Green sewer, and is at present but little used for house drainage. This is under the jurisdiction of the Metropolitan Board, and should be deepened and converted into a covered sewer as far as the dwelling-houses extend, viz., to a distance of about 1,250 feet.

The Uxbridge-road from the boundary of the metropolitan area to its eastern extremity, where it adjoins Kensington parish, is most imperfectly drained by open ditches, covered roadside ditches, and pipe-drains, the aggregate lengths of which are about 5,750 feet.

The main sewer suggested in the main drainage scheme, the length of which is 7,140 feet, will afford drainage for this road, and also provide outlets for streets abutting thereon.

The New-road from Starch Green to Brook Green-lane is at present imperfectly provided for by about 1,000 feet of 3 ft. 9 in. × 2 ft. 6 in. brick sewer, and about 3,000 feet of pipe and barrelled drains.

A main sewer 3,500 feet in length is here required of sufficient capacity to receive the drainage of the several streets at present entering it on each side, and provision should be made for future requirements, as the greater part of the ground is intended for building purposes; an outlet at a sufficiently low level would be afforded at Starch Green by the new sewer recently constructed (the main line of the Stamford Brook), or should the Brook Green sewer be reconstructed (which is necessary), an outfall would also be afforded at Shepherd's Bush, and the New-road sewer could be constructed with a fall each way.

New-road from Starch Green to the high road to Turnham Green, about 3,500 feet.

A suggestion has been made to the Metropolitan Board to divert the western branch of the Stamford Brook sewer at the point where it crosses the New-road, and to carry it southward along the New-road to the Great Western-road, from thence eastward to join the main line at the south end of the Albion-road; by so doing, the new road to the extent of 1,300 feet will be provided for, and an abominable open ditch (a source of annoyance to a considerable area) got rid of.

The remaining portion of the New-road can be readily drained by a sewer entering the main line at Starch Green, or into the new sewer here proposed.

King-street or High-road, from the western extremity of the parish to Albion-road, about 2,400 feet, would be provided for by the above-described sewer; it is at present most imperfectly drained by covered roadside ditches.

King-street, between the creek or main line Stamford Brook sewer, and Brook Green-lane 2,300 feet, at present most imperfectly provided for as above described. A sewer commencing at about the centre of this length, and running westward to the Stamford Brook sewer, and joining it at the creek, and a similar one commencing at or about the centre and running eastward to the Brook Green sewer, and joining it in the Broadway, would provide for this street, and also afford drainage for those streets abutting thereon, which are at present without drainage. Of the streets between King-street and the river, some are well provided for, viz., Bridge Avenue, Mall-road, and Bridge-road. Waterloo-street is without drainage, but could be readily drained into King-street sewer as here proposed, at the west end. St. Peter's road is tolerably well drained half its length, the other half is almost without drainage; St. Peter's-square imperfectly, and several other by-streets wholly without drainage; but all these could be readily drained by the system here proposed. Shaftesbury-road on the north side is well drained into the main line in Albion-road. Ravenscourt Park is wholly without drainage, but outfalls will be provided by the sewers here proposed.

Between Albion-road and Brook Green-lane there is a considerable area, part of which is imperfectly drained by the Grove sewer and the Cambridge-road sewers, but as arrangements for building are not yet perfectly defined, it would be futile to attempt any description of what is required; all that is at present necessary will be to provide sewers of sufficient capacity in King-street to receive a portion of the drainage of this district hereafter.

The continuation of King-street from the Broadway eastward, to the boundary of the district at the West London Railway, in length 4,200 feet, is imperfectly provided for to the extent of 3,100 feet, partly by a brick sewer, partly by covered roadside ditches, and pipe-drains here and there. A main sewer is required throughout the whole length, and which might be connected with the Brook Green sewer at the Broadway.

Brook Green-lane: the main sewer here which is an old one, and which has been formed from time to time by covering in an open ditch by the roadside, is very imperfect, and is not at a sufficiently low level to drain some of the adjacent lands, one portion of which north of Blythe-lane is a most unwholesome and noxious swamp.

Brook Green is also most imperfectly provided for by pipe-drains, and covered ditches; a line of sewer is much needed; this sewer, by a substitution of a brick for the present pipe-sewer in Masborough-road, would afford an outlet for the drainage of a considerable quantity of land, now in course of being built on to the north of Blythe-lane, and at present wholly without drainage.

An offensive open ditch, known as the Black Bull Ditch, forms the boundary between the parishes of Hammersmith and Fulham.

By the construction of the proposed sewer along King-street, east of the Broadway, a large quantity of sewage will be diverted from this channel to the entrance to Brook Green.

That portion of the ditch adjoining the river, and to the extent of 2,500 feet from its outlet should be diverted from its present channel, and a brick sewer of sufficient capacity for future requirements be constructed along the new roads which have been recently formed almost along the line of the old ditch. The sewer might subsequently be continued along the course of the ditch, or through such new roads or streets as may be formed along its line.

The parish of Fulham contains but a very small quantity of sewer, and the greater part of it is most imperfect, and wholly inadequate to its requirements.

Fulham town has a main sewer vested in the Metropolitan Board, and which is very imperfect, and which runs at the backs and under many of the houses on the west side of the street; the east side is therefore almost wholly unprovided for.

The main drainage scheme does not appear to me to provide for the requisite alteration here, but simply provides a branch from the mouth of the sewer running in a north-easterly direction along the King's-road, and joining the intercepting sewer near Eel Brook-common.

If this were carried along Fulham High-street, and along the London-road to Walham Green, it appears to me that the same object might be attained, and it would give a greater amount of facility for house drainage in its course.

Branch sewers might then be connected with it from the several side streets from time to time as necessity arose.

The King's-road, at present wholly without drainage, would be drained into the main intercepting line,

line, and that portion near the town of Fulham, by a line down Church-street to the head of the Fulham branch.

The main road from Hammersmith-gate to Walham Green is quite without sewerage, although it is built on almost throughout its entire length on each side of the road.

A sewer from end to end is requisite to join the main line at Walham Green, of sufficient capacity to receive a considerable amount of collateral drainage, as the market-garden ground on each side will in all probability at no very distant day be covered with buildings; the length of this line is about 6,000 feet.

The London-road, between Walham Green and Stamford Bridge, has a good brick sewer of about 1,600 feet in length, and a continuation of pipe-sewer to a distance of about 1,400 feet; this at present discharges itself into the canal, and does not appear to me to be in any way intercepted by the proposed scheme. Lilly-road has also a similar sewer about 1,100 feet in length, also discharging itself into the canal; these, I apprehend, will eventually have either to have the falls reversed, or to be carried under the bed of the canal to the main Counters Creek line. The open ditches in the two parishes are numerous, but none of them appear to me to be in such situations as would render it desirable to cover them in as sewers; most of them by the system of drainage here proposed will be rendered unnecessary, and may be filled up.

With regard to the inquiry as to whether, in my opinion, Mr. Bazalgette's plan is sufficient for the Fulham district, I beg to say that after a most careful examination, and having also had the good fortune to hear Mr. Bazalgette's personal explanation of the scheme, I am of opinion that it is sufficient for the purpose proposed; but at the same time, I would venture to submit, that the alteration of the course of the Fulham branch as herein suggested will be an improvement. I also beg to say, that there is no sewer at present in the district at so low a level as not to be susceptible of efficient drainage by the proposed works.

With reference to occasional floodings, I have no personal knowledge of such an event during upwards of 20 years' residence in the neighbourhood, but I have been informed that the lower parts of Fulham-fields have been occasionally under water for some little time, owing, I should imagine, to tidal influences combined with heavy rain-falls. I am not aware that I can furnish you with any further information, but will readily answer any inquiries you may be pleased to make, if in my power to do so.

I am, &c.
(signed) *Alfred C. Bean*,
Surveyor to the Fulham District Board of Works.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(6.) Fulham District.

(7.) Greenwich District.

(7.) Greenwich District.

(i.)

Sir, Offices, Church-street, Greenwich, S. E., 27 March 1857.

I beg leave to acknowledge the receipt of your letter of the 26th instant, and to inform you that the same shall be laid before the Board of Works for this district at their next meeting.

I am, &c.,
(signed) *J. Nidd Smith*,
Surveyor to the Board

To Herbert Saunders, Esq.

(ii.)

Re Drainage, Greenwich Drainage.

Sir, Offices, Church-street, Greenwich, S. E., 15 May 1857.

The following is a reply to your letter of the 26th March 1857; taken *seriatim*.

1. The length of covered sewers in the Greenwich district is about 88,697 feet.

2. The length of open sewers in the Greenwich district, including all ditches under the management and control of the Greenwich District Board, situate in the Greenwich marshes, and in the several market gardens, is about 33,850 feet, and the cost of reconstructing and covering the same, about 13,817 *l.*

3. The length of streets and places, exclusive of uncovered sewers which are not already drained, is about 145,232 feet, and the cost of the sewers' works thereon (exclusive of sewer works proposed to be carried out by the Metropolitan Board of Works) is about 64,436 *l.*

I have also to state, that in my opinion the plan proposed by the Metropolitan Board of Works for the main drainage, as described in Mr. Bazalgette's reports of the 3d of April 1856, and 1st December 1856, is (so far as the level given in sections attached to said reports) sufficient for the drainage of this district.

The sewers on the north side of the low-level intercepting sewer in the parishes of St. Paul and St. Nicholas, Deptford, will have to be reversed, at a cost of about 3,261 *l.*

Also, the sewers on the north side of the high-level intercepting sewer in the parish of Greenwich will have to be reversed, at a cost of about 5,218 *l.*

With reference to the last portion of the letter I have to state, that the overflowing of the sewers in East-lane, Church-street, and Horseferry-road, Greenwich, and also Mill-lane, Deptford, have occasioned some damage to houses in their immediate vicinity.

The sewage from the high-level portions of the district being precipitated into the low-level portions, which are tide-locked for nearly 18 hours out of the 24, become rapidly filled, and during storms they are so overcharged as to cause the sullage therefrom to overflow cellars and premises adjacent thereto, and therefore during the hours before mentioned they are nothing less than elongated cesspools.

It is not possible, I think, to conceive a worse state of things. The basement of houses being covered with stagnant sewage become at once the seat of disease and pestilence.

I am, &c.
(signed) *J. Nidd Smith*,
Surveyor to the Board.

To Herbert C. Saunders, Esq.

(8.) Hackney District.

(8.) Hackney District.

(i.)

Sir, Surveyor's Office, Town Hall, Hackney, 6 April 1857.

I beg to acknowledge the receipt of your letter, dated 4th April 1857, and to inform you that it will be laid before the Board on Thursday next.

I remain, &c.
(signed) *James Lovegrove*,
Surveyor.

Herbert C. Saunders, Esq.,
29, Gt. George-street, Westminster.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(8.) Hackney District.

(ii.)

Town Hall, Church-street, Hackney, 25 April 1857.

Sir,

In accordance with the order of the Board I beg to forward herewith three copies of my report on the main drainage of the Metropolis, and also to inform you that there are about 16 miles of covered sewers in the Hackney district, and seven miles of open sewers, the Hackney Brook inclusive.

In my report on the sewerage of the district, already in your possession, provision is made for diverting or covering over the greater part of the open sewers vested in this Board, and also for the drainage of all streets and places in this district which require to be drained.

I am, &c.

(signed) *James Lovegrove*,
Surveyor to the Board.

Herbert C. Saunders, Esq.,
29, Gt. George-street, Westminster.

(9.) Hampstead District.

(9.) Hampstead District.

Surveyor's Office, New End, 9 June 1857.

Sir,

In answer to your letter to me of the 17th April last on the subject of main drainage of the Metropolis, I have delayed answering your questions on the subject of local drainage until I was in possession of full information of its future requirements, &c.

Question 1st. The length of covered sewers for permanent use is about six miles, all recently constructed, exclusive of about three miles and a half of main sewers, under the jurisdiction of the Metropolitan Board.

Question 2. The length of open sewers and watercourses is about 14 miles, and the estimated cost will be about 55,300 *l.* to cover the same.

Question 3. The length of streets and places which require to be drained is about seven and a half miles, and the estimated cost about 21,000 *l.*

I have every reason to believe that Mr. Bazalgette's proposed scheme of intercepting sewers will be found to be in every respect well adapted for the efficient drainage of this parish.

Floodings did occur previous to the execution of the main line of sewer, known as the Fleet Sewer, commencing at Flask Walk and terminating at the parish boundary in Gospel Oak Fields; we have had no flooding since.

Trusting this may be in time,

I am, &c.

(signed) *John Douglas*,
Surveyor.

Herbert C. Saunders, Esq.

(10.) Holborn District.

(10.) Holborn District.

Surveyor's Department, Little Gray's-inn-lane, 4 May, 1857.

Sir,

I beg leave to forward for the information of the Referees appointed to consider and report upon the plan proposed for the main drainage of the Metropolis by the Metropolitan Board of Works, the following particulars in answer to your circular letter of the 17th ult.

1. The total length of covered sewers in the Holborn district is 9 miles 1,364 yards.
2. There are no open sewers or uncovered ditches in the Holborn district.
3. The length of sewers required to be constructed and reconstructed is 1 mile 1,182 yards, and the estimated cost of the work is 5,600 *l.*

It must be understood, however, that this sum does not represent the whole amount that is required to put the sewerage of the district in an efficient state, inasmuch as a large additional amount will have to be expended in maintaining the existing works, and in the alteration of the present levels, which may be described generally as being far from satisfactory, and capable of considerable amendment.

I may here state, in answer to your request for information as to the state of the drainage of the district, that the representations put forth by the late Holborn and Finsbury Commissioners of Sewers were calculated materially to mislead the public with reference to the efficiency of the sewers in their charge, their design, and the method of construction employed.

I had been led to anticipate from these representations that the works already in existence would not have required any considerable amount of outlay either for their maintenance or amendment, and that the rates levied by this Board could have been devoted to the construction of new sewers in those portions of the district at present unprovided; but, in the reports presented by me from time to time, I have had occasion to regret my inability to employ the rates for this desirable object through the great absorption of funds consequent upon the reparation of evils, whose existence is in no way attributable to this Board.

With reference to the floodings that have occurred in this district, I find that several have taken place along the valley of the Fleet, which is the outfall of the greater part of the drainage of this and adjoining districts, and that in the month of August 1846, a flooding was experienced in this part which was productive of serious mischief, and entailed the loss of property to a large extent. I believe this flooding may be mainly attributed to the fact of the Fleet river at that time containing many obstructions to the passage of the heavy volume of storm water committed to it, and the circuitous route it then took; but the alterations which have been effected in this line by the late Metropolitan Commissioners of Sewers will prevent the recurrence of any floodings for the future.

The information desired as to the sufficiency of the plan proposed for the main drainage by the Metropolitan Board of Works to meet the requirements of the Holborn district, has necessitated a careful consideration of that plan on my part, and, after closely examining the sections of the proposed intercepting sewers attached to the published reports of Mr. Bazalgette, the Engineer-in-chief, I am of opinion that these sewers will be sufficient for the Holborn district, and their levels such as to afford efficient drainage for the lowest portions of the district; but, with reference to the Piccadilly branch which is designed to traverse a portion of this district, I would particularly call your attention to its capability as to size to drain the area embraced by it. It intercepts in its course several main sewers which are daily charged with large quantities of water, and, I fear, its proposed capacity will prove insufficient for the purpose; and, as it is intended to pass through a densely populated district along its whole course, any flooding that might occur would be productive of very serious mischief.

I would also direct the attention of the Referees to that part of the Engineer's report of the 22d of May 1856, which describes the interception of the Fleet at the bottom of Back-hill. The proposed sewer at that point will be some feet above the invert of the Fleet in Warner-street, and I am unable to see how the sewer in question can be intercepted, unless a long length of branch sewer is constructed running by the side of the Fleet until the difference of level is overcome.

Reference certainly is made in the report to a branch "from the Fleet into the intercepting sewer," but it might be implied from the slight allusion thereto, that this would be little more than a simple junction.

It

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(10.) Holborn District.

It will be seen that these remarks apply to the main drainage scheme simply as far as the requirements of this district are concerned, and it must be understood that my approval of the proposed plan has reference only to this district, and not to the scheme in its entirety.

I feel it my duty to add, that as from my examination of the plan as it affects this district, the necessity of modification has become apparent in points that can scarcely be considered detail, I should recommend that great caution should be exercised in its consideration, as it affects adjoining districts and London generally, since it might be found that additional modifications might still be needed to ensure a perfect system of intercepting drainage for this great Metropolis.

I have, &c.

(signed) *Lewis H. Isaacs*,
Surveyor to the Board.

Herbert C. Saunders, Esq.,
29, Great George-street, Westminster.

(11.) Islington District.

(11.) Islington District.

(i.)

Vestry Offices, 21 Milner-square, 9 April 1857.

Sir,

Your communication of the 26th of March has been laid before the Sewers and Buildings' Committee, and I beg to inform you that I have been directed by them to prepare a Report embodying the particulars you require. This I hope to lay before them at their next meeting, after which I will communicate to you the result.

I am, &c.

(signed) *Chas. Higgins*,
Surveyor.

H. C. Saunders, Esq.,
29, Great George-street, Westminster.

P.S. Mr. Bazalgette's Report of the 1st of December 1856 has not been forwarded to this office: will you oblige me by sending a copy? *C. H.*

(ii.)

Main Drainage, Metropolis.

Vestry Offices, 21 Milner-square, 30 April 1857.

Sir,

With reference to your communications of the 12th February and the 17th and 26th March last, I am directed by the Sewers and Buildings' Committee to forward you a copy of the Report presented to them by their surveyor, and to inform you that the Surveyor has been instructed to give any further information you may require.

I am, &c.,

(signed) *Adam J. Berry*,
Chief Clerk.

H. C. Saunders, Esq.,
29, Great George-street, Westminster.

Enclosure in (ii.)

Main Drainage, Metropolis.

To the Sewers, Drains, and Buildings' Committee.

The Vestry of St. *Mary, Islington*.

Gentlemen,

In obedience to your directions that I should prepare a Report, giving the information required by the Referees appointed by the First Commissioner of Her Majesty's Works, in their communications of the 12th February and the 17th and 26th March last, I beg most respectfully to report as follows, viz:

That at Christmas 1856 there were 45 miles 1,343 yards of covered sewers (see my Report to the Vestry of 11th February, a copy of which accompanies this), and six miles 1,106 yards of open sewers.

20,910 feet of these sewers are in open fields conveying very little sewerage, and their present course would probably be diverted when the ground is built upon; it would therefore be an unnecessary expense to cover them in their present course: the lengths and sizes for such as require to be covered are 1,850 feet of 3′ 9″ × 2′ 6″, 5,020 feet of 3′ 0″ × 2′ 0″, 1,550 feet of 2′ 0″ × 2′ 0″, and 5,670 feet of 12-inch pipe. Total, 14,090 feet: the estimated cost is 3,683 *l.*

In answer to the inquiry contained in the letter of 26th March, viz., "What is the length of streets and places, exclusive of uncovered sewers, which require to be drained, and the estimated cost of the sewer works thereon?" I beg to refer to the accompanying statement, the details of which are given at the end.

Most of the streets and places in this parish are either directly or indirectly drained into a sewer of some description; the subjoined list contains the names of places where either no sewers at present exist, or where they are of such a shallow and defective description as to be inadequate for the drainage of their localities, and in which new or reconstructed sewers will be required. The lengths are 25,920 feet of 3′ 9″ × 2′ 6″, 21,070 feet of 3′ 0″ × 2′ 0″, 250 feet of 18-inch and 24,590 feet of 12-inch pipe. Total length, 71,830 feet; estimated cost, 31,143 *l.*

With reference to Mr. Bazalgette's plan for the main drainage, so far as applies to this parish, it is part of his scheme that the whole of the sewerage of the district should be delivered into the Thames by gravitation, or without pumping, and that the northern or Holloway portion of the parish will have its outfall into the high-level sewer, which has better gradients and a greater fall than any of the other lines. The sewers of the southern and eastern portion of this parish will have their outlets, as at present, into the adjoining parishes, where they will be intercepted by the middle level sewer, the gradient of which is proposed to be only 1 in 2,640. There being a fall of about 50 feet from the lowest portion of the parish to the middle intercepting sewer, no possible inconvenience could arise to the Islington district; but I suggest that it would be more advantageous to divert nearly the whole of the Islington waters into the northern high-level sewer.

That portion of the main drainage, the high level sewer as proposed by Mr. Bazalgette, will in my opinion be sufficient for this parish, and will provide an efficient outlet for the northern or Holloway district, where floodings are of frequent occurrence; for instance, on the 9th January last the water was two feet above the top of the culvert, under the Great Northern Railway near the Hornsey-road.

I cannot conclude this Report without drawing attention, not only to the great expense proposed to be incurred in constructing the main drainage works, but the large amount which will require to be expended annually in working and keeping them in repair; there is not only the cost of pumping the water from the low level sewers, but upwards of 7¼ miles of a super iron sewer or aqueduct, with two, three, and four channels, will have to be kept from leaking and in thorough repair; and I am of opinion that the silt and heavy deposit will have to be removed from the sewers which have small gradients by hand labour.

I would suggest, as one method of reducing the annual cost, that an undershot water-wheel should be fixed, and such arrangements made that the water of the high level sewer should lift the water from the low level sewers, and steam power used only as an auxiliary to the water-wheel, and thus save a large annual cost.

(signed) *Chas. Higgins*,
Surveyor of Sewers and Buildings.

22 April 1857.

Appendix to Report from Surveyor of the *Islington* District.

A.

The Vestry of *St. Mary, Islington.*

List of Streets and Places where New Sewers are required, showing Length and proposed Sizes.

Number of Ordnance Sheet.	LOCALITY.	3′ 9″ × 2′ 6″	3′ 0″ × 2′ 0″	12-in. pipe.
		Feet.	*Feet.*	*Feet.*
365	New Wharf-road	—	—	340
365	Edward-street	—	—	350
„		—	—	240
366	George's-yard	—	500	—
„	City-road	—	380	—
„	Rodney-street, North	—	—	200
„	Rodney-place	—	—	
		—	500	—
367	Duncan-street	360	440	—
„	Duncan-terrace	—	300	—
„	Sidney-grove	—	—	240
„	Sidney-place	—	—	
		3,900	—	—
338	Maiden-lane	—	820	—
„	Junction-road	—	—	620
„	East-street	—	—	520
„	Rivers-street	—	520	—
„	Sidney-street	—	—	500
„	Bath-place	—	—	600
„	London-street	—	—	540
339	Bingfield-street	—	—	420
„	Stanmore-street	—	—	430
„	Twyford-street	—	—	520
„	Catherine-street	—	—	320
„	Edward-crescent	—	—	420
„	Copenhagen-street	—	—	120
„	Payne-street	—	—	430
„	Vittoria-place and part of street	—	—	200
„	William-street	—	—	400
„	Milton's-yard	—	—	300
„	Elizabeth-terrace	—	—	300
„	Denmark-street	—	—	540
„	White Conduit-grove	—	—	500
340	Church-lane	—	—	160
„	Chapel-street	—	—	130
„	Paradise-court	—	—	140
„	Brewer's-yard	—	—	400
„	Chalton-crescent	—	—	300
„	George-street	1,000	—	—
„	High-street	500	—	—
„	Islington-green	—	—	600
„	Paradise-place and Victoria-place	—	—	450
„	Angler's-gardens	—	1,500	—
„	New Packington-street	—	700	—
„	Queen's Head-lane	—	—	460
„	Linton-street, South	—	640	—
311	Brandon-road	—	480	—
„	Belle Isle-shoot	—	—	400
„	Alfred-street	—	—	500
„	Almina-road	—	—	360
„	Back of ditto	—	—	

Number of Ordnance Sheet.	LOCALITY.	3′ 9″ × 2′ 6″	3′ 0″ × 2′ 0″	2-inch Pipe.
		Feet.	*Feet.*	*Feet.*
312	Clayton-street	—	—	500
„	Roman-road	1,400	—	—
„	Grove-street	—	—	440
„	Albany-road	—	660	—
„	Liverpool-road	1,000	—	—
„	Brooksby-street	—	—	200
„	Barnsbury-square, 250 feet of 1′ 6″ × 1′ 6″	—	—	—
313	Compton-terrace and Upper-street	500	460	—
„	Compton-mews	—	—	200
„	Carter's-yard	—	—	200
„	Northampton-mews	—	—	700
„	Canonbury-lane	—	—	300
„	Canonbury-square	—	160	500
„	Belinda-street	—	—	340
„	Allan-street	—	—	300
„	Canonbury-street	—	620	—
„	Northampton-street	—	—	500
314	Motts-lane	—	—	540
205	Caledonian-road	900	—	—
285	Goodwin-street	360	—	—
„	Eden-place	—	—	240
„	Upper Victoria-road	—	600	—
„	Adam and Eve-lane	—	600	—
„	Aston-buildings	—	—	160
„	Nelson-place	—	—	160
„	Highbury-crescent, West	—	700	—
„	Holloway-road	1,700	600	—
„	Palmer's Mews	—	—	300
„	Madras-place	—	360	—
„	Albion-road	—	200	400
„	Union-road	—	—	500
286	Highbury-place	—	1,000	500
„	Highbury-crescent	—	1,200	700
„	Highbury-grove	—	1,200	—
„	Canonbury-park	—	150	—
„	Compton-road	—	300	500
„	St. Paul's-road	1,000	—	—
287	Newington-green	—	600	400
„	Newington-road	400	300	—
„	Mildmay-park	600	—	—
„	Suffolk-place	—	—	200
„	Arundel Grove and Street	—	—	300
288	Bentley-terrace	—	—	300
257	William-street	—	—	400
„	College-road	60	—	—
259	Park-place, South	—	—	440
„	Coach-and-horses-lane	600	—	—
„	Junction-road	2,000	—	—
231	John-street	—	300	420
„	Tavistock-terrace	—	460	—
232	Seven Sisters-road	1,340	—	—
„	Hornsey-road	4,000	—	—
205	St. John's-road, Upper Holloway	1,000	360	—
„	Highgate-hill	—	800	—
„	Highgate-archway	—	1,260	—
206	Red Cap-lane	—	600	—
207	Tollington-park	2,500	—	—
206	National Freehold Land Society	800	800	1,000
	Totals	25,920	21,070	24,690
312	Barnsbury-square, 250 feet of 1′ 6″ × 1′ 6″.			

Total Length — 71,830 feet.

Total Cost — £. 31,143

Chas. Higgins.

22 April 1857.

B.

OPEN SEWERS.

Number of Ordnance Sheet.	LOCALITY.	LENGTH.
181	East side of Hornsey-road, near Boundary	1,410
182	Near the Hanley-road	1,800
205	Near the Small-pox Hospital, Holloway	300
206	East and west sides of Hornsey-road, and south side of the Holloway-road.	1,740
207	Harrington-grove, Stroud Green-lane, and Tollington-park	4,000
230	Eastward of Junction-road, Upper Holloway	5,40
231	Eastward and westward of Holloway-road	10,250
232	Various parts of Sheet	5,600
233	West side of Black Stock-lane	620
256	Eastward of Maiden-lane	500
257	Top of Sheet	820
259	West side of Highbury Park-road	1,860
260	Westward of the Green-lanes	700
	TOTAL	35,000

C.

LENGTH of OPEN SEWERS which at the present Time require Covering over.

N.B.—These lengths form a portion of the lengths given above.

Number of Ordnance Sheet.	LOCALITY.	3′ 9″ × 2′ 6″	3′ 0″ × 2′ 0″	2′ 0″ × 2′ 0″	12-inch Pipe.
		Feet.	*Feet.*	*Feet.*	*Feet.*
181	East side of Hornsey-road, near Boundary.	-	-	-	1,410
205	Near Small-pox Hospital	-	-	-	300
231	Half Moon-fields	-	-	1,550	—
206	Near Ray-crescent, Hornsey-road	250	—	—	—
233	West side of Black Stock-lane	-	620	—	—
259	West side of Highbury Park-road	-	800	-	1,060
232	Outlet for Seven Sisters'-road	1,600	—	—	—
260	Westward of the Green-lanes	-	-	-	700
182	Near the Hanley-road	-	600	-	1,200
207	Harrington Grove, Tollington Park, and Stroud Green-lane.	-	3,000	-	1,000
	TOTAL	1,850	5,020	1,550	5,670

TOTAL Length - - - - - 14,090 feet.

TOTAL Cost - - - - - £. 3,683

22 April 1857. *Chas. Higgins*, Surveyor.

D.

REPORT of the Surveyor of Sewers, Drains, and Buildings, for the Year 1856.

THE VESTRY OF ST. MARY, ISLINGTON.

To the Sewers, Drains, and Buildings' Committee.

Gentlemen,

IN obedience to your directions, I herewith submit my first annual Report of Works in connexion with your committee, ending the 31st December 1856.

On the 1st January 1856, when the sewers in the parish of St. Mary, Islington, became vested in the vestry of this parish, there were 45 miles 1,343 yards of various sized sewers and 875 gullies. Out of this length of sewer only 28 miles 193 yards were under flushing operations at the time the sewers' committee was constituted; and I have the pleasure to inform you, that there is 34 miles 160 yards at the present time under constant flushing operations, which, together with cleansing the gullies, washing of the courts and alleys in the High-street, &c., have cost the sum of 320*l*.

The following works have been constructed by the vestry:—

Length in Feet.	Size of Sewer.	LOCALITY.	COST.
	Ft. In. *Ft. In.*		*£. s. d.*
837	3 6 × 2 6	John-street, Liverpool-road	550 11 2
402	3 0 × 2 0	Highgate-hill	124 0 3½
241	3 0 × 2 0	Shepperton-street	141 12 1
104	9-inch	Windsor-street	16 4 6½
16	12-inch		
127	3 9 × 2 6	Upper Park-street	79 0 6
200	3 0 × 2 0	St. John's-street, Queen's Head-lane	89 16 9
			1,001 5 4
		No. 53, new gullies and shoots	242 1 9
		One side entrance	6 18 1½
		Repairs to sewers, gullies, ventilating shafts, flushing shafts, drains and traps to gullies	160 18 5½
		Iron-work supplied to new sewers constructed at private expense	38 12 3
		New house-drain mouths and traps	188 17 1
		Incidentals, including outlet for urinals, at Ball's-pond and Islington-green	16 4 2
			1,654 17 2
		As contribution towards the above works you have received for new sewers, &c. £. s. d. 124 7 –	
		House-drain connexions 232 12 1	
			356 19 1
		The actual amount for works out of the rates being £.	1,298 18 1

The following works have been executed at private expense, the details of which are shown in the record of private works:—

Length in Feet.	Size of Sewer.	LOCALITY.	COST.
	Ft. In. *Ft. In.*		*£. s. d.*
110	3 0 × 2 0	Highgate-hill	41 5 –
1,167	3 9 × 2 6	Shadwell, Blenheim, Cottenham and Trafalgar-roads	529 6 –
600	12-inch		
746	3 0 × 2 0	Conduit and other new roads, Park-road, Holloway	266 5 –
236	12-inch		
576	12-inch	Mildmay-grove, South	86 8 –
784	3 9 × 2 6	New-road, Holloway	315 12 –
550	12-inch	Wyndham-crescent and Junction-road, Holloway	75 12 6
47	3 0 × 2 0	Cardigan-street	84 5 –
220	12-inch	Queen-square, Holloway	30 5 –
80	12-inch	Brewer's-yard	10 – –
80	12-inch	Mildmay-road	12 – –
144	1 6 × 1 6	Camden-passage	36 – –
70	12-inch	Goldsmith's-place	9 12 6
64	12-inch	Arundel-road	8 16 –
190	9-inch	Holloway Nursery	23 15 –
100	12-inch	Orchard-street	13 15 –
		5,764 feet—3 side entrances, 10 ventilating shafts and 13 gullies	1,540 17 –
		976 houses drained, which have involved the laying down of the following lengths of pipes:—	
		408 feet of 12-inch	
		11,913 feet of 9-inch	
		34,200 feet of 6-inch	
		11,348 feet of 4-inch	
		Making a total of 57,869 feet, or nearly 11 miles of various sized pipes used in draining the 976 houses, at a cost of	7,030 4 –
		TOTAL of works executed at private expense £.	8,571 1 –

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

The cost of the work superintended during the twelve months is as follows:—

	£.	s.	d.
Cleansing	320	–	–
Work executed by contract	1,654	17	2
Ditto at private expense	8,571	1	–
TOTAL	£.10,545	18	2

(11.) Islington District.

In accordance with the Metropolis Local Management Act, notices have been given of the proposed erection of 552 new buildings, the whole of which have been laid before you, accompanied with reports, and have been dealt with in a manner best suited for the convenience of the public; the free circulation of light and air, and that essential for all buildings, efficient drainage and sewerage.

Two persons were summoned to the police court, during the year, for illegally breaking into sewers; convictions against them were obtained, and the parties paid the expense of making the damage good.

I have, &c.
(signed) *Chas. Higgins,*
Surveyor of Sewers and Buildings.

11 February 1857.

(12.) Kensington District.

(12.) KENSINGTON DISTRICT.

Vestry Hall, Kensington, Surveyor's Department,
9 July 1857.

Sir,

In reply to your application of the 4th inst., I have the honour to hand you the subjoined answers to your inquiries:—

1st. The length of covered sewers in the Kensington district – { 27 miles 4,570 feet brick sewer. / 7 miles 880 feet pipe „

2d. The length of open sewers in the Kensington district – – – 1 mile 3,190 feet.

3d. The length of streets and places, irrespective of uncovered sewers which require to be drained, and the estimated cost of the works thereon:—

High-street, Notting-hill	500 feet.
Bedford-place, Notting-hill	500 „
New-road, Notting-hill	700 „
Fulham-road, from Hollywood-grove, West	1,850 „
Earl's-court-road and Earl's-court	1,800 „
Old Brompton-road, from Gloucester-road to Earl's-court-road	2,450 „
Thistle-grove-lane	1,100 „
St. Mark's-grove	200 „
Notting-hill-square, South Side	600 „
Raspberry-lane, Earl's-court	600 „
North-row	400 „
South-row	450 „
	11,150 feet.

Estimated at a cost of £.4,743. 16*s.*

During the period that the sewers have been vested in the vestry, there has happened but one instance of flooding, which occurred on the 17th of August 1856. The eastern branch of the Counters Creek Sewer at the Kensington workhouse is 5 ft. 6 in. and 3 ft. 6 in., and was continued from the above locality to the western branch of the same sewer in Warwick-road by 18" stone-ware pipes. These pipes were insufficient on this occasion to discharge the storm water, and consequently the basements in Kensington Newtown were flooded. To prevent a recurrence, the Metropolitan Board are having this portion of the sewer reconstructed from the workhouse to the outlet in Warwick-road.

I shall be happy to furnish any further information you may require; and

I have, &c.
(signed) *James Broadbridge*, Surveyor.

Herbert C. Saunders, Esq.

(13.) Lambeth District.

(13.) LAMBETH DISTRICT.

(i.)

MAIN Drainage, Metropolis.

Lambeth Vestry, Sewers' Office, Kennington Green,
21 April 1857.

Sir,

I BEG to send you the enclosed communication to the Referees, in reply to yours of 26th March; and

I am, &c.
(signed) *Hugh M'Intosh.*

Herbert C. Saunders, Esq.,
29, Great George-street, Westminster.

(ii.)

MAIN Drainage, Metropolis.

Sewers' Office, Kennington Green, 18 April 1857.

Gentlemen,

I AM instructed by the Committee of Sewers, to submit the following remarks and suggestions upon the plan proposed by the Metropolitan Board for the drainage of the south side of the Thames, in reply to your communication of the 25th of March; they were embodied in a Report ordered by the committee upon that communication.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(13.) Lambeth District.

The first suggestion relates to the route of the low level line from Battersea Fields to the crossing of the Camberwell New-road by the proposed plan, in which an improvement might be effected by carrying it along the Battersea-road to Nine Elms, the Wandsworth-road to Vauxhall Cross, along New Bridge-street, Harleyford-road, Kennington Oval, Harleyford-street, Camberwell New-road to Vassall-road, and there resume the proposed line onwards. In this part of the parish of Lambeth, the Wandsworth, the Clapham, and the Brixton-roads may be regarded as three terrace lines, all converging to where it is proposed by this alteration to carry the main sewer. The subsidiary sewers can then all be constructed to incline with the natural fall of the surface, which will materially economise their cost, and dispense with the necessity for the expensive reconstruction of the Effra from the Vassall-road to the outlet; inasmuch as an overflow may be constructed at Vauxhall, and the Effra be straightened and covered at a comparatively small expense; although the suggested alteration would effect a considerable saving, its importance, it is submitted, is sufficiently great to justify its adoption, even if it had been more costly.

With reference to the basis upon which the necessity for the high level is founded, it is, in the first place, stated at page 7, in Mr. Bazalgette's Report, 3 April 1856, that the rain-water from the hills falls into the sewer of the low districts and causes flooding; but in this parish not a drop of the drainage brought from Norwood and Dulwich by the Effra flows into the sewers of the low districts, but is all discharged by that sewer into the Thames at Vauxhall; and all the other existing lines are only connected with the low levels for the sake of obtaining water from them in summer time for flushing.

It is used as an argument, in justification of the expense of this line, that the cost of covering the existing sewers will be saved; this, I submit, is a serious error, for, if the whole scheme were now completed, the necessity for covering the open sewers would only become more urgent. It is made a great point in the design, to show where the Effra is intercepted, and the provision made for diverting its ordinary flow into the deep line; this is inconsistent with the abandonment of that sewer. The estimated cost of this line is 199,226 *l.*, and is calculated to provide for the suburban area, coloured red, being built upon and inhabited to the average number of 20,000 to the square mile. Although the suburbs of London are spreading with great rapidity, and with reason it may be anticipated that their increase will continue at the same, if not a greater ratio, it must be remembered that the area comprised within the first three-mile circuit from St. Paul's, is but one-third of that comprised between it and a six-mile circuit; and as the area becomes larger it does not become covered at the same rate; besides this, there are many tracts of land within that area in which building is precluded for many years by reason of the tenure; instance the hamlet of Dulwich, comprising several hundred acres, in which it is very doubtful if in 50 years so many additional houses will be built. The provision to be made for a district at present suburban, is a question requiring very mature consideration. The error of providing now for what will not be required for the next 50 years becomes very apparent, by considering that the proposed estimated outlay of 200,000 *l.* would, in about 13 years, amount to 400,000 *l.*; 26 years to 800,000 *l.*; 40 years to 1,600,000 *l.*; 52 years, 3,200,000 *l.*

At the Brixton-road, where it intercepts the Effra, the sewer is proposed to be nine feet in diameter; from the junction of the branch line from Dulwich, a double line of sewer, partly 10 feet and partly 10 feet 6 inches in diameter, is continued to Deptford. The requirement of the drainage areas, as given by the printed tables and formula, show great discrepancy in the sizes for this line from the junction of the Effra diversion line to Deptford; the result of that calculation will be found to give a 12-feet six-inch barrel where the double 10 feet are proposed. Should this arise from allowance being made for reservoir accommodation in the sewer during high water, I would submit that it is most desirable to avoid in future the construction of sewers upon the principle of providing in them reservoir room for floods. If it is necessary to hold back the drainage of a district, proper receptacles for its retention may be constructed at far less cost, from which it can be discharged at the proper time by sewers specially adapted for its conveyance.

In dry weather and summer time, when only a dribble is running in a sewer of large size, it becomes a huge gasometer charged with gases, which will escape and make their way into houses through untrapped and ill-constructed inlets, and impregnate and poison the air; although the objection may be met by professing to ventilate the sewer, it must be borne in mind that the only way in which this can be accomplished, or at all events the most probable way in which it would be attempted, would be by drawing the gases to certain points, and there discharging or consuming them; in doing this there are great difficulties, and they increase vastly with the size of the sewer.

As it is not intended by this plan to provide for carrying into the extension line below Deptford more than a 4-feet barrel will convey from the double 10-feet 6-inch barrel, and the superabundant contents are to be discharged by an overflow into Deptford Creek at low water, it is clear that this sewer will not be free from the objections to and the evils arising from the present system of intermittent discharge by a tide-locked outlet.

It is suggested for your consideration, whether there is really any necessity for the construction of the intercepting sewer at the present time.

It is generally admitted that the sewage in time of flood becomes so diluted as not to be offensive, and it is provided by the scheme to discharge such floods by an overflow into Deptford Creek; now, the contents of the sewer discharged at Deptford would be carried to Vauxhall in about three hours by the rising tide; and, if a part of it had been discharged there at first, it would be carried higher up the river, it is true; but, as it would not be in a condition to be offensive, the simple question appears to be if this difference is worth an outlay of 200,000 *l.*

The information possessed by those best informed upon the matter has not hitherto been sufficient to enable them to form a very sure judgment as to the effects of the low level sewer; in practice it will probably be found capable of taking the ordinary flow of the existing sewers, the floods being discharged by the present outlets.

It is further suggested for your consideration, that, if the necessity for the construction of the intercepting sewer is thought to exist, the sewer, as proposed, will be liable to the objections which it has been shown by experience exist against tide-locked sewers; that this might be avoided by the construction of a reservoir, and the sizes might then be materially reduced; also, whether the suburban character of the district justifies the data upon which the calculations are based; and, further, it is suggested, whether these remarks do not apply with special point to the Dulwich branch, where it is stated that the construction of this line will save covering the existing Effra, and provide a deep outlet sewer for Dulwich; as Dulwich is not likely to increase or be built upon for many years, and the construction of the sewer cannot save covering the Effra, it is submitted for consideration, if deepening the Effra and covering it along its present course, except where it may be improved by diverting, will not prove equally beneficial and more economical than constructing the proposed branch.

The length of covered sewers in the Lambeth parish is 37½ miles.

The length of open sewers is about 4,800 eet, and the estimated cost of covering them is 1,450 *l.*

The length of streets and places which require to be drained is about 47 miles 240 feet; and the estimated cost of sewer works thereon is about 94,000 *l.*, exclusive of the works which are proposed to be executed by the Metropolitan Board.

I am, &c.
(signed) *Hugh M'Intosh,*
Surveyor of Sewers, &c.

To the Referees, Metropolis Main Drainage.
21 April 1857.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(14.) Lewisham District.

(14.) Lewisham District.

(i.)

Grove-place, Lewisham, Kent, S. E.
25 April 1857.

Sir,

In answer to yours, dated the 17th, relative to the several lengths and sizes of the covered sewers, and the length, sizes, and cost of the sewers, further required for the efficient drainage of this district, I beg to state I have now in hand, and which I hope to be able to supply to you in about ten or twelve days, together with other general information. And I have to request you will have the goodness to supply me with all Mr. Bazalgette's Reports on the main drainage for the south side of river, as this district requires careful consideration.

I am, &c.
(signed) *H. Treverton.*

Herbert Saunders, Esq.

(ii.)

Lewisham District Board of Works, 21 May 1857.

Gentlemen,

In accordance with your order at the meeting of the Board, held on the 21st April, relative to the application from the Referees appointed to examine the plans and sections laid down by Mr. Bazalgette for the main drainage of the metropolis, requesting information as to the sewers that is already laid down, the sewers that is proposed to be constructed, and the sewers that will be necessary some future day, when the chief part of this district may become building ground, including Lewisham, Penge, and so much of Beckenham that lies west from Beckenham-bridge.

The Referees also request that I may give them my opinion as to Mr. Bazalgette's plans and sections for the drainage of the south side of the river.

I have examined the plans and sections prepared by Mr. Bazalgette for the drainage of the south side of the river, and I believe them to be efficient for the great work such main line will have to perform.

Appended is the length, size, and locality of the covered sewers in this district.

The length, size, locality, and approximate cost of the proposed sewers for this district.

And the length, size, locality, and approximate cost of sewers that may be proposed and executed some future time.

The Referees also refer to the flooding of this district. The last took place about five or six years ago, but the sewers was not constructed to receive those extraordinary floods, such water being preserved for the use of the mills, and great care has always been taken to prevent the waters from the rivers flowing into the sewers.

The length of sewers laid down since I have had the superintendence of this district under the Board is 12,544 feet; 9,990 is constructed of brickwork, and the remainder, 2,554, is constructed of pipes.

The above length does not include 2,500 feet of pipes laid down to prevent the storm water from flowing into the sewers.

I am, &c.
(signed) *H. Treverton,*
Surveyor to the Board.

A.

Appendix to Letter from the Surveyor of the *Lewisham* District.—Sewers proposed to be executed.

LOCALITY OF WORKS.	Number of Ordnance Sheet.	Length in Feet.	Size. Height.	Size. Width.	Thickness.	£. s. d.
			Ft. In.	*Ft. In.*		
Along the east side of Blackheath Village - -	671	500	1 6 ×	1 6	½ brick	119 – –
From Lewisham-hill along Dartmouth-grove to the Green Man - - - - - - -	643 669	1,650	1 6 ×	1 6	½ brick	262 – –
From Bell-green to the Brighton Railway, near the Greyhound.	826–7	3,800	3 0 ×	2 0	½ brick	1,623 – –
From the Brighton Railway, Spoil-bank, along the open ditch at Kirkdale.	826	950	3 0 ×	2 0	½ brick	400 – –
Opposite Sydenham Church in Rock-hill - -	826	650	12-inch pipe.		- -	65 – –
Wells-road - - - - - - - - -	805	1,555	2 0 ×	2 0	½ brick	
Jews'-walk - - - - - - - - -	805	425	3 0 ×	2 0	½ brick	819 – –
Sydenham-hill, opposite the Fox and Hounds -	826	550	2 0 ×	2 0	½ brick	
From Whittle's property, Forest-hill, along the Dulwich-road to the boundary of the district.	785	835	2 0 ×	2 0	½ brick	265 – –
From Bell-green, Lower Sydenham, through part of the parish of Beckenham, and Vail-house-lane to the Bellott-road.	- -	8,500	3 4 ×	2 3	4½	3,326 – –
Green-lane, Penge - - - - - -	- -	900	3 0 ×	2 0	4½	150 – –
					£.	7,029 – –

Appendix to Letter from the Surveyor of the *Lewisham* District—Sewers proposed to be executed—*continued.*

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(14.) Lewisham District.

B.

Streets and Roads, the Drainage of which will fall in the proposed Main Line.

LOCALITY.	Length in Feet.	Size. Height.	Size. Width.	Thickness.	£. s. d.
From the main line, Bell-green, along Southend-lane to Southend.	6,000	3 ft. 9 in. ×	2 ft. 6 in.	9″	3,726 – –
From the main line at Rushey-green to Southend -	6,500	3 ft. 9 in. ×	2 ft. 6 in.	9″	4,072 – –
From opposite the "Bull" public-house in the Bromley-road, along Hither-green to the junction with Whitefoot-lane.	11,300	3 ft. 9 in. ×	2 ft. 6 in.	9″	7,004 – –
From the junction, Southend, along Whitefoot-lane, to the junction with Hither Green-lane.	5,600	3 ft. 9 in. ×	2 ft. 6 in.	9″	3,472 – –
From the main line in the Bromley-road, along George-lane to the junction at Hither-green.	2,800	3 ft. 0 in. ×	2 ft. 0 in.	4½	1,400 – –
From the junction by the Lewisham Station, along Lewisham-road and Morden-hill.	2,200	3 ft. 0 in. ×	2 ft. 0 in.	4½	1,100 – –
From the east corner of the Burial-ground in Brockley-lane, to the main line in Stanstead-lane.	7,600	3 ft. 9 in. ×	2 ft. 6 in.	9″	4,700 – –
From Rushey-green along Cockshed-lane - - - -	3,500	3 ft. 9 in. ×	2 ft. 6 in.	9″	1,820 – –
From the Valley line at Peak-hill, along Rock-hill to the junction of the Crystal Palace New-road.	4,000	3 ft. 9 in. ×	2 ft. 6 in.	9′	2,100 – –
From Wells-road along Springfield - - - - -	600	2 ft. 0 in. ×	2 ft. 0 in.	4½	120 – –
From the top of Wells-road, along Sydenham Upper-road, to the east corner of the Palace.	2,300	3 ft. 9 in. ×	2 ft. 6 in.	9″	1,250 – –
From Sydenham-hill, near High-street, along Sydenham-hill and Upper-road to the corner of Wells-road.	4,900	1 ft. 6 in. ×	1 ft. 6 in.	4½	1,253 – –
Frederick-place and the south end of Park-road - -	1,300	3 ft. 0 in. ×	2 ft. 0 in.	4½	650 – –
From the Forest-hill Station along Dartmouth-road to the chapel near Willow-road.	2,200	2 ft. 0 in. ×	2 ft. 0 in.	4½	660 – –
From the east end of Perry-vale along Catsford-hill to Beckway's Cottages.	4,200	3 ft. 0 in. ×	2 ft. 0 in.	4½	2,100 – –
From Bell-green, along Perry-vale to Forest-hill Station	5,000	3 ft. 0 in. ×	2 ft. 0 in.	4½	2,500 – –
				£.	36,107 – –

C.

PENGE,

In the *Lewisham* District, the Drainage of which will fall in Mr. *Bazalgette's* proposed Main Sewer.

LOCALITY.	Length in Feet.	Size. Height.	Size. Width.	Thickness.	£. s. d.
					36,107 – –
Along Bridal-road and Belvedere-road to the boundary of the district.	2,800	3 ft. 0 in. ×	2 ft. 0 in.	4½	1,400 – –
From Annerley-hill, along New-road, belonging to the Crystal Palace, to the Crystal Palace-bridge.	3,000	3 ft. 0 in. ×	2 ft. 0 in.	4½	1,500 – –
From the east corner of the Crystal Palace, along part of Rock-hill, turning in through the New-road to the Valley line by the Crystal Palace-bridge.	4,500	3 ft. 0 in. ×	2 ft. 0 in.	4½	2,250 – –
				£.	41,257 – –

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(14.) Lewisham District.

Appendix to Letter from the Surveyor of the *Lewisham* District—Sewers proposed to be executed—*continued.*

D.

PENGE in the *Lewisham* District, and Part of the Parish of BECKENHAM that is not in the *Lewisham* District.

Street and Roads, the Drainage of which will fall in Mr. *Bazalgette's* proposed Main Line.

LOCALITY.	Length in Feet.	Size. Height.	Size. Width.	Thickness.	£.	s.	d.
					41,257	–	–
Palace New-road, south of Sydenham Church, to the junction with the sewer near the Crystal Palace-bridge.	2,200	2 ft. 0 in.	× 2 ft. 0 in.	4½	660	–	–
Wythe's New-road, east from Brighton Railway	2,500	3 ft. 0 in.	× 2 ft. 0 in.	4½	1,000	–	–
From the Annerley Station eastwards and along Clay-lane to the junction at the end of Kent House-lane.	4,500	3 ft. 0 in.	× 2 ft. 0 in.	4½	2,250	–	–
From the Palace-bridge to the junction in the Bellott-road, at the end of Kent House-lane.	2,700	3 ft. 0 in.	× 2 ft. 0 in.	4½	1,350	–	–
From the junction of Kent House-lane and the Green-lane to the Beckenham-bridge.	2,600	3 ft. 0 in.	× 2 ft. 0 in.	4½	1,300	–	–
From the National Freehold, under the Canal, and along Annerley-hill to the Palace-road, from this point to turn southwards and along the Valley line to the back of Mr. Masters' Hotel.	4,300	3 ft. 4 in.	× 2 ft. 3 in.	9″	2,580	–	–
				£.	50,397	–	–

E.

COVERED SEWERS in the *Lewisham* District.

LOCALITY.	Length in Feet.	Size. Height.	Size. Width.
Brockley-lane	600	12-inch pipe.	
Brockley-view	4,000	12-inch pipe.	
Park-road, Dartmouth-park	1,000	2 ft. 6 in.	× 2 ft. 6 in.
North-road, West Kent-park	1,300	12 inch pipe.	
Grove-road, West Kent-park	1,400	12-inch pipe.	
South-road, West Kent-park	1,700	12-inch pipe.	
West-road, West Kent-park	900	12-inch pipe.	
Park-road, West Kent-park	800	12-inch pipe.	
M'Skulback's New-road, on the north side of Stanstead-lane	420	1 ft. 6 in.	× 1 ft. 6 in.
Meadow-croft	1,000	2 ft. 3 in.	× 2 ft. 0 in.
Dartmouth-road	–	12-inch pipe.	
From Catsford-hill along Stanstead-lane to the west corner of Dartmouth-park.	5,618	3 ft. 9 in.	× 2 ft. 6 in.
Along Stanstead-lane for land drainage purposes	2,500	12-inch pipe.	
From Stanstead-lane to Sydenham-park	3,237	3 ft. 4 in.	× 2 ft. 3 in.
From the corner of High-street, Sydenham, to Sydenham-park	1,600	2 ft. 6 in.	× 2 ft. 6 in.
Along High-street and part of Sydenham-hill	850	18″ pipe.	
Willow-road	500	12-inch pipe.	
Willow-road	360	9-inch pipe.	
Crossing the fields on the west side of Sydenham-hill	400	9-inch pipe.	
In the Valley-lane at Kirkdale	500	2 ft. 6 in.	× 2 ft. 6 in.
In connexion with the above	400	2 ft. 0 in.	× 2 ft. 0 in.
From the Railway-bridge, Forest-hill, towards Peckham-road	1,100	2 ft. 0 in.	× 2 ft. 0 in.
From Peckham-road to the boundary of the district	300	12-inch pipe.	
Ragland-street, Dartmouth-road	200	1 ft. 6 in.	× 1 ft. 6 in.
From the boundary of the Greenwich District, through a part of Shepard's-garden, crossing Loampit-vale, through Silver-street, thence across the fields to the west side of the Vicarage-house, and along the Bromley-road to Rushey-green, through the Avenue to Catsford-bridge.	9,800	5 ft. 3 in.	× 3 ft. 6 in.
Catsford-hill	1,100	4 ft. 5 in.	× 4 ft. 2 in.
Catsford-hill	600	4 ft. 6 in.	× 3 ft. 0 in.
From Beckway's Cottages at Catsford, through the fields to Bell-green.	4,600	3 ft. 9 in.	× 2 ft. 6 in.
From the Greenwich parish alongside the Ravensbourne-river and Quaggy-river to Lee-bridge.	2,500	3 ft. 9 in.	× 2 ft. 3 in.
Along Loampit-vale to Silver-street	1,450	3 ft. 9 in.	× 2 ft. 6 in.
Along Loampit-vale west of Silver-street	850	3 ft. 0 in.	× 2 ft. 0 in.
Handover-street	550	3 ft. 0 in.	× 2 ft. 0 in.
Cross-street, Loampit-vale	300	12-inch pipe.	
Branch from Hanover-street	200	12-inch pipe.	
Slasher's-buildings, Loampit-vale	200	12-inch pipe.	
HAMLET of PENGE:			
The National Building Society, from near the back of Annerley-gardens along part Annerley-hill.	500	3 ft. 6 in.	× 3 ft. 6 in.
The east end of Belvidere-road, the boundary of Penge and Croydon.	300	12-inch pipe.	

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(15.) Limehouse District.

(15.) LIMEHOUSE DISTRICT,

Comprising the Parish of *Limehouse*, the Hamlet of *Ratcliff*, and the Parishes of *Shadwell* and *Wapping*.

MAIN Drainage, Metropolis.

Office, White Horse-street, Commercial-road East,
7 July 1857.

Sir,

I BEG to forward the Referees the following information, requested in your letter of the 26th March last, viz.:

1. The length of covered sewers in the Limehouse district is 11 miles 871 yards.
2. The length of open sewers in the Limehouse district is 133 yards.
3. The length of streets and places in the Limehouse district, which are without sewers and are not efficiently drained, is 6 miles 308 yards.

The plan for the main drainage, described in Mr. Bazalgette's Report of the 22d May 1856, appears to me to be sufficient for the drainage of the greater portion of the Limehouse district.

With respect to the drainage of those parts of the parishes of Shadwell and Wapping, south of the London Docks, I am unable to give a definite opinion, the said plan not showing the branch sewers required to convey the drainage of the same into the intercepting sewer.

No floodings occurred in this district in 1856.

I am, &c.
(signed) *Charles Dunch*,
Surveyor of the Board.

Herbert C. Saunders, Esq.

(16.) Mile End Old Town District.

(16.) MILE END OLD TOWN DISTRICT.

Sir,

Surveyor's Office, Town House, 15 May 1857.

IN answer to yours of the 4th April, I beg to say, that in this hamlet there are about 8 miles 635 yards of covered sewers in various streets, &c., and 600 yards of uncovered sewers. The cost for repairing and covering the same would be about 500 *l.*

Seven miles 1,026 yards of streets, &c., not sewered (several of which, however, have a back drainage into sewers some distance from the houses). The cost of sewering these streets would be about 16,000 *l.*

The vestry contemplate sewering Bow-common and South-grove, at an expense of about 3,500 *l.*

I am, &c.
(signed) *Robt. Lemon*, Surveyor.

Herbert C. Saunders, Esq.,
29, Great George-street, S. W.

(17.) Newington District.

(17.) NEWINGTON DISTRICT.

MAIN Drainage of the Metropolis.

Sir,

29 Trinity-square, Newington, 3 April 1857.

I HAVE the honour to acknowledge the receipt of your letter of the 26th ultimo, and, in compliance with the request of the Referees, now beg to hand to you the following information, namely:—

1st. The length of the covered sewers in the Newington district is 18 miles 2,410 feet, of which 5 miles 4,405 feet are main sewers, under the especial control of the Metropolitan Board.

2d. The length of the open sewers in the Newington district is 1 mile 1,375 feet, of which 3,900 feet belong to the Metropolitan Board, and the cost of reconstructing and covering the same, together, would be about 4,000 *l.*

3d. The length of streets and places, exclusive of uncovered sewers which require to be drained, is 15 miles 2,290 feet, and the estimated cost of sewer works thereon is about 19,000 *l.*

With regard to my opinion of Mr. Bazalgette's plan, I beg to refer you to my printed Report forwarded to you on the 24th ult.

In furnishing you with this information, I beg to remark, that the estimated cost of the drains must be taken only as an approximate estimate, inasmuch as no drain can be executed without being first approved of by the Metropolitan Board, and it is more than likely that I shall be required to alter the size of the drains as now proposed by me.

Again, the quantity required may also vary; for, although I have been careful to include every street not shown to have a drain in it, or that may be imperfectly drained, yet it is very probable that in some cases I shall ultimately find some of the present old drains may be made available.

With reference to the state of drainage generally, I believe the greatest evil arises from floodings, where the storm water falls at the time the sewers are pent up by the back tidal water, and the injury and damage from this cause is, I think, most severely felt in the Trinity district, viz., in St. George's-road, St. Andrew's-road, Devonshire-street, William-street, and even in the cellars of the houses in Newington-causeway, which are seldom free from water occasioned by the sewers being thus overcharged.

I have, &c.
(signed) *Henry Jarvis*, Surveyor of Sewers.

To H. C. Saunders, Esq.

(18.) Paddington District.

(18.) PADDINGTON DISTRICT.

Sir,

Vestry Hall, Paddington, 14 April 1857.

HAVING received instructions from the vestry of Paddington to furnish the Referees of the Main Drainage of the Metropolis with the information applied for in your letters of the 17 and 27 March, I herewith enclose three printed copies of my first Annual Report on sewerage and drainage works, which were executed in the year 1856; also, answers to your various questions, together with some observations on the present condition of the Ranelagh Sewer.

In the parish of Paddington there are about 24 miles of brick sewer, and about four miles of pipe sewer, together with about one mile of open ditches passing through ground that has recently been let for building purposes, which will obviate the necessity for sending an estimated cost of covering them in, as they are now being abolished.

There are about 28 miles of roadway, the whole of which are drained either directly or indirectly, *i.e.* by a sewer passing along the centre of the roadway, or along the rear of the houses abutting on the same.

With reference to flooding, I have to inform you that during the last six years the lower part of Paddington, during heavy rain, is inundated with back-water from the Ranelagh Sewer.

The last flooding occurred on 17th August 1856, when the water from the Ranelagh Sewer backed up the collateral sewers in the Bishop's-road and Westbourne-grove, inundating the houses with two feet of foul sewage water. If this catastrophe had happened in the middle of the night, the destruction of property would

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(18.) Paddington District.

would have been fearful to contemplate. The immediate cause of the flooding is the inefficient capacity of the Ranelagh Sewer in the Uxbridge-road, between the head of the Serpentine and Albion-street. Until the main drainage is carried out, I suggested that the storm-water should be allowed to flow into the Serpentine, but Sir Benjamin Hall objected to that lake being converted into a common sewer.

It is quite evident, whatever scheme may be carried out for the drainage of the north side of the Thames, that Paddington should be provided with a better outlet as quickly as possible. I would humbly suggest, as an improvement on Mr. Bazalgette's scheme, so far as it applies to Paddington, that a branch sewer be carried along the Edgware-road from Oxford-street to Kilburn toll-gate, for the purpose of intercepting the Grove End-road Sewer by the New-road, and the Ranelagh Sewer at Kilburn, by which means the lower part of Paddington would be relieved of about 1,300 acres of flood waters.

I am quite convinced, from ten years observation and experience in this district, that when the whole of the parish is covered with houses, the capacity of the existing main line in the Gloucester-road will only just be large enough to take off the storm-waters; and therefore the sewer which Mr. Bazalgette proposes to carry along the Uxbridge-road for the purpose of intercepting the Ranelagh, and a portion of the Counter's Creek districts, should not be less than 8 feet in diameter.

I am, &c.,
(signed) *Wm. Merry*,
Surveyor.

H. C. Saunders, Esq.,
29, Great George-street, Westminster.

(19.) Plumstead District.

(19.) Plumstead District.*

(*Plumstead Sub-district.*)

Plumstead Board of Works, Charlton, Blackheath,
31 March 1857.

Gentlemen,

I am directed to forward you the accompanying copy of a Report made by the board surveyor for the parish of Plumstead on matters bearing upon the main drainage question.

I am, &c.,
(signed) *E. L. Burnett*,
Assistant Clerk.

(Enclosure.)

To the *Plumstead* Board of Works.

Main Drainage Scheme.

Gentlemen,

It is but within the last few years that Plumstead has been other than an agricultural district; and, as is common with such districts, house drainage was disregarded. But when the South Eastern Railway Company formed the North Kent Line in 1848, the sites of land eligible for building purposes were opened to the public, and house property covered that which before was used for agricultural purposes. This, coupled with the increase of the Government works in the parish, has caused the western boundary to be a thickly-populated neighbourhood. But the ground being built on chiefly by speculative builders, whose object was to make a speedy return for their outlay, drainage in no system nor order was adopted.

The estate known as the Burrage Estate, which borders on the east side of Woolwich, has to an extent availed itself of the Government sewers. But the sewers on this estate are mostly so small as to be insufficent for any complete system of drainage; besides which they lie so near the surface as to be unavailable for underground kitchens.

On the estate which lies to the east of the Burrage Estate, known as the Park Estate, there are three drains that lead to the railway cutting; these are laid at a depth of nine feet from the surface to the railway cutting, but the remainder of their course is in an open ditch.

There are some other small drains used chiefly for road drainage, that lead to the marsh ditches.

The sewers on the Government property are the best constructed in the parish, and have a ready discharge into the river.

The Government works intercepting the whole of the parish from west to east, no means is afforded the parish to drain itself into the river, although the levels of the land are most eligible for the purpose. Such being the case, the drainage of the houses is mostly led to cesspools; and, as the soil is gravelly and sandy, there is no trouble (if the cesspools are properly constructed) to get rid of light sewage.

I am, &c.,
(signed) *H. A. Fisher*,
Surveyor for the Parish of Plumstead.

23 March 1857.

(*Charlton Sub-district.*)

Plumstead Board of Works, Charlton, Blackheath,
13 July 1857.

Gentlemen,

I am directed to transmit you the accompanying copy of a Report made by the Board's surveyor for Charlton, relative to the main drainage scheme, so far as it affects that portion of the Plumstead district which is comprised within the limits of the parish of Charlton.

I am, &c.
E. L. Burnett, Assistant Clerk.

Messrs. Galton, Simpson, and Blackwell.

(Enclosure.)

Plumstead Board of Works, Parish of Charlton,
18 May 1857.

Gentlemen,

In compliance with your request, I beg to lay before you the following information as to the drainage of this parish, with reference to the proposed main drainage of the metropolis, and as to Mr. Saunders' communication requesting information on behalf of the Referees.

1st. As to the length of covered sewers in the parish.

I may here observe, that the parish is but in a slight degree built upon, and, in the absence of a proper outlet, the subject of drainage has received but little consideration; indeed, the only sewer existing, is one situate in that part of the parish known as Lee-road, commencing near the entrance of Blackheath-park, and running from thence in the direction of Lee-green, the length of which is about 1200 feet. There is also existing, in a temporary form, an 18-inch barrel drain running through the village of Old Charlton, which is used by a small portion of this locality for house and road drainage.

2d. The

* The district of Plumstead is divided into four Sub-districts, each having a separate surveyor.

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(19.) Plumstead District.

2d. The length of open sewers, and the estimated cost of reconstructing and covering the same.

There are no open sewers, other than tidal ditches situate in the marshes, between the lower Woolwich-road and the Thames, containing in all several miles, none of which do I propose to cover for the purpose of drainage.

3d. The length of streets and places, exclusive of uncovered sewers, which require to be drained, and the estimated cost of the sewer works thereon.

The length of streets and places which will require drainage is about 7,500 feet, and the estimated cost for executing the same about 5,500 *l.*

4th. Whether the plan proposed by the Metropolitan Board of Works for the main drainage, as described in Mr. Bazalgette's Reports, dated 23 April and 1 December 1856, will in your opinion be sufficient for the Plumstead district, and whether there will be any sewer at such a low level as not to be susceptible of efficient drainage by the proposed works.

I found it necessary to apply to Mr. Bazalgette for information with reference to his Reports, and to the proposed level of intercepting sewer. I beg to state, that I have, in answer to my application, received information from Mr. Bazalgette, to the effect that the proposed main sewer will drain all houses likely to be built on the marsh land lying between the Lower Woolwich-road and the Thames; therefore, assuming this information to be correct, and that there will be no deviation in respect to levels, I can have no hesitation in informing you that the proposed main sewer will be available for the drainage of the principal portions of the parish, including all streets and places lying between the village of Old Charlton and the River Thames.

With respect to that part of the parish lying near Blackheath, the principal portion could be drained into the sewer in the Lee-road.

I am, &c.
(signed) *James Collis.*

(*Lee and Kidbrooke Sub-district.*)

Plumstead Board of Works, Charlton, Blackheath,
15 July 1857.

Gentlemen,

I am directed to transmit you the accompanying copy of a Report made by the Board's surveyor for Lee and Kidbrooke, relative to the main drainage scheme, so far as it affects that portion of the Plumstead district which is comprised within the limits of the parishes of Lee and Kidbrooke.

I am, &c.
E. L. Burnett, Assistant Clerk.

Messrs. Galton, Simpson, and Blackwell.

(Enclosure.)

To the Chairman and Members of the *Lee* and *Kidbrooke* Committee of the Plumstead Board of Works.

Gentlemen,

In compliance with the instructions I have received from the Plumstead Board of Works, I have to report, for the information of the Referees of the Metropolis Main Drainage scheme,—

Firstly. That the length of covered sewers in Lee and Kidbrooke, is as follows:—

	Miles.	*yds.*
Sewer vested in the Metropolitan Board of Board of Works, extending from Lee-green along the high road to Lee-bridge, Lee, about 1⅛ mile	1	220
Sewers vested in the Plumstead Board of Works. The main sewer in Lee-road, Blackheath, situate upon the boundaries of Lee, Charlton, and Kidbrooke respectively, half-a-mile	0	880
The main sewer from Blackheath village (running parallel with the North Kent Railway) to Lewisham-road, near the Lewisham North Kent Railway station, the whole being nearly a mile long, but that portion in Lee parish is about five-eighths of a mile	0	1100
The Church Terrace Sewer quarter of a mile, and the pipe sewers in the several streets in Lee village, altogether 1 mile	1	0
The covered sewers upon the Belmont Estate, belonging to Messrs. Todd's, about 35 chains, and that upon Mount Elliot Estate, near Lee-bridge, Lee, about five chains together, half-a-mile	0	880
The covered drain or sewer belonging to the North Kent Railway Company, extending along the south side of the railway from Blackheath station to the connexion of this drain with the Blackheath main sewer near Love Lane-bridge, about three-eighths of a mile	0	660
The Lee parish old drains in Lee-road and the rear of Boone's-road, Church-street, and High-road, originally used for sewerage purposes before all the houses in this neighbourhood were connected with the new sewers, but now used only for surface water drainage from the streets, roads, &c., and these are connected with the main sewer, nearly three-fourths of a mile	0	1320
	4	1540

Total covered sewers in Lee and Kidbrooke 4⅞ miles.

Secondly. The length of open sewers, and the estimated cost of reconstructing and covering the same.

Parish of Lee.

The open ditches (exclusive of the piece of water on Mr. Penn's property), used partly for sewerage, and extending all along the north boundary of Lee parish, close by the North Kent Railway, of which a length of three-eighths of a mile is connected, and a quarter of a mile is not connected, with the main sewer there,—altogether	⅝ mile
The Quaggy River about	1½ ,,
The tributary streams thereto in Burnt Ash-lane, Lee	1⅞ ,,
The ditto upon the west boundary of Lee parish in Manor-lane, &c.	1⅝ ,,
Total open sewers in Lee	5¾ miles

Liberty of Kidbrooke.

The Upper Kidbrooke streams running south of Blackheath Park, and springing from a pond in the rear of Morden College, Blackheath, about	1½ miles
The Lower Kidbrooke stream running along the south boundary of Kidbrooke Liberty, about	2¼ ,,
Total open sewers in Kidbrooke	3¾ ,,
Total open sewers in Lee and Kidbrooke	9½ ,,

I have

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(19.) Plumstead District.

I have adopted the term open sewers in reference to the Quaggy River and the Kidbrooke streams, merely in the sense of their being courses for conveying away the surface drainage from the fields and roads in the thoroughly rural localities through which they flow, with occasional and very partial use, and taking away the overflow drainage from farm-yards, and from the cesspools of a few houses scattered about far and wide, by which the water in the streams is injuriously affected to an exceedingly small extent; and should this practice of drainage into these streams, or even into the ditches running along the north boundary of Lee parish, by the side of the North Kent Railway, at any time or place become noxious or prejudicial to health in any way, the Plumstead Board of Works can easily prevent the continuance or recurrence of such evils, by putting in force the proceedings prescribed by the Acts of Parliament, which it is appointed to carry out. It is, therefore, quite unnecessary to incur any expense in covering these open sewers if they may be so termed

Thirdly. The length of streets and places, exclusive of uncovered sewers, which require to be drained, are as follows:—

Lee-terrace, Lee-lane	25 chains
Dacre-park and Eton-grove	20 „
Old-park, Lee	15 „
Lee-park	35 „
Lee-lane from Lee Church to Belmont-hill and Lee-bridge	35 „
TOTAL length	130 chains, or 1⅝ mile.

And the probable expense of the construction of these sewers will be about 5,000 *l.*

Of these proposed new sewers, those in Lee-terrace, Dacre-park, and the Old-road, Lee, are immediately required, and these would cost about 2,000 *l.*

The houses throughout the Liberty of Kidbrooke are generally in such open and healthy positions, that I am of opinion that no new sewers will be required there for some years. Hence, indeed, at the present time, the benefits to be derived from new sewers in this district would not be at all adequate to the great expense attending their construction.

Fourthly. I think that, from what I can learn from Mr. Bazalgette's Reports of 3d April and 1st December 1856, that the plan proposed by the Metropolitan Board of Works will be sufficient for the drainage of Lee and Kidbrooke, and I consider that all the sewers in Lee and Kidbrooke will be susceptible of efficient drainage by the proposed scheme for the main drainage of the metropolis, as the whole of the district of Lee and Kidbrooke lies at very convenient altitudes for drainage in every direction, and especially towards the proposed main trunk sewer.

Lastly. With regard to floodings, I have no information to offer, for the main sewers in this neighbourhood, as far as I can learn, acted in quite a satisfactory manner; and I beg further to remark, that if the Referees should desire to make inquiries upon any points connected with this locality, I shall be glad to give them every assistance they may wish.

I am, &c.
(signed) *Francis F. Thorne*,
Surveyor to the Plumstead Board of Works for Lee and Kidbrooke.

7, Eton-terrace, Dacre-park, Lee,
1 May 1857.

(*Eltham Sub-district.*)

No information received from this sub-district.

LETTERS from Mr. *Smith*, relating to the PLUMSTEAD DISTRICT and its Sub-districts.

(i.)

Croom's-hill, Greenwich, 8 July 1857.

Sir,

SINCE I wrote to you hereon, I have seen Mr. Fisher, the surveyor for the sub-district of Plumstead, and he informs me that he has already forwarded to the Referees all the information in his power, in reply to the inquiries addressed to him. You were, doubtless, not aware that this district (the Plumstead district nominally) consists of five parishes: Plumstead, Charlton, Eltham, Lee, and Kidbrooke; and that there are four surveyors, one for each parish, except Kidbrooke, which is joined to Lee for that purpose. Charlton is the only parish of the district, besides Plumstead, having the River Thames for a boundary, and the surveyor of that parish is Mr. Collis, to whom I have written requesting his attention to your request. Should any further information be required as to this district, it will be better to address your communication to me.

I am, &c.
(signed) *Chas. Aug. Smith*,
Clerk to the Board.

H. C. Saunders, Esq.,
29, Great George-street, Westminster.

(ii.)

Croom's-hill, Greenwich, 10 July 1857.

Sir,

I HAVE lost no time in sending to our surveyors, to request that they will forward to you, in the course of to-morrow at latest, some communication in reply to the requisitions of the Referees as to the sewerage arrangements and requirements of the district. I would observe, that the Metropolis Local Management Act has only been in operation since January 1856, and that previously no machinery existed for carrying into effect any sewerage arrangements, the disposal of sewage matter being provided for by means of private cesspools and ditches, with the exception of a small portion of the district which was included in the old metropolitan sewers' limits.

Under the Metropolitan Sewers' Act, the lower portion of the parish of Lee, and part of Kidbrooke, and also a part of Charlton and Eltham, have been drained by means of a main sewer, communicating ultimately with the River Ravensbourne, at Deptford Creek; but that portion of the district which abuts on the River Thames, comprising the bulk of the parish of Charlton, and the whole of the parish of Plumstead, is without any main sewer, the drainage being provided for by cesspools and drains, passing ultimately into the tidal ditches in the marshes, an outfall open to manifest objections, as tending to pollute the marsh ditches, and render them unfit for the use of cattle, and offensive as permanent boundaries between the fields. The uncertainty which prevails as to the course and nature of the proposed metropolitan main drainage sewer has paralysed the exertions of the Board with reference to improving the sewerage of the district which has its watershed immediately towards the River Thames.

I remain, &c.
(signed) *Chas. Aug. Smith*,
Clerk to the Board of Works for the Plumstead District.

H. C. Saunders, Esq.,
29, Great George-street, Westminster.

(20.) POPLAR DISTRICT.

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(20.) Poplar District.

East India Dock-road, E., 8 July 1857.

Sir,

BY the direction of this Board, I beg to enclose you a copy of the Report made to this Board by their clerk of the works, in reference to the main drainage of the metropolis.

I am, &c.
(signed) *Charles C. Cecly*,
Clerk to the Board.

H. C. Saunders, Esq.,
29, Great George-street, Westminster.

(Enclosure.)

Gentlemen,

IN pursuance of an order of the Board, 7th instant, as to the main drainage of the metropolis, so far as it affects this district, I have to submit the following Report thereon:—

The Poplar district includes the parishes of All Saints, Poplar, Saint Leonard's, Bromley, and Saint Mary, Stratford, Bow.

The main sewers of the metropolis are designed to pass through each of the aforesaid parishes, which are called the High, the Middle, and Low-level Sewers, and the Isle of Dogs branch.

The High Level Sewer is to pass through Victoria-park, under Sir George Duckett's Canal, near Homerton footpath, and from thence over the River Lea, at the outlet of Hackney Brook Sewer.

The Middle Level Sewer is to pass along Bethnal Green-road and Green-street, under the Regent's Canal, along Old Ford-road, beneath the North London Railway, near Sir George Duckett's Canal, where a junction will be effected with the High Level Sewer.

The Low Level Sewer is to pass along the Commercial-road to Salmon's-lane, at which point it turns northward to and along Devon's-lane, Three Mills-lane, and under the River Lea, near the Three Mills-bridge, to a pumping station by the Abbey Mills.

Should the foregoing sewers be constructed along the routes described, they will be well adapted for the ultimate drainage of the district.

The Isle of Dogs branch commences at Ferry-street, along East Ferry-road, Preston's-road, Bow-lane, Catharine-street, under the Limehouse-cut, to join the main line in Brickfield-lane.

With reference to this line of sewer, I have to say, that the proposed route is not laid down to the best advantage for the drainage of the district through which it is to pass, more particularly north of Preston's-road, Poplar.

The existing sewers from High-street to the Lea-cut have a current, and discharge eastward of the main sewer.

Therefore should the line, as recommended, be adopted, it will involve the diversion of the existing sewage, which can be maintained by changing the course as hereinafter described.

I would recommend the route to be thus: along East Ferry-road, Preston's-road, Bedford-street, Brunswick-street, Robin Hood-lane, East India Dock-road, St. Leonard's-road, beneath the Lea-cut, and from thence to join the main sewer in Brickfield-lane.

If this course be adopted, in lieu of that proposed by Mr. J. W. Bazalgette, it will be a saving to the ratepayers, in not having to divert the existing sewers and drain Also it will be a better line for the future drainage of this district.

14 April 1857.

(signed) *R. Parker*, Clerk of Works.

(21.) ROTHERHITHE DISTRICT.

(21.) Rotherhithe District.

MAIN Drainage of the Metropolis.

61, King William-street, London Bridge,
13 April 1857.

I REGRET that the meeting of the Board of Works for Rotherhithe only taking place on the 7th instant, that prevented me replying to your letter of the 27th ultimo before, and I now do so seriatim.

1st. The vestry, during the year 1856, executed nearly 9,000 feet of public sewers, of which about 7,000 feet were the removal of the worst nuisances of open sewers in thickly inhabited localities.

2d. There has not been any estimate made of covering the open sewers for this district, as many of them are little more than open ditches, with only a small portion of sewage into same; but the open sewer most requiring to be covered, or reconstructed, is that of the Earl, under the control of the Metropolitan Board of Works.

3d. The length of streets and places requiring to be drained are about two miles, of mostly new streets, the old are generally drained, but, in many instances, very imperfectly, into open sewers of a high level character; and the cost of the sewer works in the former has not been estimated, as it would be in a great measure affected by the course of the proposed main drainage through Rotherhithe.

4th. The vestry of Rotherhithe, in May 1856, in their Memorial to the Metropolitan Board of Works, adopted my Report to them, viz., that the proposed north, or Bermondsey branch intercepting sewer, was not of sufficient area to receive the sewage from the district where the largest manufactories are carried on, using immense quantities of water, and about one mile and a-half of the parish, I apprehend, could not be drained by the proposed plan, without a separate branch under the lock of the Surrey Canal, or under the cut of the Commercial Docks; but, by the adoption of either, the main sewer proposed, I think, would require to be laid at a lower level; and in that case I am of opinion that it would require pumps of immense power to keep down the water during the execution, as the action of the pumps at the formation of the new Commercial Dock, two years since, drew the water from wells 1,500 feet off: and, on the formation of the dock, and letting in of the water, the water rose again in the wells in one day.

5th. There have been three floodings in ten years, and most of the district being about six feet below Trinity high-water standard, many houses, streets, and turnpike-roads, were injured, the water flowing up the sewers and gullies, and leaving a large deposit on the surface. I am of opinion that the additional sewage proposed to be carried through Rotherhithe from all the present outlets into the river, east of London Bridge, will be three times as much as that received into the Earl (being 11 ft. × 9 ft.), and that overflows the banks thereof at times, and even with the constant lifts would require a main of nine feet in diameter, as suggested in Mr. Forster's Report.

I am, &c.
Geo. Legg, Engineer and Surveyor.

H. C. Saunders, Esq.

Appendix VII.

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Text of Surveyors' Answers to Circular.

(22.) St. George-the-Martyr District.

(22.) St. George-the-Martyr, Southwark District.

(i.)

Vestry Clerk's Office, 31 March 1857.

Sir,

I beg to acknowledge the receipt of your letter of the 26th inst., addressed to the surveyor of this vestry, and to inform you that the same shall be laid before this vestry at their next meeting, on Monday the 13th April next.

I remain, &c.
(signed) *Fred. Tritton*, Vestry Clerk,
37, Bridge House-place, Newington Causeway.

Herbert C. Saunders, Esq.,
29 George-street, Westminster, S. W.

(ii.)

St. George-the-Martyr, Southwark, Vestry Clerk's Office,
37 Bridge House-place, Newington Causeway, 30 April 1857.

Sir,

Having last night received an order from the Sewers' Committee of this parish to forward an answer to your communication, dated 26 March 1857, I shall feel obliged if you will lay the inclosed letter before the Referees on the Main Drainage of the Metropolis.

I remain, &c.
(signed) *James Smith*,
Clerk of Works for Sewers.

Herbert C. Saunders, Esq.,
Secretary to the Referees on the Main Drainage of the Metropolis.

Enclosure in (ii.)

St. George-the-Martyr, Southwark,
Vestry Clerk's Office, 30 April 1857.

Gentlemen,

Having been directed by the vestry of this parish to reply to your last communication, dated 26 March 1857, I have, in the first place, to state, that I cannot furnish you with the correct length of covered sewers in this parish.

I have by me a set of Ordnance maps of the parish to a scale of five feet to the mile, as supplied to the vestry by the Metropolitan Board of Works; on these maps we have delineated the low level brick and pipe sewers that the late Commissioners of Sewers usually allowed the owners of property in this parish to drain into. The united lengths of covered sewers so shown, amounts to about 10¼ miles; and, allowing a similar length of 10¼ miles for a series of old high level drains in various parts of the parish, we have a total of 20½ miles as the probable total length of covered sewers in the parish of St. George-the-Martyr, Southwark.

In addition to the 10¼ miles of covered sewers shown on our maps, there is an extra length of about 6½ miles of brick and pipe sewers laid in the boundary between this parish and the adjoining parishes of Bermondsey, Camberwell, St. Mary Newington, Lambeth, and St. Saviour's.

Thirdly. The length of streets and places, exclusive of uncovered sewers, which still require to be drained in accordance with the practice of the present day, amounts to about 6 miles; and the estimated cost of carrying out such works will amount to about 10,000 *l.*

Fourthly. The plan proposed by the Metropolitan Board of Works, as described in Mr. Bazalgette's Reports, and dated the 3d April and the 1st December 1856, may relieve the sewers in this parish, to a certain extent, although I feel assured that it will eventually be requisite to prolong the proposed deep level sewer or sewers into various parts of this and the adjoining parishes.

In conclusion, I have merely to add for your information, that from the increased stowage for sewage in this parish obtained by the old high level sewers, combined with the new low level sewers, that of late years no serious floodings have occurred in this parish.

I remain, &c.
(signed) *James Smith*,
Clerk of Works for Sewers.

Douglas Galton, Esq. R. E.,
James Simpson, Esq., C. E.,
Thos. E. Blackwell, Esq., C. E.,
Referees on the Main Drainage of the Metropolis.

(23.) St. George's in the East District.

(23.) St. George's in the East District.

Main Drainage, Metropolis.

Sir,

34 Cannon-street Road, 4 July 1857.

In reference to your letter of the 1st inst., I beg to transmit to you the following information:—

1st. The length of covered sewers in the St. George in-the-East district, is 4 miles 156 yards.

2d. The length of open sewers; not any open sewers.

3d. The length of streets and places other than uncovered sewers which require to be drained, 6 miles 1,510 yards.

Estimated cost of reconstructing old sewers and making new sewers, 12,300 *l.*

I am of opinion that the plan proposed by the Metropolitan Board of Works for the main drainage, described in Mr. Bazalgette's Report, dated May 22d and December 1st 1856, will be sufficient for St. George-in-the-East district; and beg to report, that there is no sewer in that district of so low a level as not to be susceptible of efficient drainage by the proposed works.

The covered sewerage in St. George's district is in very good condition.

The sewer in St. George-street has been flooded frequently, which, in my mind, may be attributed to the flood-gates being closed by the tide at high water during a very heavy fall of rain.

I have, &c.,
(signed) *Andrew Wilson*,
Surveyor to the Vestry of St. George-in-the-East.

H. C. Saunders, Esq.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(24.) St. George Hanover-square, District.

(24.) St. George, Hanover Square, District.

Sir,

43, Lower Belgrave-place, 31 March 1857.

In reply to the questions contained in your letter of the 27th inst., I beg to state as follows:—

1st. The length of covered sewers in the parish of St. George, Hanover-square, is about 30 miles.

2d. There are no open sewers.

The foregoing answers refer to the sewers vested in the vestry, and do not include the two main lines, the King's Scholars' Pond Sewer and the Ranelagh Sewer, the former of which is open next the Thames for a length of about 1,000 feet.

3d. There are comparatively few streets and places in this parish without sewers, and in these few places the houses are generally drained. Improvements may probably be made in some of these places at a future time.

The only new sewers at present contemplated are for Bolton-street, 580 feet in length, estimated at 435 *l.*; and for Gregory-street, 170 feet in length, estimated at 40 *l.* I have submitted to the Board an estimate for proposed works, amounting to 3,166 *l.* 12 *s.* 6 *d.*; but the works contemplated are the altering, repairing, deepening, or renewing existing sewers.

With reference to the question as to whether the plan proposed by the Metropolitan Board of Works, as described in Mr. Bazalgette's Reports, dated 22 May and 1 December 1856, will, in my opinion, be sufficient or this parish, I would observe that an opinion on such a subject, to be of any value, could only be arrived at after careful investigation of the various matters in connexion with this question; and my duties unfortunately occupy my time so fully, as effectually to prevent my accomplishing such a task in a manner satisfactory to myself.

From an examination of the section of the Penitentiary branch of the northern low level intercepting sewer, it would appear that the sewers of Lupus-street, and one or two other places to the southward of Lupus-street, are at a lower level than the proposed sewer of interception; but possibly some alterations may be contemplated which do not at first sight appear, which would render these places susceptible of efficient drainage.

In conclusion, I may state that I consider the drainage of the parish to be generally good.

I am, &c.
(signed) *Edm. Chas. Richman*,
Surveyor, St. George's, Hanover-square.

(25.) St. Giles's District.

(25.) St. Giles's District.

Sir,

Office, 109, Holborn, 3 July 1857.

In answer to your communication, dated 26th March last, I beg to state, that the length of covered sewers in this district is about 12¾ miles; and that there are not any open sewers in this district.

That the length of streets and places without sewers is nearly 1¾ mile; and, as the cost of constructing sewers varies considerably, I can, of course, only base my calculations upon those already constructed by the Board, upon which an approximate amount would be 5,000 *l.*

With reference to Mr. Bazalgette's plan for the general drainage, as it may affect this district, I beg to say, that the subject is of such a comprehensive character that I do not feel justified in expressing an opinion thereon. I have, however, carefully examined that portion of the section taken through this district, and find that the proposed "middle level line" is of ample depth to intercept any of its sewers.

I am, &c.
(signed) *W. J. Tremaine*,
Surveyor to the Board.

Herbert C. Saunders, Esq.

(26.) St. James', Westminster, District.

(26.) St. James', Westminster, District.

(i.)

Vestry Offices, 14, Marshall-street, Golden-square,
20 April 1857.

Sir,

Having received a letter from you, dated 18th April, I beg to state that I will forward the replies to the various questions at my earliest convenience; at the same time I should be obliged by a copy of Mr. Bazalgette's Reports of the dates mentioned, as I cannot otherwise speak with certainty as to the relative levels of our sewers, though I do not anticipate any difficulty from the sewerage of this district.

I am, &c.
(signed) *A. P. Howell*, Surveyor.

Herbert C. Saunders, Esq.

(ii.)

Vestry Offices, 14, Marshall-street, Golden-square,
22 June 1857.

Sir,

I beg to inclose the accompanying replies to the questions submitted by you; having had some trouble in procuring Mr. Bazalgette's Reports of the dates mentioned, has caused the delay.

If there is any definite point on which I can be of service, I shall only be too happy to assist the Referees in their labours.

Believe me, &c.
(signed) *A. P. Howell.*

Herbert C. Saunders, Esq.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(Enclosure.)

(26.) St. James', Westminster, District.

Questions.	*Replies.*
1. Length of covered sewers in district - - -	As nearly as can be ascertained, 44,180 feet.
2. Length of open sewers, and estimated cost of covering same.	None, to my knowledge.
3. Length of streets, and places which require to be drained, and estimated cost of same.	The whole district is tolerably efficiently drained at present, but I think the sum of 1,000 *l.* should be allowed for repairing some of the old sewers.
4. Main drainage scheme, as described in Mr. Bazalgette's Reports, May 22d and December 1st 1856, as to its efficiency with regard to this district.	In point of level, the Piccadilly branch would unquestionably take all the sewerage, above or on the north side of Piccadilly, not on the south.
5. Defects in present main drainage - - -	The main drains or sewers, into which our local sewerage discharges itself, answer extremely well as they are at present, I am not aware of anything to be complained of; but I have every reason to believe that some of our small local sewers were completely full on the night of the storm, Friday 19th instant, and that some of the 3'9" × 2'6" sewers were hardly adequate to convey away the sudden accumulation of water on that occasion.

A. P. Howell, Surveyor,
St. James's District.

(27.) St. Luke's, Middlesex, District.

(27.) St. Luke's, Middlesex, District.

Surveyor's Office, 3, Regent-terrace, City-road, E. C.,
13 April 1857.

Sir,

In reply to yours of the 27th ultimo, I beg to state, first, that the only information I can get on the subject must be derived from the plan of the sewers furnished to the vestry by the late Commissioners of Sewers, the original of which is at Greek-street, and to that I beg to refer you for the first and third questions; and to add, that no estimate has been made of the total cost of providing drainage where wanting, the estimates in each case being made as required; the additional sewerage laid down by the vestry, and not shown on the plan of the Commissioners, is a 12-inch pipe sewer in Little Arthur-street, Golden-lane, 142 feet in length; one in continuation of that in Hatfield-street, Goswell-street, 12-inch pipe sewer, 204 feet long, and now in progress; a 12-inch pipe-sewer in Ropemaker-street, Finsbury-street, and Type-street, not yet measured.

Number 2, none.

The intercepting sewer, as proposed, will effectually drain our lowest levels. No floodings have occurred in this parish.

I am, &c.
(signed) *Wm. Christie*, Surveyor, St. Luke.

(28.) St. Martin-in-the-Fields District.

(28.) St. Martin-in-the-Fields District.

Vestry of St. Martin-in-the-Fields, Surveyor's Office,
Castle-street, Long Acre, 3 April 1857.

Sir,

In reference to your letter of the 27th ultimo, requesting information upon certain points, in connexion with the drainage of this district, I beg to state that, with respect to the length of covered and open sewers, the same is given in my Report. The estimated length of streets that require to be drained is about 8,000 lineal feet, and the estimated cost, upon a rough calculation, would be (say) 4,000 *l.*

The second part of your letter has reference to the proposed plan of main drainage by Mr. Bazalgette, so far as it may effect the drainage of this parish.

In respect to the main sewer, which is proposed to be constructed along the Strand, in continuation of the Victoria-street Sewer, there is an alternative plan to construct the same upon the north side of the river, from Hungerford Market-bridge. This latter plan would drain the district south of the Strand, such as the Adelphi, &c., without incurring the expense of reconstructing and reversing the present system of district sewers.

In this parish, at or near Scotland-yard, three of the main sewers have their outlets into the River Thames, viz., Victoria-street Sewer, Regent-street Sewer, Northumberland-street Sewer.

At the present time, two of these main sewers are tide-locked, and necessarily the accumulated sewage has to remain until the recession of the next tide. I have made reference to this subject in page 9 of my printed Report.

I am, &c.
(signed) *R. K. Burstall*,
Vestry Surveyor.

Herbert Saunders, Esq.,
29, Great George-street, Westminster.

(29.) St. Marylebone District.

(29.) St. Marylebone District.

St. Marylebone Court House, Paving and Sewers' Department,
16 June 1857.

Sir,

I am directed to forward to you the inclosed Report on the lengths of sewers in Saint Marylebone, and a copy of a printed Report on the sewers, prepared by a committee of the vestry in 1847, being the only printed Report on the subject of sewers, prepared by the vestry, the sewers of the parish having been under the management of the vestry for so short a period, there has been no general Report on their condition prepared and printed. Reports on portions only of the sewage have been prepared by me, recommending the construction of some particular works.

I am, &c.
(signed) *Robert Scace*,
Surveyor to the Vestry.

H. C. Saunders, Esq.,
29, Great George-street.

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Information on District Drainage.

Text of Surveyors' Answers to Circular.

(29.) St. Marylebone District.

To the Sewers Committee of St. Marylebone.

Gentlemen,

Pursuant to your order of the 29th April, directing me to report on the application of the "Referees of the Main Drainage of the Metropolis," for certain information respecting the sewers of St. Marylebone, and, also, in pursuance of your order of the 6th May, directing me to request the attention of the said Referees to the defective state of the King's Scholars' Pond Sewer, in the Park-road, I beg to submit the following Report:—

To the Referees on the Main Drainage of the Metropolis.

Gentlemen,

I am directed by the vestry of St. Marylebone, in answer to your application of the 18th April for certain information respecting the sewage of St. Marylebone, to furnish you with the following particulars:

Your questions are,—

First. The length of covered sewers in the St. Marylebone district:

	Miles.	*Feet.*
The length of covered sewers is - - - -	39	1,728
„ of pipe sewers - - - -	6	1,352
„ of small sized sewers, barrel drains, &c. -	1	1,000
Total - - -	46	4,080

Second. The length of open sewers in St. Marylebone, and the estimated cost of reconstructing and covering the same.

There are no open sewers in the parish or district of St. Marylebone.

Third. The lengths of streets and places irrespective of uncovered sewers which require to be drained, and the estimated cost of the sewer works thereon.

	Miles.	*Feet.*
The length of streets, roads, and other places requiring sewers, is - -	5	1,890
And the length of the same requiring pipe drains - - - - -	1	680
Total - - -	6	2,570

These lengths of required sewers and pipe drains include streets and roads entirely devoid of sewage, and streets, roads, and other places where sewers are laid in portions only of the streets, &c., and require extension, continuance, and connexion with other sewers, and the estimated cost of constructing such sewers and pipe drains is 23,005 *l.*

But this additional sewage does not include any alterations, amendments, or reconstructions of sewers, a very great extent of which is requisite.

With respect to the fourth question, whether the plan proposed for the main drainage of the metropolis, by Mr. Bazalgette, will, in my opinion, be sufficient for the St. Marylebone district, and whether there will be any sewer in the district at such a low level as not to be susceptible of efficient drainage by the proposed works:

The plan referred to will be sufficient for the drainage of the St. Marylebone district, inasmuch as the proposed new sewer in Oxford-street is shown on a level with the Regent-street Sewer, such Regent-street sewer being 54 feet below the level of Regent-circus, and nearly 20 feet below the level of any other sewage in St. Marylebone.

By the New Road Railway Act of Parliament, compensation is to be made to the parish for any damage or injury sustained by the loss of water to the wells which supply the street pumps; there are 12 public pumps in the line of Oxford-street.

And with respect to any general information respecting the drainage of the St. Marylebone district, I am directed to request your attention to the state of the main sewer in Park-road, being a portion of the King's Scholars' Pond Sewer, respecting which there has been great complaint for many years, from the inhabitants of the locality, and promises of amendment from several commissions.

The sewer northward of the bridge over the Regent's Canal, for a distance of nearly half-a-mile along the Primrose-hill-road, is a large sewer, 7 ft. by 3 ft., and 6 ft. by 4 ft., and is contracted at the said bridge to a size of 3 ft. 10 in. by 2 ft., and the sewer itself carried over the canal in the Park-road, by means of an iron trough or channel, which passes over the crown of the bridge in the said Park-road, under the carriage-way of the road, but above the water of the Regent's Canal, and for a distance of 500 feet southward of the canal, the sewer is only 4 ft. 6 in. by 2 ft.: from this contraction, and from a portion of the large sewer on the north side of bridge having a fall in the wrong direction, there is always a quantity of stagnant matter retained in this hollow of the sewer, and for a considerable distance on the north side.

The sewer on the south side of the bridge is not sufficiently deep for the construction of proper sewage in some of the roads on the west side of Park-road: as Alpha-road, Alpha-place, and Hanover-cottages.

The alteration or reconstruction of the sewer in the Park-road is therefore much to be desired.

There has been no floodings from the main or other sewers in St. Marylebone for many years; the large old main sewer, in Dorset-street, broke up about 50 years back, but since the construction of the present main sewer there has been no overflow, or stoppage, or other cause of complaint.

With respect to the general state of the drainage of the St. Marylebone district, a very large extent of sewage, in the parish, has been most improperly constructed in all the particulars of level, form, and bad materials.

The district or parish of St. Marylebone rises in almost an uniform ascent from the hollow of Wigmore-street (such hollow being in the line of the old main sewer) to the eastern and western boundaries of the parish; and northward to the Eyre Arms; and sewers could have been laid through all the streets of the parish, with proper inclinations, especially as most of the new streets were constructed in regular gradation from the low levels towards the higher parts of the parish; but the sewers have been built of all forms and sizes, and at such irregular inclinations as in many cases to come near the surface at portions only of the lengths of the streets, leaving the residue of such streets without proper drainage. Many of the sewers have also been constructed of such improper materials as to be now in ruinous and dangerous condition.

It has been my duty to recommend to the vestry the rebuilding, the reconstruction, or formation of additional sewage in the following places:—

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(29.) St. Marylebone District.

NEW SEWAGE.

Adam and Eve Court.
Adam-street, West.
Abercorn-mews.
Bentinck-mews, P. T.
Charles-street, M. S.
Charlotte-mews, East.
Cross Keys-mews.
Grove-mews.
Hanover-cottages.
Henry-street, P. T.
Marylebone-street, Upper.
Little Queen-street.
Riding House-lane.

RECONSTRUCTION OF OLD SEWAGE.

Adam's-mews.
Capland-street.
Croydon-street.
Cumberland-mews, Great.
Crawford-street.
George-street, Upper.
Horace-street.
Homer-row.
John-street, E. R.
Marylebone-lane.
Molineux-street.
Nassau-street.
Newnham-street.
Newman-yard.
Portland-street, Great.
Queen-street.
Seymour-place.
Shouldham-street.
South-street.
Titchfield-street, Great.
Union-street, M. H.
York-street, M. H.

Being an extent of about two and a quarter miles.

And it will be my duty to recommend as early as possible the rebuilding and reconstruction of a very much larger portion irrespective of the construction and formation of entirely new sewage.

(signed) *Robert Scace*,
Surveyor to the Vestry.

13 May 1857.

(30.) St. Olave, Southwark, District.

(30.) ST. OLAVE, SOUTHWARK, DISTRICT.

(i.)

Sir, 191, Tooley-street, Southwark, 7 April 1857.

IN reply to your favour of the 27th ult., I beg to state that I have laid the same before a committee of this Board, who have directed me to prepare a Report upon the drainage of the district, which will embody the information you ask for on behalf of the Referees. As soon as the same has been laid before the Board and approved, so much thereof as is necessary to answer your inquiries shall be forwarded to you.

I am, &c.
(signed) *Arthur J. Newman*, Surveyor.

H. C. Saunders, Esq.,
29, Great George-street, Westminster.

(ii.)

Board Room, 86, Queen Elizabeth-street,
St. John's, Southwark, 27 July 1857.

Gentlemen,

AT the request of this Board, I have the pleasure to send you the copy of a Report upon the subject of the sewage of this district.

I have, &c.
(signed) *J. Robson*, Clerk.

Douglas Galton, Esq.,
James Simpson, Esq.,
Thomas E. Blackwell, Esq.
29, Great George-street, Westminster.

(Enclosure.)

Gentlemen,

IT may probably be known to most of you, that the plans for the main drainage of London, after having been discussed for upwards of twelve months, and finally agreed upon by the Metropolitan Board of Works, have been referred by Sir Benjamin Hall to three engineers. These gentlemen, in order, I suppose, to test the accuracy and to prove the capability of Mr. Bazalgette's plans, have forwarded to the several vestries and district boards certain questions.

Before furnishing the required information, I deemed it advisable to lay the letter asking for it before the committee for general purposes. It was thought by them that the whole subject would be better dealt with in the form of a Report.

In endeavouring to submit this Report to you, I propose to divide the subject into two parts.

1st. The nature of the district in relation to its capability of drainage.

2d. The present condition as to sewerage.

1st. The nature of the district in relation to its capability of drainage.

On this point I must ask your indulgence if I travel rather beyond the limits of the district immediately under your jurisdiction, for the purpose of showing the difficulties that have had to be encountered, and the manner in which those who have the control of the execution of the sewerage have endeavoured to meet them. The surrounding districts of St. Saviour, St. George, and Christchurch are so intimately connected with this as to their sewerage, that I must be allowed to consider them collectively.

In order that you may rightly appreciate this part of my subject, I will endeavour to present to your view the physical aspect of Southwark.

* As a general fact, you must bear in mind that a very considerable portion of the district (Southwark) lies below Trinity high-water mark; and, were it not for the maintenance of the banks of the river, scarcely a year would passbut, on the occasion of extraordinary high tides, nearly the whole of the district would be

* The substance of the greater part of this report is contained in one made by Mr. I'Anson to the Commissioners of Surrey Sewers, dated February 1843.—*See* Appendix VIII., page 317.

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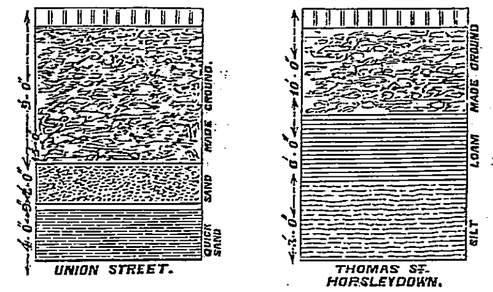
Text of Surveyors' Answers to Circular.

(30.) St. Olave, Southwark, District.

be flooded. It is doubtless in the recollection of many of this Board, that, besides the floods which, at the times of high tides and heavy rains, spread over the low lands of Lambeth and Rotherhithe, the district southward of the New Kent-road was frequently under water. So important is the full consideration of this part of the subject, that I have subjoined a table, which shows the actual surface levels at various points, as ascertained some few years since.

			Ft.	in.
High-street Borough and Tooley-street	above Trinity high-water mark		3	0
Obelisk Blackfriars-road (artificial mound)	ditto		4	0
Borough-road	below	ditto	1 ft. 6 in. to 1	11
Cross-street, near the Elephant and Castle		ditto	2	1
Southwark Bridge-road		ditto	1	9
New Kent-road		ditto	5	0
Swan-street, Old Kent-road		ditto	6	0
Bermondsey New-road		ditto	5	0

The most elevated points of the surface are those along the old lines of road, the High-street, Borough, and Kent-street, the ancient highways into Kent and Surrey. In these the great thickness of made ground, the accumulation of ages, has given an artificial elevation to the surface, averaging about three feet above the Trinity high-water mark, or nearly on a level with the occasional highest tides. The same observation applies to the ancient parts of Southwark; but the thickness of the made ground southward, westward, and more especially south-eastward, of the above-named localities, is much less (*see* Sections at the side), and the surface continues to decline until it reaches the base of the Surrey Hills.





Such, then, are the general features of the district. I proceed now to show the ancient nature of the sewerage.

Many of the watercourses seem to have been originally tide mill-ponds. Some of them bear names that help, in addition to other evidence, to prove this. These mill-ponds were sometimes banked up above the level of the surrounding land, to such an extent that the surface drainage was carried off by culverts passing under them. In ancient times, a large portion of Southwark was occupied by monastic establishments, and branches were carried in different directions from these mill ponds, to supply them with water. In later times, when manufactories, requiring water, were established, these ancient streams became the only sewage of the district.

I adduce these facts to illustrate two points peculiar to this district, viz., that the ancient sewers were but surface drains, and to show the reason of the very tortuous course of the old sewers, ofttimes through private property.

The Battle-bridge Sewer, which is one of the main sewers which passes through the St. Olave's districts and which has its outlet at Mill-lane, was one of the first lines of sewage adopted. This sewer was commenced about 9,000 feet from its outlet, not far from Bethlehem Hospital, and its immediate object was the drainage of the marshy district of St. George's-in-the-fields. To this main line the several deep sewers that have been constructed in the parishes of St. Saviour, St. George, St. Thomas, and Christchurch have been laid.

Another line of sewers, which may be called a second main artery, is the main sewer which takes the principal drainage of the parishes of St. Olave, St. John, and part of Bermondsey. This is a sewer which is known by the name of the Great St. John Sewer, which has its outlet at Shad Thames. It thence takes its course through Horseleydown, to the junction of Tooley-street and Bermondsey-street.

Thus you will see that your predecessors endeavoured, to the best of their judgment, in a district naturally difficult of drainage, to construct deep and efficient sewage, in many cases, in anticipation of the great improvements which could not but be expected, and which have resulted in numberless instances.

2d. The present condition of the district as to sewage.

The south side of London must be divided into two divisions, the High Level area and the Low Level area. The brooks and ditches, which have received, from time immemorial, the overflow of cesspools, have emptied themselves into the sewers of the low district. The low district, being for the most part below high-water mark, and many of the houses in it having cellars and basements which required to be drained, it became necessary to form the outlets of the sewers so low, that for 18 out of 24 hours they are closed by the tide.

To this circumstance much of the evil of the present system of drainage is attributed. During the hours that these sewers are tide locked, they become nothing less than elongated cesspools, and one of the natural consequences of this is, that when storms or prolonged rains occur, the ground becomes saturated, and cellars are flooded.

Several causes tend to increase this evil; the increase of paved surfaces, better formed roads, buildings taking the place of open ground, discharging more rapidly the flood of water.

In this district, which comprises the parishes of St. Olave, St. John, Horsleydown, and St. Thomas, there are eight miles of sewers; of which nearly two miles are main sewers, under the jurisdiction of the Metropolitan Board of Works. About four miles are brick sewers, and the remainder are pipe sewers of recen construction, in many cases laid where open ditches formerly existed. There are now no open sewers in this district. I can hardly imagine a district which generally is so well provided with sewerage; it is true that some of the old high level sewers are dilapidated, and will require occasional repair, and in some cases

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alterations may be made, whereby they may be rendered more efficient; yet, taken as a whole, the district is one in which the probable outlay for new drainage will be comparatively small. The expense which will necessarily accompany the carrying out of the main drainage scheme, in the alteration of the main lines of sewers, will be assessed upon the metropolis by the Metropolitan Board. There are but very few streets not already provided with sewers running through them, and, with few exceptions, there are but few public courts; owing to the measures that have been adopted, and are still being pursued by you, many owners of private courts have and are still effecting proper drainage.

Trusting you will excuse the length to which I have been led in this Report,

I beg to remain, &c.
(signed) *Arthur J. Newman*, Surveyor.

(30.) St. Olave, Southwark, District.

191, Tooley-street,
June 1857.

(31.) St. Pancras District.

(31.) St. Pancras District.

Department of Works,
Office, 10, Edward-street, Hampstead-road, N. W.,
7 July 1857.

Sir,

I have to apologise for not having acknowledged the receipt of your letter of the 27th March, in consequence of a misapprehension, on my part, that the clerk had been instructed so to do.

On receipt of that letter I laid it before the Highways and Sewers Committee, and was directed to inform you, that the particulars you requested were not in possession of this office; but that the committee had reason to believe they could readily be obtained at the office of the Metropolitan Board of Works, the plans and papers of the late Commission of Sewers being in the possession of that Board.

I am, &c.
(signed) *Wm. Booth Scott*,
Chief Surveyor.

Herbert C. Saunders, Esq.

(32.) St. Saviour's, Southwark, District.

(32.) St. Saviour's, Southwark, District.

Board Room, Emerson-street, Bankside, Southwark,
3 June 1857.

Sir,

I have this morning received instructions from the Sewers Committee of this Board to forward to you, for the use of the Referees on the main drainage scheme, the fullest information to your several inquiries that the plans and documents of this Board can supply.

There is in this district 33,500 feet run of brick sewer; 15,804 feet run of pipe sewer.

There is no open sewer in the district.

The new sewers works proposed to be done, and which have received the sanction of the Metropolitan Board of Works, comprise 9,987 feet run of brick and pipe sewer, at an estimated cost of 3,231 *l.* 5 *s.* 6 *d.*

I have examined the sections of the proposed main drainage, as referred to in Mr. Bazalgette's Reports of 3 April and 1 December 1856, and am of opinion the proposed drainage will effectually relieve the sewers in this district.

The existing drainage in this district is effective and in good condition.

This district has not of late been affected by any floodings from defects of the main drainage.

Any further information that the documents in my possession can furnish I shall be happy to forward to you.

I remain, &c.
(signed) *John Howe.*

Herbert C. Saunders, Esq.

(33.) Shoreditch District.

(33.) Shoreditch District.

Office of the Vestry, 37, Hoxton-square,
Chief Surveyor's Department, 6 July 1857.

Sir,

In reply to your letter of the 1st inst., I beg to state, that since receiving your circular letter, dated 4 April 1857, I have endeavoured, from time to time, to give the Referees the required information relative to the existing sewerage, and the non-sewered districts of this parish.

But such are the varied and overwhelming duties connected with my department, that I have found it wholly impossible to comply with your request in the exact manner such requirements ought to be rendered; and I have been unable to devote any of the time of the only assistant surveyor I have to this purpose.

By a printed Report on the main drainage,* and by a written communication on the main drainage of the metropolis generally, forwarded to you some months ago, my opinion, as to the plan proposed by the Metropolitan Board of Works, can be readily adduced; and I am clearly of opinion, that the drainage of this neighbourhood will be less efficient by the intercepting lines of sewer, in after-time, than by the existing outlets.

I am, &c.
(signed) *William Yates Freebody*,
Chief Surveyor to the Vestry.

Herbert C. Saunders, Esq.
29, Great George-street, Westminster.

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* *See* Report, page 291.

Appendix VII

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(34.) Strand District.

(34.) Strand District.

23, Henrietta-street, Covent-garden, W. C.,
4 July 1857.

Sir,

I herewith forward, for the information of the Referees appointed to consider the plan proposed by the Metropolitan Board of Works for the main drainage of the metropolis, answers to the questions contained in your circular of the 16th April 1857.

I am, &c.
(signed) *George Fred. Fry*,
Surveyor to the Strand District Board of Works.

Herbert C. Saunders, Esq.,
29, Great George-street, Westminster.

(Enclosure.)

Answers to Questions contained in Circular, dated 16th April 1856.

1. The total length of covered sewers in the Strand District is 11 miles 1,390 yards, or thereabouts.
2. There are no open sewers or uncovered ditches in the Strand district.
3. The length of sewers required at the present time to be constructed and re-constructed is 1 mile 1,000 yards, and the estimated cost thereof 5,091 *l.*
4. My opinion is, that the plan of sewerage proposed by Mr. Bazalgette, and described in his Reports, dated 22d May and 1st December 1856, will be quite sufficient for the drainage of the Strand district, both as respects size and levels; it being taken for granted that the main middle level intercepting sewer will intercept the drainage of the St. Martin's-lane Sewer, and not the Piccadilly branch; which latter, I fear, would not be sufficiently capacious.
5. The Strand district has never been flooded, to my knowledge, during the last eight years.

(signed) *George Fred. Fry*,
Surveyor to the Strand District.

(35.) Wandsworth District.

(35.) Wandsworth District.

(i.)

Bolingbroke-grove, Wandsworth-common,
16 April 1857.

Sir,

I beg to acknowledge the receipt of your letter of the 28th ultimo, which was laid before a meeting of this Board yesterday; and, in reply, I beg to inform you that I have received instructions to prepare a Report as to the information required, but which will first have to be submitted to this Board.

I am, &c.
(signed) *D. W. Young.*

H. C. Saunders, Esq.
29, Great George-street, Westminster.

(ii.)

Bolingbroke-grove, Wandsworth-common,
5 May 1857.

Gentlemen,

In pursuance of your request, I have the pleasure of forwarding you the information desired by you in your letter of the 27th ultimo, viz.:—

As to the length of open and covered sewer in this district, the estimated cost of covering the open sewers, and the length and estimated cost for the new sewers required, exclusive of the main sewers proposed to be built by the Metropolitan Board of Works, as shown and described in Mr. Bazalgette's Report and Plans, dated 3d April 1856.

For the whole of this information, and for the general statement as to the state of drainage of this district, I beg to refer you to the Report and Appendix on the open and covered sewers vested in the Board, and upon the new sewers required for the district, which I was directed by this Board to prepare, at the commencement of their duties, under the "Metropolis Local Management Act," and three copies of which I have the honour of forwarding enclosed.*

Upon reference to this Report, it will be there found that the length of the covered sewers in this district is 45¼ miles.

The length of open sewers, 21 miles.

The estimated cost for their temporary covering, 8,237 *l.*

The estimated length of new sewers which will be required, nearly 39 miles, and the estimated cost, 111,840 *l.*

With respect to the depth proposed for the low level sewer, at its commencement at High-street, Putney, viz., 8′ 90″ above Ordnance datum, being 15′ 4″ below the level of the road, I am of opinion that this is required to be deeper, so as to enable any new sewer that may be built along the Lower Richmond-road to be also intercepted.

The level of this new sewer when built, with an inclination of 1 in 369, and with a depth varying from 8′ 4″ to 17′ 6″ at its outlet into High-street, Putney, a distance of about 140 yards from the commencement of the low level sewer, I propose to be 7′ 0″ above Ordnance datum, or nearly 2′ 0″ lower than the proposed main low level intercepting sewer.

With this exception, I am of opinion that the intercepting sewers proposed by the Metropolitan Board of Works will be of incalculable advantage, as affording outlets for the sewerage of this district.

There are, no doubt, many details connected with the scheme, such as keeping the high level sewer at such a depth as to allow it to be extended so as to allow it to intercept as much drainage as is possible into it, which was intended to be fully considered before being carried into effect.

From complaints made at this office, and from inquiries made, I find that, in times of heavy rains, floodings take place along each of the principal main lines of sewers, vested in the Metropolitan Board of Works, in this district.

Along the valley of the River Wandle, which river is vested in the Metropolitan Board of Works, as a main sewer, this flooding arises from the numerous obstructions along its course by the different mills, the level of the water in dry weather being some feet above the level of the adjoining land.

Along the Falcon Brook there are various ponds which were formerly ornamental pieces of water, but are now in dry weather little better than foul, open cesspools, and also form obstructions to the drainage.

The Heathwall Open Sewer, along Battersea-fields, in consequence of the large and increasing quantity of soil drainage being discharged into it, is in a very bad state, and about which this Board is continually receiving complaints.

I have, &c.
(signed) *D. W. Young*,
Surveyor to the Board.

To the Official Referees, to whom the Main Drainage of the Metropolis is referred to report upon.

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* *See* Report, page 297.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(36.) Westminster District.

(36.) Westminster District.

Millbank-row, Westminster, 3 April 1857.

Sir,

I beg herewith to hand you my replies to the questions put by you on behalf of the Referees on metropolitan drainage, in your communication of the 27th ultimo.

I am, &c.
(signed) *R. R. Arntz.*

Herbert C. Saunders, Esq.

(Enclosure.)

Millbank-row, Westminster, 3 April 1857.

Main Drainage, Metropolis.

Replies to Questions put by the Referees to the Surveyor to the Board of Works for the Westminster District, by Letter, dated 27 March 1857.

Questions.	*Replies.*
1. The length of covered sewers in the Westminster district?	18¾ miles.
2. The length of open sewers in the Westminster district, and the estimated cost of re-constructing and covering the same?	The only open sewers in the Westminster district are the King's Scholars' Pond Sewer from Bessborough-street to Ponsonby-street, and a short length of sewer in Gore-lane, Knightsbridge. The former is under the control of the Metropolitan Board of Works, and the latter need not be regarded, as it must very shortly be either diverted or arched over by the Great Exhibition Commissioners.
3. The length of streets and places, exclusive of uncovered sewers, which require to be drained, and the estimated cost of the sewer works thereon?	6 miles. Estimated cost of sewer works, 25,000*l.*
4. Whether the plan proposed by the Metropolitan Board of Works for the main drainage, as described in Mr. Bazalgette's Reports, dated 22d May and 1st December, will, in your opinion, be sufficient for the drainage of the district under your charge, and whether there will be any sewer in the district at so low a level as not to be susceptible of efficient drainage by the proposed works?	Taking it to be the intention of the Referees to inquire whether, main lines of sewers being laid down at the levels, and in the situations proposed by Mr. Bazalgette, the whole of the Westminster district could, in my opinion, be sufficiently drained, I beg to draw attention to the following circumstances, viz.: That Mr. Bazalgette proposes to adopt the Victoria-street Sewer as a portion of the new low level main sewer. That the depth of the Victoria-street Sewer, at the intersection of Parliament-street and Great George-street, is 1·56 feet (Ordnance datum). That the distance from Great George-street to Wood-street is about 1,400 feet, and that, taking the rate of inclination of the new main sewer to be, as given, 1 in 1,400, its depth at Wood-street will be 0·56 feet. That the distance from Millbank-street, by Wood-street, to Great Peter-street, by Saint Ann-street, is about 1,100 feet, and that, taking the rate of inclination of a branch sewer along Wood-street, Little Peter-street, and Great Peter-street, at 1 in 550, the depth of such sewer in Great Peter-street, by St. Ann-street, will be 1·44 feet. That the surface level at this point is 10·65 feet above Ordnance datum, and that, taking 4 feet as a minimum level, at which a basement floor should be laid above the adjacent sewer, such floor must, in this situation be laid at 5·41 feet only below the surface of the street; and that, in consequence, to obtain a basement story of the minimum clear height of 7 feet (as required by the Metropolitan Buildings Act), the ground floor must be laid at a height of 2·59 feet above the level of the street. There are many other points at which the surface level is about the same as at this point, and there are very many at which, while the surface level is some 18 inches higher, the distance from the main sewer is so great as fully to reinstate the circumstances above described.
5. As to the state of the drainage of the Westminster district, with a description of any floodings which may have occurred from defects of the main drainage?	The drainage of the Westminster district generally has been greatly improved of late years, but even now much difficulty is experienced in draining the basement floors of houses and buildings. Flooding has occurred several times during the last year in the Vauxhall Bridge-road, and in each case from the great depth of water ponded during heavy or long-continued rains in the King's Scholars' Pond Sewer. (signed) *R. R. Arntz,* Surveyor to the Board of Works for the Westminster District of the Metropolis.

Appendix VII.

Information on District Drainage.

Text of Surveyors' Answers to Circular.

(37.) Whitechapel District.

(37.) Whitechapel District.

No. 15, Great Alie-street, Whitechapel,
3 July 1857.

Sir,

In reply to your letter, dated 27th March, requesting information respecting the sewerage of this district,—

1st. The length of the covered sewers (including pipe sewers) in the Whitechapel district is 13¼ miles.

2d. There are no open sewers in the district.

3d. I am not in a position to give the length of streets requiring sewers, nor the estimated cost of such required sewers, such estimates not having been made.

I am of opinion that Mr. Bazalgette's Reports, dated 22d May and 1st December 1856, describe a plan of main drainage which would be quite sufficient for the drainage of this district, only the portions of the existing main lines on the south side of the proposed main low level sewer will have to be reconstructed, and the inclination reversed; and this alteration will necesitate the reconstruction of some other sewers which at present discharge into the aforesaid portions of the existing main lines.

There is no sewer in this district at so low a level as not to be susceptible of efficient drainage by the proposed works, nor any portion of the district at present undrained which could not be efficiently drained by the proposed system.

The only floodings which have occurred in this district since I have held the office of surveyor took place on the occasions of the late heavy storms last Wednesday, 1st July, and Wednesday, 17th June, when the sewage came back up the drains and into the cellars of houses in various parts of the district. All inconvenience had, however, subsided in about eight or ten hours.

For further information, I beg to forward you the enclosed table, *printed, by order of this Board of Works, in March last.

I am, &c.
(signed) *H. R. Fricker,*
Surveyor to the Board.

Herbert C. Saunders, Esq.

(38.) Woolwich District.

(38.) Woolwich District.

Office of the Woolwich Local Board of Health,
Town Hall, Woolwich, 7 April 1857.

Sir,

In reply to your letter of the 27th ult., I beg to inform you that the whole of this district has been drained during the past five years, upon plans approved by the General Board of Health, and is now acting to the entire satisfaction of this Board, but having outlets into the Thames.

Qy. 1 - - - - - -	17 miles.
„ 2 - - - - - -	None.
„ 3 - - - - - -	None.

With reference to the proposed plan for the drainage of the metropolis being sufficient for the drainage of this district, I beg to state that I am of opinion the plan alluded to will be sufficient, and that there is no sewer at so low a level but may be drained by it, but the whole of the outlets will require to be brought up to the proposed sewer at a very considerable cost.

In addition, I beg to inform you, that, by application to the General Board, the Reports of Mr. Rawlinson on the state of the town prior to the introduction of the Public Health Act, and Mr. Rammell's Report, with plan, of the drainage, as carried out by this Board, may be obtained.

I am, &c.
(signed) *John Barnett*, Surveyor, &c.

H. C. Saunders, Esq.

Miscellaneous Letters, &c.

(3.)—LETTERS containing General Information, &c., as to District Drainage, received from Clerks to District Boards of Works and others.

(1.) Bethnal Green.

(1.) Bethnal Green.

Town Hall, Bethnal Green, N. E.,
20 February 1857.

Gentlemen,

We are directed to acknowledge the receipt of your letter of the 12th instant, addressed to the Chairman of the Vestry of this parish, and, in reply, to state, that the officers are authorised to furnish you with any information you may require.

We are also directed to say, that the Vestry consider the question of ventilating the sewers of vital importance to this district, and trust that means will be devised effectually to prevent the escape of poisonous gases and noxious effluvium.

We are, &c.
(signed) *Brutton & Voss,*
Vestry Clerks.

Messrs. Galton, Simpson & Blackwell,
29, Great George-street, Westminster.

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* Not reprinted.

Appendix VII.

Information on District Drainage.

Miscellaneous Letters, &c.

(2.) Camberwell.

(2.) Camberwell.

(i.)

Vestry Hall, Camberwell, 19 March 1857.

Gentlemen,

I am requested, by the committee appointed by the Vestry of this parish, to send, as requested, three copies of the surveyor's report on the drainage of this parish, and also a copy of a Resolution passed at a Vestry held specially to consider the proposed system of drainage by the Metropolitan Board of Works; and I am further requested to acquaint you, that the committee are desirous of waiting upon you, as a deputation, for the purpose of explaining the views of this Vestry with reference to the drainage of the metropolis and this parish, and they will be happy to attend any appointment you may make to receive it.

I am, &c.
(signed) *Geo. W. Marsden*, Vestry Clerk.

Messrs. Galton, Simpson & Blackwell,
29, Great George-street, Westminster.

Resolved, That any system of metropolitan sewage, to be thoroughly effective and economical, ought to embrace the separation of solid and liquid matter; and also, by deodorising or otherwise dealing with the animal matter therein contained, whilst in its recent state, to diminish the bulk of the substance to be removed, with a view to the ultimate utilization of the same, and enabling the fluid portion to pass by the ordinary channels into the Thames in a state of purity, which will keep up the quantity of water therein without injury to its quality.

(ii.)

Vestry Hall, Camberwell, 28 March 1857.

Sir,

In reply to your favour of the 24th inst., I beg to inform you, that the deputation from Camberwell will wait upon the Referees at 3 o'clock on Wednesday next; and I send you enclosed the points which the deputation will more immediately bring under their consideration.

I am, &c.
(signed) *Geo. Wm. Marsden.*

H. C. Saunders, Esq.,
29, Great George-street, Westminster.

(Enclosure.)

That, as the use of pure water is essential to health, it is of the highest importance that the River Thames, from which a large portion of the water supply of the metropolis is obtained, should not be polluted, by being made the common receptacle for its sewage.

That in any plan for intercepting and dealing with the sewage of the metropolis, a careful consideration should be given to the great fertilizing properties which it is known, when not too largely diluted, to contain; and that every encouragement should be held out for discovering the means of turning those properties to the best account for the interests of the ratepayers, and the welfare of the country.

That to expend a sum of millions of pounds on the construction of intercepting sewers, which are only to be used for conveying the sewage a distance of a few miles into reservoirs of many acres in extent, from which it is to be permitted finally to flow into the Thames, is, apart from other evils, to fix a heavy burden not only on the present, but future generations, in making a gigantic effort foolishly to throw away that which the wisdom and economy of other nations have taught them, without any such expense, to convert into the means of individual and national advantage.

(3.) Fulham.

(3.) Fulham.

Broadway House, Hammersmith, W.,
19 March 1857.

Gentlemen,

I am instructed to inform you that this Board have had under consideration the plan of Mr. Bazalgette, dated 22d May 1856, for the "Sewage Interception and Main Drainage of the Districts north of the Thames;" and that, for the purposes of interception, they regard it as providing for the wants of the Fulham district; but that in respect of main drainage it is defective, leaving large areas of the parish of Hammersmith unprovided therewith.

That they have also considered the earlier scheme of Mr. Bazalgette, dated January 1854, and consider that it provided for the wants of the said parish in this latter respect more adequately, as it proposed to carry the main intercepting sewer along the high road, thereby providing "main drainage" for a densely populated district of more than one mile in length, and which is now but very inadequately drained.

That, in order to remedy the defect in the first-mentioned plan, as applying to this district, this Board suggest that a sewer be constructed along the high road of Hammersmith, from the western boundary to the Albion-road Sewer, and from the eastern boundary to the Bridge-road Sewer, and that another sewer be constructed between the said Albion-road Sewer and the said Bridge-road Sewer, and along the said high road; that the Stamford Brook Sewer should be diverted at the point where it crosses the New-road, carried along the New-road southward, till it unites with the proposed new sewer at the west end of the aforesaid high road; that the Bridge-road Sewer should be continued to Wood-lane; and that the Counter's Creek Sewer should be carried along the Uxbridge-road, till it unites with the Victoria Sewer at Starch Green.

The clerk and surveyor have instructions to supply you with such information as may be in their power to give.

I have, &c.
(signed) *W. Lovely*, Clerk.

Captain Galton.
J. Simpson, Esq.
T. E. Blackwell, Esq.
&c. &c. &c.

(4.) Greenwich.

(4.) Greenwich.

Offices, Church-street, Greenwich, 15 May 1857.

Gentlemen,

Your letter of the 12th of February last having been referred to the several committees acting in and for the respective parishes in the Greenwich district, who have communicated with the medical officer and surveyor thereon, I am now directed by the District Board to transmit to you a copy of a letter from the medical officer of this district on the subject of the Main Drainage scheme, and to request your particular attention to the several points contained in that letter.

I am, &c.
(signed) *E. H. James*,
Clerk to the Board.

Captain Douglas Galton.
James Simpson, Esq.
Thomas E. Blackwell, Esq.
&c. &c. &c.

Appendix VII.

Information on District Drainage.

Miscellaneous Letters, &c.

(4.) Greenwich.

(Enclosure.)

Metropolis Main Drainage.

Gentlemen,

Crooms Hill, 26 March 1857.

On taking into consideration the subject of the letter referred to me by your committee, I will at once observe, that it would be a folly on my part to offer any opinions connected with the many engineering difficulties that will be likely to arise in connection with the Main Drainage of the Metropolis; but I will venture to lay before you a few observations, in a sanitary point of view, as regards this district.

1st. I will mention the receiver, and the lifting of the sewage at Deptford Creek. I confess that I view with considerable anxiety and alarm the proposition to erect such works in the very centre of this densely-populated neighbourhood. Although every precaution, no doubt, will be taken to render such works air-tight, and as little injurious as possible, still I cannot believe but that some escape of gas and noxious effluvia must at times take place. The receiver may become damaged from various causes, and the pumps may get out of order. What, I would ask, would become of the sewage should either of these accidents occur, and more particularly during the repair of such accidents?

2d. I would bring to your notice the discharge of the overflow, or storm-water, from the whole of the south side of the Thames into the creek at Deptford. Those storm-waters must contain a large amount of sewage and fœcal matter, however much diluted, and the district would suffer from the discharge of such waters. I strongly recommend an opposition to be offered to the discharge of such waters at the point in question.

3d. As regards the ventilation of the main sewer, and the receiver at Deptford Creek. In the progress of the sewer through this large district, a large number of ventilating shafts must be erected, or other openings formed, to allow of the escape of the gases from the sewer. Such ventilators would be pouring forth large volumes of these noxious matters into the surrounding atmosphere; and it would be difficult to estimate the dangers that would be likely to accrue from such effluvia.

4th. I would ask what provision is to be made in case the main sewer should at any time become damaged, obstructed, or out of order. It would be fearful to contemplate what mischief would arise in Deptford, for instance, provided the main sewer were damaged at Deptford Creek, or even at the pumping-station itself. The whole town would be inundated with the sewage from the whole of the south side of the Thames. On the whole, therefore, I cannot but view the scheme as very impracticable, and one that will be very injurious to this district in particular.

The foregoing observations I believe to be very important in connection with the sanitary condition of your district, and with that impression I leave them to you to deal with according to their worth, and remain

Yours, &c.
(signed) *Henry N. Pink.*

To the Parish Committees of the Greenwich District Board of Works.

P. S.—In addition to the foregoing observations, there are one or two points connected with the sewers already made in this district that I wish to bring before your notice; viz., I would ask the Board of Works what plan is proposed to be adopted in respect to the sewers already constructed by the late Commissioners of Sewers in those parts of this district below the line of the proposed Main Sewer. The sewers in Roan-street, Union-street, and Horseferry-road, for example, now discharge their contents into the river; such sewers, I apprehend, must be taken up, and relaid, with a fall in the direction of the Main Sewer. At whose expense are these works to be carried out? I think it would be very unfair towards this district to be at that extra expense; and more particularly as the district appears to be already much overtaxed in regard to the liquidation of the debt left by the late Commissioners of Sewers.

(5.) Kensington.

(5.) Kensington.

Gentlemen,

Vestry Hall, Kensington, 9 March 1857.

Your letter of the 12th February last, on the question of the main drainage of the metropolis, having been under consideration of the Kensington Vestry, I have to inform you the following order was made thereon, viz.

"That the clerk be directed to transmit to the gentlemen appointed by Her Majesty's Commissioners of Works the resolutions passed by this vestry in reference to the subject of the main drainage of the metropolis, and the letter forwarded to the Metropolitan Board of Works thereon; and that the clerk and surveyor be authorised to furnish the said gentlemen with any information on the subject they may possess."

In compliance with the above resolution, I beg to forward you copy of the letter therein referred to; and to state, the surveyor and myself will be happy to furnish any information you may require on the subject which we may possess.

I am, &c.
(signed) *R. Green*,
Clerk to the Vestry.

Messrs. Galton, Simpson, & Blackwell, the Commissioners appointed by Government to consider the Metropolitan Main Drainage Scheme.

(Enclosure in above Letter, A.)

Copy of Letter referred to in Resolution passed by the *Kensington* Vestry on the 4th day of March 1857.

Sir,

Vestry Hall, Kensington, 4 December 1856.

I am directed by the vestry of Kensington to forward to your Board the following copy of a resolution, passed at a meeting held on the 26th November last, in reference to the sewage manure of the metropolis, viz.

"That in the opinion of this vestry, it is desirable that Mr. Hawks should invite the Metropolitan

Appendix VII.

Information on District Drainage.

Miscellaneous Letters, &c.

(5.) Kensington.

Board of Works to offer a reward to any person who shall discover any easy practical and inexpensive method of converting the sewage manure of the metropolis into a substance as portable as guano; without impairing any of its fertilising properties; and that a letter be addressed to the Metropolitan Board on the subject."

And I am further instructed to inform you, that it appears to this vestry that, at the time the question of carrying off the sewage manure beyond the precincts of the metropolis is engrossing the attention of your Board, it is much to be regretted that the consideration of the manner in which that manure may be economically disposed of is almost entirely ignored.

It is generally admitted, that if the fertilising substances, contained both in suspension and solution, in the sewage water, could be separated from that fluid, deodorised and made portable, they could be sold for a very large sum of money: probably some millions annually. Every exertion ought therefore to be made to prevent so valuable a commodity from being wasted, as it now is by being merely washed away into the ocean.

A strong opinion, almost amounting to conviction, exists in the minds of scientific men, that the problem of collecting this large amount of manure, and applying it to agricultural purposes, is to be solved, if really competent persons were to undertake its investigation in that spirit of sincerity and determination by which alone difficulties of this nature are to be surmounted. Instead, therefore, of continuing to rely on the present *laissez faire* system, this vestry is of opinion, that it would be extremely desirable to hold out some great inducement to scientific men to devote their energies specially to this inquiry, by offering a reward commensurate with the importance of the subject to anyone who should discover how the solid parts of sewage manure can, without impairing their fertilising propensities, be made by an easy and inexpensive process as portable as guano.

The advantages likely to accrue from offering a liberal reward to promote so desirable an investigation cannot be better illustrated than by referring to the results which followed the adoption of a similar course by Napoleon I. during the last war between this country and France.

In consequence of the strict blockade of the French ports at that period by British cruisers, the importation, both of sugar and saltpetre, into France was almost completely interrupted. The French nation suffered greatly by being deprived of so valuable an article of food as sugar; and the French armies were threatened with being rendered almost innocuous to their antagonists on account of the impossibility, which seemed likely to occur, of obtaining saltpetre to manufacture the large quantities of gunpowder which were indispensably necessary to carry out the aggressive policy of the Government. Under such emergencies, the Emperor Napoleon appealed to the scientific men of France to aid him with their talents and advice.

He was recommended to offer social distinctions, appointments, and pecuniary recompenses to anyone who would show how sugar might be procured from any indigenous vegetable production of the French soil, and how saltpetre might be produced at home, and thus render France independent of importations from foreign countries for supplies of the two abovenamed substances.

The wisdom and advantage of this policy became manifest in a very short period of time; for the French chemists soon demonstrated that large quantities of sugar could be easily procured from beet-root, and saltpetre readily obtained, to an unlimited extent, by the formation of artificial saltpetre beds.

When it is known that chemistry has accomplished such triumphs as these, it is only reasonable to infer that the professors of science, on proper inducements being held out to them, would be able to remove the great difficulty of the sewage question.

Some objection may be felt about giving a reward, on account of the additional fiscal burden which might have to be imposed on the inhabitants of the metropolis to raise the sum offered; but, to meet this apparent obstacle, it must be remembered, that should a reward be offered, if the discovery is not made, nothing will have to be paid: and if the discovery be made, then it is assumed, that, the fee of the sewage manure being vested in the Metropolitan Board of Works and the Government Board of Works, a source of wealth would be opened up, which would be not only sufficient to provide for the charge of any reasonable reward, but also adequate to furnish funds to defray the cost of nearly all the improvements which are required in the metropolis.

Having now expressed the views of the Kensington vestry on this important question, I have to request that the Metropolitan Board of Works will give the subject their very serious and early attention.

I have, &c.
(signed) *R. Green*,
Clerk to the Vestry.

E. H. Woolrych, Esq.,
Metropolitan Board of Works.

(Enclosure B.)

RESOLUTIONS passed by the *Kensington* Vestry touching the Main Drainage Scheme.

Resolved,—That this vestry objects to the reservoirs for deodorising the sewage matter in Fulham Fields, and the outlet so near the metropolis as Barking Creek; and desires to express its preference to the embankment of the Thames to the sewer in Fleet-street (11 June 1856.)

That, in the opinion of this vestry, it is desirable that Mr. Hawks should invite the Metropolitan Board of Works to offer a reward to any person who shall discover an easy practical and inexpensive method of converting the sewage manure of the metropolis into a substance as portable as guano, without impairing any of its fertilising properties, and that a letter be addressed to the Metropolitan Board on the subject (26 November 1856.)

That, in the opinion of this vestry, it is desirable that the Metropolitan Board of Works should offer suitable and liberal rewards for the best plan of draining the metropolis, so as entirely to intercept the flow of the sewage into the River Thames, and to apply the sewage to the purposes of fertilisation (10 December 1856.)

(6.) Mile-End Old Town.

(6.) MILE-END OLD TOWN.

Hamlet of Mile End Old Town,
Town House, Mile End-road, E., 31 March 1857.

Sir,

IN answer to yours of the 17th instant, requesting information respecting the drainage of this Hamlet, I beg to say, that most of the Districts of this Hamlet have very good outlets, as those parts rise from the Thames northward, giving the sewers a very good fall; the other parts (particularly the locality of Bow Common, shown on the Ordnance Maps Nos. 399 and 426) are very bad, to remedy which, the Low-level Sewer would be required.

The

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Information on District Drainage.

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(6.) Mile-End Old Town.

The following are the most important works that have been constructed and sanctioned by the Metropolitan Board of Works:

East-street, Globe-fields	Ord. Sh.	398	700 ft. 3′ × 2′ half brick. 400 ft. 12″ pipe.
Albert-road and Albert-street		397	700 ft. 12″ pipe.
Portman-street and North-street	„	397	420 ft. 18″ barrel half brick.
Charles-street, Essex-street, James-street, Ann-street			2,478 feet 12″ pipe.
John-street, Commercial-road	„	451	190 feet 18″ barrel half brick.
Gloucester-street	„	450	420 ft. 12″ pipe.
York-place, Bull-lane	„	425	1,100 ft. 3′ 6″ × 2′ 6″ half brick.

I am, &c.
(signed) *Robert Lemon*, Surveyor.

Herbert C. Saunders, Esq.

(7.) Paddington.

(7.) PADDINGTON.

Vestry Hall, Harrow-road, 12 March 1857.

Gentlemen,

I AM directed by the Vestry to acknowledge the receipt of your letter of the 12th February, in which you seek for information on the Main Drainage of the Metropolis.

I have to inform you that the lower part of Paddington, namely, Bayswater, is subject to periodical flooding from the backwater of the Ranelagh main sewer. In August last the houses in Grove-terrace, Sussex-terrace, and Westbourne-grove, were inundated with two feet of feul sewage water. As a temporary relief, our surveyor suggested that the stross-wall at the Tumbling-bay in the Uxbridge-road should be removed, to allow the storm-water to pass into the Serpentine; to which the First Commissioner of Public Works objected.

It will therefore be necessary to enlarge the existing sewer in the Uxbridge-road.

I am, &c.
(signed) *Fred. Aveling*, V. C.

Messrs. Galton & Co.

(8.) Poplar.

(8.) POPLAR.

Hertford, 21 July 1857.

Dear Sir,

I ENCLOSE for the information of yourself and colleagues appointed to consider and report upon the sewerage of the Metropolis, copies of letters I have received upon the present impure state of the Limehouse Cut of the River Lea Navigation; there is no doubt about the existence of the nuisance. The trustees of the navigation do not consider themselves responsible for the wretched state of the sewage of the district, and they would adopt any practicable means for preventing the nuisance complained of, but they will *not* undertake to change the water every third tide, as proposed, as that would be a most serious injury to the navigation. The cause of the mischief is the greatly increased quantity of sewage turned into the cut, which ought not to be allowed to enter it, but some other outfall should be found. I have thought it desirable to forward these complaints to you and Mr. Beardmore, and I shall be happy to give you any further information we can, so that you may consider the subject before completing your report upon the sewerage of that portion of the metropolis.

I remain, &c.
(signed) *John Marchant*.

James Simpson, Esq.,
Great George-street, Westminster, S. W.

(CORRESPONDENCE enclosed in above Letter.)

(i.)

BOARD of Works, Poplar District.

East India Dock-road, 15 July 1857.

Sir,

I AM directed by the Board of Works for this district to forward you a copy of a letter they have received from the vestry of Bromley St. Leonard, complaining of the foul and offensive state of the water of the River Lea, in consequence of the stopping back the waters for navigation purposes, and wholly regardless of the impure state of the water caused thereby.

I am further directed by this Board to point out the urgent necessity there exists to change the water every third tide, as a means of preventing the outbreak and spread of disease, which there is much reason to fear will speedily occur if the water is any longer allowed to remain in its present condition.

I am, &c.
(signed) *Charles C. Ceely*,
Clerk to the Board.

Mr. Marchant, Clerk,
River Lea Navigation, Hertford.

(ii.)

Re Nuisance of River Lea.

Vestry Clerks' Office, Bromley, Middlesex, 14 July 1857.

Sir,

I AM directed by a numerously attended vestry of this parish to call the attention of the Poplar district Board of Works to the very disagreeable and dangerous nuisance arising from the stagnant waters of the River Lea, occasioned by the trustees of that navigation stopping back the waters for navigation purposes; by which means all the sewage and refuse water and filth flowing from chemical, dyeing, and starch factories, from Edmonton to Bow Common, are collected into one motionless mass of stinking fermentation, producing the most noxious effluvia, arising from the speedy decompositionof animal and vegetable matters.

I am therefore directed most earnestly to request that the Board of Works will, without delay, use their utmost exertions for the removal of this nuisance, by such means as they may deem most advisable.

I am, &c.
(signed) *James Dunstan*, Vestry Clerk.

To Chas. C. Ceely, Esq., Clerk,
Poplar District Board of Works.

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Information on District Drainage.

Miscellaneous Letters, &c.

(8.) Poplar.

(iii.)

West Ham Local Board of Health, 15 July 1857.

Sir,

I am directed by the West Ham Local Board of Health to inform you that complaints have been made to them of the noxious effluvia arising from the bed of the River Lea, bounding their district, during low water. It is represented to the local Board that the flow of water through the locks or tide gates being unduly restrained occasions this serious nuisance; if it be so the Board feel sure the trustees will direct the gates to be opened more frequently, or take such other steps as they may deem practicable, to prevent danger to the health of the inhabitants residing near the river, from the noxious exhalation so constantly arising from it.

I remain, &c.
(signed) *W. J. Barsham,*
Clerk to the Local Board.

John Marchant, Esq.,
Clerk to the River Lea Company,
30, Great George-street, Westminster, S. W.

(9.) Rotherhithe.

(9.) Rotherhithe.

Vestry of the Parish of St. Mary, Rotherhithe,
Offices, 61, Paradise-street, 20 February 1857.

Gentlemen,

Your letter of the 12th inst. on this subject has been laid before the Vestry of this parish. And I am instructed to forward you a copy of a Memorial presented to the Metropolitan Board of Works on this subject. I am further directed to state that the officers of the Vestry will be most happy to furnish you with any information you may require, and the surveyor of this Vestry, Mr. Geo. Legg, will wait upon you for that purpose, should you consider it desirable.

I am, &c.
(signed) *R. Shafto Hawks,* Vestry Clerk.

Messrs. Galton, Simpson, and Blackwell,
29, Great George-street, Westminster.

(Enclosure.)

Memorial to the Metropolitan Board of Works.

The Memorial of the Vestry of the Parish of *Rotherhithe, Surrey,*

Sheweth,

That your memorialists have charge of a large district comprised within the boundaries of the parish of Rotherhithe, containing 886 acres, most of which is low ground, being generally below the level of Trinity high-water standard, and in many instances six to seven feet beneath the same.

The inhabited portions of the parish are densely populated, mostly by the poorer classes, who have frequently suffered from heavy rain-falls and flood-waters, causing considerable injury to property, and affecting the health of the inhabitants.

Your memorialists learn (from the Report of the Engineer of your Board), that it is proposed to construct a barrel sewer, five feet and five feet six inches in diameter respectively, diagonally across the south-west portion of the parish of Rotherhithe; and that it is proposed to substitute this intercepting sewer (*vide* page 18, Engineer's Report, 3d April 1856), for the existing outlets of the Battlebridge, the Earl, the Great St. John, and the Duffield Sewers, by which a very large flow of additional sewage will be brought through the district of Rotherhithe, being wholly extra sewage, with the exception of the Earl Sewer, now serving as the outlet for the parish of Rotherhithe; and that by this means the drainage of an additional area of 2,013 acres will be brought into this low district without the means of being discharged during storms or floods; and the vestry view with great alarm the consequences that must necessarily arise from the very limited area of the sewer proposed to be constructed, and such a vast increase of sewage through this particular district.

Your memorialists beg to bring to the notice of the Metropolitan Board that they believe the drainage of the additional district proposed to be conveyed through Rotherhithe makes a much greater quantity of sewage than any other district of similar area, owing to a very large quantity of water being used in the particular class of manufactures carried on in the adjoining locality; and the Vestry respectfully submit that the proposed Low-level or Bermondsey Branch Sewer will prove greatly inadequate to the requirements of the locality, and in confirmation whereof, the vestry beg to state, that upwards of 4,000,000 gallons of water are supplied to only a small portion of the district by the water companies daily, without the large supply that must flow and is used by many of the factories from private wells; the Vestry have only to mention that some of the factories receive a supply of upwards of 100,000 gallons from the water company, in addition to the quantity the owners obtain from their own wells, to afford any idea of the magnitude of the drainage required.

Your memorialists would respectfully submit that the estimate of 30,000 inhabitants per square mile in this district is only about half the proper estimate per square mile, and are borne out in this fact by the Registrar-general's returns; and on reference thereto, it will be found that the population exceeds 60,000 per square mile, with some large areas in Bermondsey and Rotherhithe uncovered, although being rapidly converted to building purposes, and this without any allowance for sewage contributed by the large factories, (which the Vestry do not see is provided for in the Appendix B., of five cubic feet of sewage per head per diem), although a single factory in many instances exceeds that allowed for 3,000 inhabitants in such calculation.

Your memorialists would further call the attention of the Metropolitan Board of Works to the fact that there are about 700 houses at the north-east portion of the parish of Rotherhithe already inhabited that have not been provided for by the intercepting sewer, and where improved means of drainage are much required, and which, they submit, should receive your engineer's attention.

Your memorialists also beg to suggest, that the Metropolitan Board will be pleased to direct that the North Branch or Low-level Sewer should not have its outlet on the storm overflow of the South Low-level Sewer, but that the former should come separately into the lift, and that the storm overflow should be on the east side of the lift, otherwise the property of this district must be injured in a much greater degree by floods, on the execution of the works proposed, than it has hitherto suffered by the isolated position thereof, and freedom from the high levels.

Your memorialists likewise submit, that all intercepting sewers through so low a district as the parish of Rotherhithe must necessarily act as reservoirs for storm-waters at times, and that 1¼ inches of rain-fall over this closely populated neighbourhood is the least that ought to be provided for, as the absorption is considerably less than it is in more open localities.

Your memorialists submit that the present Earl Sewer serving for other parishes, and flowing through this district, should be covered over without delay, as they know of no other district where the outlet for a main sewer passing through a densely inhabited locality remains uncovered.

Your

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Information on District Drainage.

Miscellaneous Letters, &c.

(9.) Rotherhithe.

Your memorialists respectfully request—

1st. That the Metropolitan Board will be pleased to direct that the Northern or Bermondsey Branch Low-level Sewer should be constructed of not less than nine feet in diameter, that being the smallest size which this vestry consider the sewer should be made, to meet the requirements of the area to be drained by the same, and taking into consideration the rapid increase of population on the sites abutting thereon.

2d. That the said sewer may be provided with a storm overflow, independent of the other sewers.

3d. That the Earl Sewer may be lowered in its invert, and covered over, as this Vestry submit is highly requisite, and can be readily accomplished on the execution of the intercepting drainage.

Signed by order of the Vestry of the parish of Rotherhithe.

(signed) *Joseph Goddard,* Chairman.
James Ford.
James Arnold.

(10.) St. Marylebone.

(10.) St. Marylebone.

56, Acacia-road, St. John's Wood,
20 May 1857.

Sir,

As one of the vestrymen of Marylebone and one of the members of the Sewers Committee, I had an opportunity of perusing your letter of the 18th April last, addressed to the parish surveyor, and asking for information as to the main drainage which passes through this parish.

You will, I hope, hear officially from the Sewers Committee, or from their surveyor, on the subject.

In the meantime, I take the liberty, as one of the largest owners of property at St. John's Wood, and one of the oldest resident inhabitants, to call the serious attention of the Referees to the defective state of King's Scholars' Pond Sewer, where that sewer crosses the Regent's Canal, "through the bridge" in the Park-road, Regent's Park, near St. John's Wood Chapel.

This sewer, as I have stated, passes through the bridge, that is, in the air above the canal, in an iron trough under the carriageway; and in effect this bridge and trough operate as a bay or dam, by which all sewage on the north side of the Regent's Canal is bayed or dammed up, until it rises to the height of the bay; in the winter, and after heavy rain, such a quantity of water descends as gives a sufficient escape; but in dry weather and in the autumn these sewers on the north side are merely elongated cesspools, and the stench and effluvia arising from them is intolerable; while few people are acquainted with the cause, all are crying out against the foul smells and epidemics; fevers and contagious disorders are constantly arising in a neighbourhood, which, from its altitude and position, should be one of the most healthy near London.

This state of the sewer alluded to was well known to the old Commissioners of Sewers; I have frequently called their attention to it, and they have admitted the truth and justice of my statements; but they did nothing. Since I have been on the Sewers Committee of Marylebone, I have attended the Metropolitan Board of Works as chairman and spokesman of a deputation from the Sewers Committee on the subject; on this occasion, Mr. Bazalgette, the engineer, admitted the great evil complained of as to the defective sewer alluded to, and stated that the evil was well known; and that plans involving an outlay of 10,000*l.* were prepared to remedy the evil by carrying the sewer under the canal, and then lowering the sewer under the Park-road (now too high to drain the adjoining property undrained) down towards Baker-street; and on this occasion (now near a year since) the chairman said it should be one of the first matters attended to; still nothing is done.

I do, therefore, most earnestly hope that the Referees will be pleased to turn their attention to this terrible defect in this sewer. The immense town and neighbourhood which has grown up, and is still increasing on the north side the canal, and consequently the sewage discharged into this sewer having no proper vent, really excites the most alarming feelings as to what may be the sanitary condition of this portion of the town should the cholera again visit us.

I take the liberty of inclosing some leaves, containing the evidence of Mr. G. Duncombe, taken 20th July 1843, before a Committee of the House of Commons, as to the then state of the drainage of Portland Town. Although that drainage is much improved, and we are trying to improve it, much remains to be done; but all efforts are useless until the monster evil of a main sewer without a proper outfall or vent is remedied, and to this, I again earnestly call attention.

I shall be happy to attend the Referees, and give any further explanation if required, and will be much obliged by your placing this letter before them.

I have, &c.
(signed) *Charles Freeth.**

Herbert C. Saunders, Esq.

(11.) City of London.

(11.) City of London.

(i.)

1, Greek-street, Soho, 8 April 1857.

Sir,

I am directed by Mr. Bazalgette to forward you the enclosed copy of Mr. John Roe's Report on the Fleet Sewer, dated 5 August 1846, for the use of the Referees.

I am, &c.
(signed) *W. Conquest.*

H. C. Saunders, Esq.

(Enclosure.)

Report on the late Flood in the River Fleet Sewer.

To the Worshipful Her Majesty's Justices and Commissioners of Sewers for Holborn and Finsbury Divisions.

The surveyor respectfully begs to lay before the Commissioners some particulars connected with the flood which occurred on the 1st of this month.

Much damage has been done to property along the sides of the River Fleet Sewer, particularly between Peter-street and Back-hill.

The

* *See* Mr. Freeth's Evidence, p. 307.

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Information on District Drainage.

Miscellaneous Letters, &c.

(11.) City of London.

The embankment walls have been much injured, and having given way near Vine-street, three houses and a warehouse built thereon have fallen.

The walls of a slaughter-house and mill-house at the back of Bull-court, Peter-street, have also fallen down.

It is a matter of thankfulness that no lives were lost.

Relevant to the subject of floods, the surveyor begs to call the attention of the Commissioners to the increased flow of waters to the River Fleet Sewer since the year 1790.

In the year 1831 the surveyor made diligent inquiry as to the extreme height to which the waters had risen in the River Fleet Sewer from persons who had observed them from the year 1790. Subsequently the surveyor has noticed the height of water in any particular flood. The following are the particulars obtained in one among many localities noticed, showing the superficial area of the transverse section of the sewer occupied at each respective period named, viz.:—

Locality in the 12 ft. sewer at the south end of Lord Calthorpe's estate.	From 1790 to 1831 area occupied was— *ft. in.* 39 0	In sudden thaw of snow 1841. *ft. in.* 54 0

In Thunder-storm, July 1842.	In Thunder-storm, July 1844.	In Thunder-storm, August 1846.
ft. in. 74 0	*ft. in.* 79 0	*ft. in.* 106 0

These results show that the late flood gave an increase of more than one-third above the greatest flood before noticed, and about three times as much as had been observed to 1831.

The old sewer, a little below Vine-street, has an area of 66 feet; and as the late flood above that point occupied an area of 106 feet, the water could not pass off quick enough; hence the flood rose five feet high in the houses which fell down.

At the back of Bull-court the area of the old sewer was still less; and additional waters also coming to this part, occasioned the waters to rise in Bowling-street to the height of six feet above the pavement.

The new sewer in Victoria-street would have passed the waters; for as soon as the flood entered the new branch at Peter-street, the surface became lowered six and a-half feet, being below the pavement in Bowling-street; and the fall in the new sewer in Victoria-street is four times as much in each 10 feet as the fall in each similar length in the 12-feet sewer on the Calthorpe estate; the relative capacity for passing water being as 166 in the new sewer, to 120 in the 12-feet sewer.

In the year 1746 there was 581 acres of surface covered with streets, roads, and houses; and 3,819 acres of surface occupied as meadows and nursery-gardens, &c., draining to the River Fleet sewer. From 1746 to 1831 there was 995 acres added to the amount of covered surface. From 1831 to 1846 there has been 312 acres more added to the covered portion; the proportions being now 1,888 acres covered, and 2,512 acres uncovered.

Of the 106 feet of area occupied by the late flood in the 12-feet sewer, 12 feet was due to the increase of covered surface since 1831; the remaining excess was due to the greater quantity of rain which fell in a very short space of time.

As soon as the Commissioners can obtain possession of a line of public way along Victoria-street to Back-hill, it will be extremely desirable to complete the arching thereof, so as to prevent a recurrence of any similar calamity as that noticed above.

5 August 1846. (signed) *John Roe.*

(ii.)

Engineer and Surveyor's Office, City Sewers,
Guildhall, 30 April 1857.

Sir,

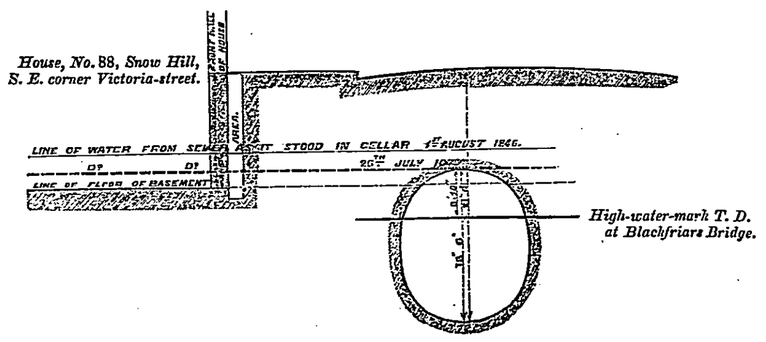
I am directed by Mr. Haywood to forward you a tracing, showing the height the water stood in the Fleet Sewer on the 1st August 1846.

Yours obediently,
(signed) *H. G. Haywood.*

J. Simpson, Esq., C.E.

SKETCH showing the height at which the water stood in the basement of the house of Mr. Lamplough, at the south-east corner of Victoria-street, upon the 1st August 1846, during the heavy storm on that day, and also upon the 26th July 1849, during a heavy storm.

The drain of this house communicates with the Fleet Sewer.



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Information on District Drainage.

Copy of Circular, asking for Reports.

4. MINUTES of EVIDENCE given by the Surveyors of the District Boards of Works, &c., and Copies of Reports forwarded to the Referees in answer to Circular of 16 March 1857.

COPY of CIRCULAR.

MAIN DRAINAGE, METROPOLIS.

Sir, 29, Great George-street, 16 March 1857.

I AM directed by the Referees to request you will have the goodness to furnish them with three copies of any general Report or Reports upon the drainage of your district, which may have been made by you, or any previous surveyor, to the District Board of Works, and printed.

To the Surveyor of the Board of Works. I am, &c. *Herbert C. Saunders.*

Surveyors' Evidence and Reports, &c.

Camberwell.

Evidence of Deputation.

(1.) CAMBERWELL DISTRICT.

1. MINUTES of EVIDENCE given by a Deputation from the *Camberwell* Vestry.

Meeting of Referees, 29, Great George-street, Wednesday, April 1.

A DEPUTATION from the Vestry of Camberwell, consisting of A. L. Irvine, Esq., James Pew, Esq., H. Blake, Esq., H. T. Godden, Esq., W. C. Stone, Esq., Mr. G. W. Marsden (Vestry Clerk), and Mr. J. C. Reynolds (Surveyor), attended by appointment.

Mr. Irvine, who spoke on behalf of the deputation, stated that the population of Camberwell was about 70,000, but only about one quarter of the area of the district was at present drained. The cost up to this time had been 70,000*l.*, and a further expense of more than 100,000*l.* would be necessary if the tunnel sewers were to be carried out.

Not more than one-tenth part of the population would have drains going into the main sewers, as at present directed by the Metropolis Local Management Act.

The plan which the vestry of Camberwell proposed, was that of having deodorising works at various points in their own and other parishes, where the operations might be carried on at the cost of the ratepayers, without a view to profit.

The deputation called the attention of the Referees to the fact, that the sewer which Mr. Bazalgette proposed would have to pass through a quicksand, and would be very difficult of construction.

Mr. Irvine did not think that even if the intercepting works were carried out, the river would be freed from pollution, as it was not proposed to prevent all the other towns from Oxford, westwards, draining into it.

In answer to a question, whether the deputation did not think the establishment of deodorising works would create a nuisance, Mr. Irvine related that he had visited Leicester, Tottenham, and other sewage works, and found the ammonia was so effectually fixed as to obviate any nuisance.

Another gentleman stated that works were carried on for some time in the heart of the City at Paul's Wharf, without any inconvenience being felt.

The surveyor (Mr. Reynolds) promised to show the Referees at his office any of the larger maps and plans of his district in his possession, which they might desire to see.

Mr. Irvine stated as another objection to Mr. Bazalgette's scheme, that the noxious gases would either remain in the sewers to escape at any open point, or have to be provided for by ventilating shafts at a cost of 40,000*l.* per annum.

The whole annual cost of maintaining Mr. Bazalgette's proposed works, Mr. Irvine estimated at not less than 400,000*l.* per annum (including interest on first outlay), whereas the whole expense of carting away manure in order to rid London of any fear of odours arising from it when stacked, would not exceed 40,000*l.* per annum.

Evidence of Mr. Reynolds.

2. MINUTES of EVIDENCE given by Mr. *J. C. Reynolds*, Surveyor.

Meeting of Referees, 29, Great George-street, Saturday, May 9.

Mr. Reynolds attended by appointment.

Mr. Reynolds did not think that the carrying out the proposed drainage, and the consequent lowering of the water in the soil, would have any serious effect in causing a shrinkage or settling. Mr. Reynolds stated, that this opinion was founded upon his own experience in a case where the sand had been relieved of water to a great extent. The locality where this occurred was at least two miles from the river.

Nearer the river, where there was peat charged with water, instead of sand with water in it, as in the above case, the effects might be more serious; but Mr. Reynolds did not apprehend this peat extended far inland.

Mr. Reynolds thought it not improbable that the smell from deodorising works might prove a nuisance.

In answer to a question, Mr. Reynolds said that several attempts had been made in his district to put down nuisances arising from factories, such as the making of the varnish and other matters used in oil-cloth works, &c., and had in many cases succeeded.

Mr. Reynolds said, that he did not think there was likely to be much building going on in Dulwich within the next few years.

In answer to Mr. Blackwell, Mr. Reynolds said that the Effra occasionally, but very seldom, overflowed its banks.

Sewage might be detected in the Effra sewer as far up as the Crystal Palace.

Mr. Reynolds thought that it would be practically impossible to keep any channel pure through which the Effra might be made to pass, in an endeavour to separate surface from house drainage, looking at the probability of the ground being eventually built over in this district; or at all events, without incurring a considerable expenditure in sewerage works.

The soil in this district is a very retentive clay, which passes all water off its surface very quickly when once fully charged.

Mr. Reynolds stated that very little, if any, flushing was necessary in the higher parts of the district; but that in the lower, occasional cleansing of the sewers was necessary. A large quantity of road detritus gets into the higher sewers, but Mr. Reynolds thought that, by proper construction of the gully-holes, this might be prevented. The debris of the roads does not travel far in the sewers, but remains pretty nearly where it falls from the roads.

In answer to a question Mr. Reynolds said, that he thought it would be a question whether any attempt to utilise the sewage could be effected without nuisance. He was rather inclined to think it could not.

Mr. Reynolds said, the value of sewage manure would be materially diminished by the competition it would have to meet in stable and other manures, which now monopolise the markets.

Mr. Reynolds explained that though several members of his vestry advocated the establishment of deodorising works, yet he did not think they went so far as to propose wholly to separate the surface drainage from that of the houses, which is generally the consequence of a wish to deodorise.

Mr. Reynolds said, that in August 1846 several parts of Camberwell were very seriously flooded for more than two hours. This would not have occurred if there had been an intercepting sewer to keep the upland waters from coming down into the lower districts.

Mr. Reynolds did not think it would be possible effectually to separate the house from the surface drainage, the district surveyors having but little practical supervision over the connexions of pipes, &c., in the private houses.

In addition to this, the expense would be very great; and moreover, the beneficial scour of storm waters would be lost by this separation.

In answer to a question from Mr. Simpson, Mr. Reynolds said that he thought it was quite possible by proper regulations to prevent rubbish and decaying matter being thrown into the streets, as at present done. This opinion, Mr. Reynolds said, his experience in improvements he had made near Bowyer-lane justified him in holding.

Mr. Reynolds said he thought there might be some difficulty in carrying out Mr. Bazalgette's sewer, under and near the Kent-road, where there was running sand, but that the engineering appliances of the present day would be able to overcome any such difficulties.

Report by Mr. Reynolds.

3. Report on the Proposed Drainage of the Parish, by *J. C. Reynolds*, Surveyor.*

To the Vestry of the Parish of St. Giles, Camberwell.

Gentlemen,

In compliance with the order of the vestry, of the 9th day of April last, "that the surveyor prepare a plan and approximate estimate of the cost of laying down the entire sewerage of this parish," I beg to present to you a cartoon map,* showing the roads and streets of this parish, with the sewers (both open and arched) now in existence, and in addition thereto, such as will be necessary to be constructed for the conveyance of the local sewerage into the proposed arterial or main sewers.

In the first place, allow me to submit a few remarks upon the natural levels of this portion of the southern district of the metropolis, and on the present condition (as regards drainage) of much of the property erected therein, describing the remedial measures proposed by the Metropolitan Board of Works, in carrying out their main drainage scheme; and then follow on with the collateral works, which I beg to propose for your consideration, and which will have to be constructed under your authority and direction.

It is scarcely necessary to acquaint the members of this vestry with the fact, that a large portion of this parish lies exceedingly low, it being in many places six feet under Trinity high-water mark. At this level there are cellars and basements, which it would be impossible to drain into any existing sewer, without submitting them to the certainty of being submerged during wet seasons; for the flow of the sewerage is intermittent, and during the period that the tidal flaps next the river Thames are closed, the hill-water pours down to these lower levels, producing the effect above described. The result of this is, to keep the subsoil of the district thoroughly saturated, and afford little more than surface drainage; for

* Maps, Plans, and Sections accompanying the original Report not engraved.

for when cesspools are sunk for temporary drainage, the water level of the distri lying near the surface, their contents rise so high that constant emptying is requisite, entailing heavy expense and annoyance.

Metropolitan Main Sewerage.

To remedy the defective condition of the drainage of this district, a scheme has recently been decided upon by the Metropolitan Board of Works, and a brief description, as far as it concerns this parish, I beg now to lay before you.

It consists of two sets of sewers, viz., high and low levels. After pursuing its way upward from the pumping-station at Deptford Creek, the low level sewer enters this parish near to the High Kent-road, at White-Post-lane, continues along the High Kent-road as far as the Canal Bridge, passes under the Grand Surrey Canal, and thence onward in a westerly direction, parallel to the canal, and along Neate-street; it crosses the Albany-road near to the Camberwell-road, and thence proceeds towards Kennington by Grosvenor-square. The depth of this line of sewer has been so arranged, that it will provide sufficient outlets for all the collateral lines of sewers, which will eventually fall into it; and it will also in its course intercept all the present natural valley lines into which the district sewerage now discharges itself.

This low level sewer will be constant in its flow, and will therefore afford also a continuous discharge from all the new lines which may be put into connection with it.

The high level intercepting sewer, which I next proceed to describe, enters this parish on the high ground near St. Mary's Church, Deptford-lane, and proceeds in a westerly direction to South Grove, Lyndhurst-square, Camberwell Grove, and Denmark Hill at Love-walk, at which point it enters Lambeth parish. It is proposed to construct this line of sewer at such a level that it will provide a sufficient drainage for the upper districts, and prevent the hill-waters from discharging into the lower portion of the same. It will, at the same time, be constant in its flow towards the outlet, by gravitation.

There is also an Effra branch high level line, which, it is proposed, shall relieve the present overcharged sewer between Croxted-lane, Dulwich, and Brixton; its course is from Croxted-lane, under the Long Pond, near the lower end of Red-Post hill, in a north-easterly direction, into the main high level sewer last described at South Grove, near the Lyndhurst-road, Peckham. The principal object of constructing this relief line is, the diversion of the waters of the now surcharged Effra, and a provision for a direct outlet into the gravitating sewer before described, for the drainage of the localities of Dulwich and its vicinity.

I have prepared the sections A, B, and C, for the purpose of showing the nature of the works just described; the positions are indicated on the plan, by dotted red lines. I need not here, I think, further describe the main or arterial lines, it being my purpose only in this report to show their position and object in relation to the local sewerage of this parish, which I now proceed to lay before you.

Local Sewerage.

The plan and sections herewith exhibited show generally the various lines of proposed new sewers, their sizes and inclinations, calculated from the Ordnance datum.

They are indicated on the plan thus:—

Proposed metropolitan main-lines—thick dotted red lines.
Proposed local sewers—red lines.
Present local sewers—brown lines.
Low level permanent sewers—brown dotted lines.
Open sewers—blue lines.

Section No. 1 commences at the present low-level sewer in Addington-square, passes through the square, crosses New Church-road into and along Southampton-street as far as Cottage Green, through Cottage Green in the course of the present sewer there (which will have to be lowered), along Wells-street as far as Grosvenor-place, and thence along Grosvenor-place to Peckham Grove, and continues along the line of an intended road called Gloucester-road (which will eventually be continued across the open ground to the Coburg-road at its present termination on the north side of the Grand Surrey Canal), and which will hereafter connect (as a main line of thoroughfare) the High Kent-road with Peckham in a line with East Surrey Grove. This line of sewer in the course just described will then be carried under the canal at the crossing of the proposed new road, and will fall into the Metropolitan Trunk Line in Neate-street.

I beg to observe, that, in adopting this course for the principal local sewer, I have been anxious to avoid crossing under the canal more frequently than absolutely required, in consideration of the great expense of such a work from the peculiar nature of the soil of the district, as well as the possibility of impeding the traffic of the canal during this operation.

At present there are two culverts under this canal: one at St. George's Bridge, the other at the Wooden Bridge at Peckham Style, neither of which is sufficiently deep to form a portion of the proposed improved sewers.

To remove these or to pass under them, would be far more difficult, and considerably more expensive, for the reasons I have just named, than the construction of a new culvert at a level available for the whole of that portion of the parish, and at the only point where any casualty could be at all anticipated from passing under the canal.

The construction of this line of sewer will open up drainage for that portion of the parish bounded westward by the Camberwell-road, eastward by the Peckham branch of the Grand Surrey Canal, south by the Peckham-road, and north by the upper end of the maine line of the Grand Surrey Canal.

Section No. 2—commences at the turnpike-gate in the Peckham-road, passes down Southampton-street along Peckham-grove, and joins the local main line as described for Section No. 1, at the junction of Gloucester-road and Peckham-grove.

I may here state that this line of sewer, in addition to serving for the drainage of this particular section of the parish, will empty the low level sewer in the Peckham-road, and thereby afford a means of cleansing the same by flushing. It will also serve a similar purpose for the new line, in its progress towards the outlet sewer at Gloucester-road. It is proposed also to effect a junction between the high level (Metropolitan sewers) and these local main lines for the purpose of flushing them when required.

Section No. 3—commences at or near Camberwell Green and passes along Waterloo-street, George-street, Picton-street, Martha-street, and James-street, and joins the local main line at Cottage Green, as shown on Section No. 1.

Section No. 4—commences at the junction of roads at Camberwell Green, by the police station, and passing along the Camberwell New-road, joins the main low level metropolitan sewer at Bath-street. The upper and lower portions of this line of sewer are in Lambeth parish. Most of the property lying between the Old and New Camberwell roads, together with the ground north of the high level Metropolitan line, will drain into this sewer, which will also have the effect of drawing off the now stagnant water from the present sewer at Camberwell Green, this being a continuation of the same line of sewer described as situate in the Peckham High Road.

Section No. 5—commences at Hill-street, Peckham, near the Globe Bridge, passes along the Queen's-road, Carlton-street, Bird-in-Bush-road, into the High Kent-road, and there joins the Metropolitan main line.

This line will open up drainage for that portion of the parish bounded west by the Peckham branch of the Grand Surrey Canal, north and north-east by the High Kent-road and main line of canal, and south by the high level Metropolitan intercepting line, south of the Peckham-road.

There are some other portions of the lower levels of the parish to which I will now briefly refer.

The part lying between the present open Earl sewer, north of the Albany-road, and the main Metropolitan line between the Camberwell-road and the Kent-road, will require but little description, as from its close proximity to the trunk line ample drainage will be attainable.

That portion lying north-east of the Kent-road from the Green-man turnpike gate to the canal, can eventually be drained into the Kent-road sewer, when the execution of the main trunk line has effected the emptying of this sewer, its present water-logged condition rendering it but partially available for the purposes for which it was constructed.

From the Canal-bridge in the Kent-road (north-east side) the whole of the area, including New Hatcham, will be most favourably situated for permanent drainage into the main trunk line, which passes along its whole length, through the Kent-road, and at a depth more than will be required even for this low lying area.

The low lying ground north-east of the Kent-road from St. James's-road down to the Galley Wall Ditch (boundary sewer) will eventually drain eastward; its precise direction will depend upon the works of the Central Board in reference to this open sewer. As this area, however, is but little built upon, it presents no immediate claim for sewerage.

The construction of the works before enumerated will have the effect of doing away with many of the offensive open ditches in this parish, which will have their most offensive matter withdrawn from them, and they will become (as originally) surface water-courses, but in most cases they will be altogether abandoned, and be filled up: whereas, if now arched over, but little, if any improvement would be accomplished in their levels, and when the permanent works are executed, would in effect be valueless for improved house drainage.

I believe I have now disposed of the material explanations with reference to the low-lying portions of the parish, and I, therefore, proceed in the next place to describe the necessary requirements of the upper or hill district.

Permit me to refer to my description of the Metropolitan high-level intercepting line, running, as I before stated, from or near St. Mary's Church, Deptford-lane, and in a tolerably direct course towards Denmark-hill at Love Walk. It will be seen from the map that only the small portion of the hill ground lying below this high-level line will have to drain into the lower level. That part at the eastern end of the parish will fall into the sewers which I have suggested on the plan, and eventually discharge into the lower end of the Meeting-house lane sewer, the western portion will, as at present, discharge into the Peckham-road and Denmark-hill sewers. With regard to the high-level local sewerage—

On the plan it will be seen that I have laid down sewers for such roads only and such localities as are either wholly or partially built upon; but still with a view to the ultimate reception of all drainage which time and the improvement of property may eventually bring into them. I need scarcely say that it is unnecessary to give in detail, as I have (although, perhaps,

perhaps, imperfectly) done for the lower districts, all the various particulars regarding the sewerage of the high lands of the parish in the vicinity of Peckham Rye, Nunhead, &c. It may be sufficient for me to observe that I have endeavoured to arrange them so as to give to their respective areas and local necessities all that will ultimately be required for perfect drainage. I may, however, remark, that the fall being so rapid, the sizes and cost will be proportionally much less than for the works requisite in the lower parts of the parish, and that on the construction of the main intercepting high-level line their execution can be progressive, as the wants of the several parts develop themselves.

It now only remains for me to describe, firstly, that area which has its natural outfall first by way of Lordship-lane (lower end), to Goose-green, and which will be eventually intercepted by the high-level Metropolitan line at its crossing at Dog-kennel-lane. The small amount of house-property at present erected there, has determined me not to suggest any works at present; but the main high-level sewer just referred to will give full opportunity for the eventual drainage of this locality. And, secondly, the area which has its present drainage into the Effra, at Dulwich. The Edra relief-line, of the Metropolitan Board, purposes (as before stated), wholly to divert this drainage from its natural course between Croxted-lane and Brixton, to the relief-line which passes through the Long Pond, at Dulwich, towards Peckham. This main line suggests the construction of a new line of sewer, commencing at the Long Pond, passing through Dulwich village, as shown in section No. 6, and continuing to the angle formed by the two roads at Dulwich College, and passing on to the proposed junction with the valley line sewer, coming down through the fields from Lordship-lane into the high road, opposite the east side and south end of Dulwich College. The construction of this line will effect the following improvements:—Firstly, the diversion of the sewerage from the open line near the Greyhound Inn (now so much complained of). Secondly, the provision of permanent drainage for the house property there. Thirdly, the substitution of a lower level and permanent sewer, in lieu of the present high level and imperfect sewer through the village. And I beg to state, from a recent examination of this high level sewer, that, in consequence of its defective condition, it will, at no distant period, have to undergo very extensive repairs; some portions of it are so bad, that from the great rush of water through it in rainy seasons, portions of its side-walls have been wholly washed away. I have not designed at the present time, to construct a sewer along the road on the western side of the College, but have so arranged the size of the main line, at the confluence of the two roads, as to be proportionate to the ultimate requirements of this locality.

From the foregoing description of the sewerage of the several divisions of the parish, and from a reference to the map, it will at once be seen how little is at present done, and how much is required. Indeed it may be said that the lower portion of the parish, which lies within the influence of the River Thames, is wholly unsewered. This area is nearly all built upon, and thickly populated; consequently most in want of early attention. The upper division or hilly portion of the parish in some parts will also (where building operations are going on) require similar works, but the necessity is not so pressing as in the former case.

I beg to state that in making this report I have not troubled you with details further than absolutely necessary, or with matter merely supplementary to the general plan and sections submitted for your inspection, believing that as the localities are well known to all the members of the vestry, so also will their sanitary requirements be equally manifest.

Having, I trust, satisfactorily laid before you the material points necessary for your information, permit me to say, that although I submit the same to you in full confidence of the efficiency of the plan for future sewer operations in this parish, I do so nevertheless, with all diffidence, admitting the probablity of many detail alterations and improvements, the necessity for which will be developed when each part previous to execution will claim for itself special consideration, and when I hope to be enabled to give to the scheme generally that amount of time and deliberation which its importance demands.

The length of brick and pipe sewers comprised in this Report, with their approximate cost, is as follows:—

	Brick Sewers.	Pipe Sewers.	Approximate Cost.
			£.
Lower Division - - - -	14⅔ miles - -	7½ miles - -	54,194
Upper Division - - - -	8¼ miles - -	1½ miles - -	23,039
Making a Total of - - -	23 miles of Brick Sewer.	9 miles of Pipe Sewer.	
	= 32 miles.		
	TOTAL Approximate Cost - - £.		77,233

Vestry Hall, Camberwell,
18 June 1856.

J. C. Reynolds,
Surveyor.

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Hackney.

Report by Mr. Lovegrove.

(2.) HACKNEY DISTRICT.

REPORT of the Surveyor on the Proposed Main Drainage Scheme for London, North of the Thames, by *James Lovegrove*, Surveyor.

Gentlemen,

IN accordance with the order of the Board, dated 29th January 1857:

That the surveyor do report what, in his opinion, will be the effect upon the drainage of this district, on the Intercepting Scheme of Sewage now submitted by the Metropolitan Board to Her Majesty's Government (being carried out).—I beg, respectfully, to submit to you the following report thereon:—

It is probably in the recollection of the members of the Board, that a few years ago (1847), the whole Metropolis was divided into separate commissions; different opinions existed, and different modes were adopted in each division, both in the maintenance of old sewers, and the construction of new sewers; these differences created party bickerings and jealous demonstrations.

At this period, there was a general stir in the public mind about the polluted state of the Thames, which, together with the conflicting state of things just referred to, probably led to the dissolution of the eight commissions, and the appointment of one Metropolitan Commission of Sewers. The Metropolitan Commission was superseded, and re-constructed six times, up to the year 1856, when the commission became defunct, and in its place the present Metrodolitan Board of Works, the District Boards and Vestries, were appointed.

The agitation going on as to the Thames pollution stirred the commissions into action, and the Main Drainage Scheme was ultimately brought forth; professing to have for its objects—

The dispollution of the Thames.

The providing efficient main drainage outfall sewers for the Metropolis.

The interception of sewage, and

The extension of local drainage.

Although the scheme has undergone some modifications, it possesses somewhat the same general features as when reported upon by Mr. Bazalgette and Mr. Heywood in the year 1853, so far as the Metropolitan area is concerned.

Inquiry.

It will be my duty in this inquiry, to consider how far the objects sought will really be obtained in the Hackney district, by the proposed scheme.

To enable you to comprehend the relative connection of this district with the Metropolitan area, north of the Thames, it is necessary to briefly describe its general features, more especially as the Hackney district forms a part of each of the three general subdivisions of the Metropolitan area.

Description.

North margin.

The entire area proposed to be dealt with, is nearly 60 square miles. The northern margin is formed by a line through Hanwell Park, Hampstead, Highgate, south side of Hornsey, and Stamford Hill.

Southern.

The southern side is defined by the banks of the Thames from Brentford, to the River Lea.

Western.

Eastern.

The western, by a line through Hanwell and Brentford; and the eastern, by the River Lea.

Contour.

The general contour of this area is determined by the route of several natural watercourses having a general direction from north to south, and discharging into the Thames; also, by a natural watercourse north of this area, running due east, through the Hackney Brook Valley, into the River Lea.

The surface is therefore of an undulating character, having alternate valleys and ridges, laterally from the Thames, and the Hackney Brook Valley due north east.

Corruption of streams.

The rapid growth of London, and the mode of drainage introduced within the last 20 years, have so altered the character of these natural watercourses, that it has been necessary to cover various portions over; and the remaining open portions now being a nuisance, calls for an early remedy, for these streams find their way into the River Thames, carrying the off-scouring filth of London into, and therewith polluting its waters.

Thames pollution.

In the more dense parts of London many of the open sewers (which had acquired the significant name of black ditches), have been intercepted by new sewers, forming, in lieu thereof, artificial valleys.

Sub-division.

Now, this area of 60 square miles is subdivided for the purposes of drainage, into three general divisions or areas, designated as follows:—

The Northern High Level Area;

The Middle Level Area, and the Low Level Area.

The

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The Northern High Level Area includes part of Hampstead, Highgate, Islington, Hornsey, and Hackney; it differs from the others in this respect, it is mainly determined by a natural valley bearing from Highgate to Old Ford, in a south-easterly direction. The watercourse called the Hackney Brook) discharges into the River Lea, about three miles and a-half northward, from its junction with the River Thames. There are no existing outlets near to the intended line of sewers, which could be made available as flood outlets for extraordinary storms, as in the case of the Middle Low Level Sewer; it is, therefore, proposed to construct a sewer of sufficient size to receive both storm and sewage waters, and so to form a substitute for the Hackney Brook.

The drainage of this area does not affect the drainage of the other areas, excepting so far as it is proposed to pass through the ridge, which divides the Fleet Valley from the Hackney Brook Valley, to incercept the sewage from a portion of the River Fleet at Kentish Town.

The proposed route of this sewer is described in the following extract from Mr. Bazalgette's report, dated 22d May, 1856, page 6 to 8; as this specially refers to the question, I considered it necessary to extract it for this report:—

"This area, coloured yellow upon the accompanying map, includes about 10 square miles. The Hackney Brook open sewer shows the direction of the natural valley, which, for a considerable portion of its length, runs from west to east. The surface of this area falls towards the valley line from the northern margin with considerable inclination, and from the southern side with a gentle inclination.

"At present the area is suburban in character. Its population, though now limited, is rapidly increasing; and it is in immediate want of outfalls, for the general extension of the district sewers. Its drainage must now be treated with reference to future as well as present necessities.

"The Main Sewer designed in 1853 for this area, was intended to intercept the Fleet Sewer at the foot of Hampstead-hill; and by means of an extension, called the 'Regent's Park Branch,' it was proposed to intercept the Ranelagh and King's Scholars' Pond Sewers, as well as the Fleet, the second time, near the Regent's Park. At that period the outlets of the Ranelagh and Fleet Sewers were uncovered for considerable lengths, as was also the Ranelagh Sewer, north of the Harrow-road.

"The object of the Regent's Park branch was to reduce the sizes and cost of covering the defective portions of the above main sewers, as well as to intercept the sewage by the most direct route, and over the best inclinations, to the proposed outfall. But since that period, the covering of the Ranelagh has been extended towards Kilburn; and two of the most important works which were executed by the Metropolitan Commission of Sewers last year, were the diversion and covering of the lower portions of the Ranelagh and Fleet Sewers.

"These works became so urgently needed, that they would not admit of delay; and their execution has so far modified the previous circumstances of these districts, as to induce me, with a view to economy, now to relinquish the Regent's Park branch, and to relieve that portion of the Fleet Sewer, which is of insufficient capacity, and is still sometimes overcharged, by intercepting and directing the flow from Hampstead and Highgate into the High Level Sewer at a different point; namely, at Kentish Town.

"Whilst I have by this alteration, abandoned the advantage of intercepting the larger amount of sewage by the High Level route, I admit it to be the sacrifice of a sound principle, upon the score of economy, necessitated by the execution of works designed and executed piecemeal, since our last Report; and it may be well here to observe, that so long as a general system of interception is delayed, and in proportion as building and district drainage is extended in advance of it, so each year will some modification of the general design be necessitated, which will render it less perfect as a system. That is to say, it is better to construct the main lines first, and adapt the branches to them, rather than having first constructed the branches to be called upon to adapt the main lines to previously existing branches. I am anxious to call attention to this fact, in order that my reasons for the alteration may be thoroughly understood.

"The sewer proposed for this area commences by a junction with the Fleet Sewer, at the foot of Hampstead Hill. Thence it passes along Gordon-house-lane, crosses the Highgate-road, and intercepts the second branch of the Fleet Sewer. It then passes across fields into the Tufnell-park-road, down the Holloway-road, under the Great Northern Railway, and New River Cut, to High-street, Stoke Newington, at Abney Park Cemetery. Thence it passes along the Rectory-road, and Amherst-road to Church-street, Hackney, under the East and West India Dock Railway, through Victoria Park, under George Duckett's Canal, to the River Lea, over which it is carried by an aqueduct. At this point it is provided with an overflow for the discharge of its storm waters into the River Lea, near the mouth of the present open Hackney Brook Sewer.

"It is proposed to fix tide-gates across the outlet of the open Hackney Marsh Sewer, to prevent the ingress of the tide, and by this means, and the diversion of the sewage and upland waters, to prevent the floods to which the Hackney Marshes are now subjected.

"The High Level Sewer will relieve Stoke Newington, Kingsland, Clapton, and Hackney, from the nuisance arising from the open Hackney Brook Sewer, for which it will act as a substitute, forming a main drainage outfall of sufficient depth for the entire area, as well as an intercepting sewer for the sewage of Hampstead, Highgate, and part of Kentish Town."

Middle level area.

The Middle Level is bounded on the north by the southern margin of the preceding areas,

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areas, on the south and east by the Low Level area, on the west by Kensal Green, and extends from Harrow-road to Old Ford. For the drainage of this level, it is proposed to construct a main intercepting sewer from Harrow-road at Kensal Green to the River Lea, near which it will join the northern sewer, and from thence flow by gravitation to Erith Reach. There are also two branch sewers proposed for this line, called the Aldgate branch and Piccadilly branch; a portion of Newington, De Beauvoir Town, Kingsland, Dalston, and Cambridge Heath, is comprised in this level.

Low level area.

The Low Level area lies between the banks of the River Thames, River Lea, and Middle Level areas, including the western division, it extends from Hanwell Park to the River Lea. A considerable portion of the south-west part of Hackney is comprised in this level.

It is proposed to construct a sewer from Chiswick, parallel with, and near to the banks of the River Thames, to Abbey Mills, in Essex, with branches to the Isle of Dogs, and to Wick-road, Hackney. The pumping station would be at Abbey Mills, in Essex; where also the sewage from the low level area would be pumped into the high level sewer by an engine of 1,184 horse power, the lift being 37 feet. At this point the whole of the sewage arising from the Metropolitan area would unite in one stream, and flow by gravitation through a sewer, partly under and partly above ground, either on an embankment, or forming a tubular iron aqueduct, erected on brick piers, divided at intervals, along its course into two or three streams, to overcome engineering difficulties, and would pass through Plaistow, Barking, and Hornchurch Marsh, to Erith Marsh, 15 miles below London Bridge, where it would be received by a reservoir of the size and area of 10 acres, and from thence be discharged into the Thames at or near to high water.

Cost.

Thus far a brief outline of the main drainage scheme, north of the Thames, has been given.

The southern drainage being complete in itself, and wholly distinct and separate from the works proposed on the north side, I have considered it unnecessary to lengthen this Report by a description of the southern drainage, and beg to refer those who desire further information on that subject to Mr. Bazalgette's Report, dated 3d April 1856.

Now, a very natural question arises, what will the inhabitants of the Hackney district have to pay for this gigantic and important undertaking? Much depends on the mode of apportionment of cost: it seems but reasonable to assume, for the purpose of obtaining an approximate amount, that the expenses will be recovered by a general rate over the whole metropolitan area.

Then, according to the financial statement of the Metropolitan Board of Works, dated 26th July 1856, the rateable annual value of property, as per county rate, or other like assessment, is stated to be 11,151,939 *l.*, while that of Hackney is stated at 258,704 *l.*; this is equal to about one forty-third part of the gross rateable annual value of property in the metropolitan area.

Now the latest estimate for the Main Drainage Works on both sides of the Thames amounts to 2,836,600 *l.*; his sum divided by forty-three gives a product of 65,967 *l.* 9 *s.* as the approximate estimate of the sum to be recovered from the Hackney district, in respect of the Main Drainage Works. This is exclusive of the annual working expenses.

We will now proceed to consider other important features of the scheme in so far as the Hackney district is concerned.

From Appendix 1, of Mr. Bazalgette's Report.—The prospective population for the Hackney district appears to have been estimated at 30,000 per square mile, and the estimated area from Blackstock-lane to the River Lea, 3,875 acres; and the total area of this level from the commencement of the Northern High Level Line, at a quarter of a mile east of South-end-green to Old Ford, 7,125 acres. The prospective sewage estimated at five cubic feet per head per diem, from Blackstock-lane is equal to 580 cubic feet per minute, and the maximum sewage running during six hours of the day, is stated at 1,160 cubic feet per minute. The maximum rainfall is estimated at 1,221 cubic feet per minute, which added to the maximum sewerage, give a total of 2,381 cubic feet per minute as a maximum quantity of rainfall and sewage to be provided for, from Blackstock-lane, and 4,457 cubic feet per minute from Southend-green, to pass through the intercepting sewers.

I also gather from this statement, that 960* cubic feet will flow through the High Level sewer from Blackstock-lane, and 200 cubic feet per minute through the Lower Level sewer.

The sewage arising from part of Newington, De Beauvoir Town, and West Hackney, passes through Islington parish, and thence by the Ball's Pond Branch Main Sewer in Southgate-road, through Shoreditch parish to the Thames at London Bridge.

Part of Cambridge-heath and Dalston also discharge their sewage through Shoreditch and Bethnal-green parishes, to the Thames at Ratcliffe Cross.

Now, the whole of the sewers flowing through these adjoining parishes will be intercepted and conveyed by the proposed middle level sewer to Abbey Mills, and from thence by the main sewer to Erith Reach.

The remainder of the sewage from the Hackney district now discharges into the River Lea at or near the point where the proposed northern high level sewer would cross the Lea, being about 3½ miles northward from its junction with the Thames, and 6¾ miles distant from London Bridge.

This

* As the maximum flow of the sewage during six hours of the day.

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This sewage it is proposed to intercept in part by the High Level, and partly by the Low Level sewer.

With regard to the Low Level area, I have carefully compared the levels of the existing sewers with the proposed main sewers, for the purpose of ascertaining the actual surface which, by the proposition being carried out, would drain into the low level sewer. This area is tinted blue on the accompanying plan, and is supposed to be that portion of the district which is too low to admit of the drainage passing off by gravitation into the Thames during higher water at Erith, and therefore, that recourse must be had to pumping. The whole of the rainfall and sewage due from this area will have to flow to Abbey Mills in Essex, and there pumped up into the High Level sewer.

Now I wish to impress on the Board, that there are two important points to be borne in mind as to pumping,

Its first cost, and the perpetual annual outlay, and

Its insufficiency, as compared with a sewer, which will discharge without the aid of pumping.

The first cost appears to be in round numbers 277,000 *l.*, and the annual outlay about 22,000 *l.* for 33 square miles, which is equal to 657 *l.* per square mile per annum; therefore, every square mile of surface reduced from the Low Level area will effect a saving of 657 *l.* per year.

That a sewer, capable of discharging the sewage without mechanical means, is more efficient than a sewer which requires constant machinery at work, there cannot be the slightest question.

It behoves us, therefore, to examine carefully the Low Level area, carrying as it assuredly will, perpetual taxation.

Then what is the fact with regard to Hackney? Why, a very considerable portion of what is treated as a Low Level area, varies from 28 feet to 92 feet above Trinity high-water mark, and comprises Victoria-park, part of South Hackney, Homerton, Upper and Lower Clapton, and Clapton Common.

I would ask you to imagine the result of this; we will take the surface at Clapton Common as a starting point, thence the sewage and storm-waters will flow from an elevation of 93·0 feet above Trinity high-water mark at Clapton; 43·6 feet above Trinity high-water mark at Homerton; 37·6 feet above Trinity high-water mark at Victoria-park; 38·6 feet above Trinity high-water mark at South Hackney; and thence along the course of the brook to Wick-road, where it will flow into the Low Level sewer, and thence to Abbey Mill, in Essex, to 28 feet below Trinity high-water mark, there it will be lifted by pumping 37 feet into the High Level sewer, which is nine feet above Trinity high-water mark, and flow thence by gravitation to discharge near to Trinity high-water at Erith.

I contend, this Low Level area should be reduced, and I will presently show how it can be done.

The next question is—Will either of the proposed sewers form a more efficient outfall than the present sewer?

The northern High Level sewer will not admit of receiving from this district nearly so much drainage as now received by the Hackney-brook, because at Old Ford, the sewer will be 15 feet higher than the bed of the brook, and does not obtain its level until it arrives at Well-street.

Therefore, this portion of the sewer being 4,300 feet of 10 feet barrel, and 1,500 feet of nine feet six inch barrel sewer, will be perfectly useless, so far as this district is concerned; first, because of its elevated position, in order to enable the sewage to pass over the River Lea; second, because the length in Victoria Park and Hackney Common may never be required for local drainage.

At Wick-lane the proposed sewer will be two feet ten inches above the bottom of the existing sewer, so that its sewage must pass beneath and discharge into the Low Level sewer.

The remaining length from Well-street to the Green-lanes, Newington, will not form a more efficient outfall than the brook, neither can it be made to act as its substitute without constructing at the same time considerable lengths of branch connecting sewers, and in some places along the bed of the brook.

Applying the same question to the Hackney Marsh Low Level sewer, I can reply in the affirmative. This sewer will unquestionably benefit the Hackney Marshes, as it will form a more efficient outfall than is now obtained at Hackney Wick, and will save the cost of constructing the sewer, proposed in the sewerage report for Wick-lane, Park-street, and part of Wick-lane.

The floods to which the Hackney Marshes are now liable, will be relieved, but not remedied, by this sewer; the banks of the River Lea must be raised to effect a complete cure.

To what extent will the proposed sewer be useful for extended local drainage? is the next question.

In the consideration to the first, this question is partly anticipated; I will, however, first state what is meant by the question; simply this: through what localities will the proposed sewer pass, having no present means of drainage, and for which the proposed sewer will provide an outfall? This will apply to one side of Amherst-road and Rectory-road, about 5,000 feet in length.

The length from Old Ford to the Green-lanes is about 21,300 feet, about 3,800 feet of this will be available for local drainage. I believe the whole of that portion of the Hackney Marsh branch Low Sewer, within the district, from White Post-lane to Church-road, will

form an outfall sewer for the property already erected on one side, and partly on the other side, and also for the houses which may hereafter be erected on the land vested in Her Majesty's Commissioners of Woods and Forests; it is true, a considerable portion of the property on one side is already drained into the brook, but the proposed sewer will form a proper and less offensive outfall.

Then to what extent will the proposed sewer relieve the Thames from pollution by Hackney sewerage.

The Thames will be relieved from pollution, so far as that portion of the sewage of Hackney is intercepted by the Middle Level sewer; the sewage from the remainder, although polluting the Lea waters, becomes so strongly diluted before reaching the Thames, that I question (if no other sewage flowed into the river below the brook) whether any difference could be observed a short distance from its mouth; still the diversion of sewage from the River Lea is a work of great urgency.

I have now shown how the Hackney district will be affected by the construction of the main sewers north of the Thames, namely—

That the Hackney Marsh branch sewer only will form a more efficient outfall than is now obtained.

That the northern High Level sewer would not be of sufficient depth to form an outfall sewer for the entire High Level area, and that this involves an unnecessary increase in the Low Level area, and thereby inflicts injury rather than benefit on a portion of Hackney,

First, by providing means of drainage which will require constant mechanical action for parts of the district, which is of sufficient altitude to admit of having its sewage conveyed away by gravitation.

Second, by a proportionate increase in the perpetual annual taxation for working expenses.

That the Thames will be relieved from pollution by that portion which will flow into the Middle Level sewer.

That a small portion of the proposed sewers will be useful for extended local drainage.

That the proposed north High Level sewer cannot form a complete substitute for the Hackney Brook, without the construction of considerable lengths of branch connecting sewers.

Then the chief benefit this district is to derive from the construction of the northern High Level sewer is, that it shall form a substitute for the Hackney Brook, that brook having now become a nuisance, and while forming a substitute, is made also to form an intercepting sewer for the northern portion of the River Fleet Valley, so that some of the waters now flowing along the River Fleet sewer would be conveyed to Erith through this district.

Now, with regard to the scheme of interception, notwithstanding much has been said to the contrary, I am convinced that practically it is the proper mode of dealing with the sewage of London; and I also believe that the scheme now proposed by the Metropolitan Board of Works will, with certain modifications, be carried out; but that deviation from the line proposed should be made, and a considerable reduction in the Low Level area, so as to confer greater benefits to the districts through which the sewers would pass.

As to the question of utilising the sewage. The great practical difficulty now experienced by the advocates and strong supporters of this question, appears to be the want of customers; the market is already overstocked; however, some improvement may yet be made so as to render the products more valuable; and should this be the case, I apprehend that sufficient could be obtained during the dry months of the year, with which to stock the market.

In a very elaborate and able paper, showing mastery of the subject treated, read by Mr. Bazelgette before the Association of Civil Engineers and Surveyors, of which Association I have the privilege of membership, Mr. Bazelgette suggests copious dilution as a deodoriser, when a sufficient body of tidal water can be obtained.

I have now to submit the following suggestions on the Main Drainage sewers proposed for Hackney district.

The northern High Level sewer should be constructed at sufficient depth to admit of the reduction of the proposed Low Level area to the extent shown upon the annexed plan, forming that portion of Hackney which is too low to admit of the drainage therefrom, being conveyed by gravitation so as to discharge at Erith Reach, near the time of high water.

It may be argued this cannot be done, because of the rivers over which it is intended the northern sewer shall pass. In answer to this, I say it can be satisfactorily, shown that existing syphons constructed beneath rivers and canals are perfectly safe, having in some cases been in operation more than 20 years without requiring cleansing.

Then why not benefit the whole of the eastern district by adopting the syphon; a considerable portion of the Low Level area along the Thames margin would then be reduced, and the perpetual annual taxation modified; outfall sewers of greater depth than existing local sewers would be provided, and the eastern districts benefited.

To effect a reduction in the Hackney district, the line should be altered from Old Ford to Hackney Station the length as at present proposed will be wholly useless for local drainage, while the course herein suggested would also obviate the necessity of constructing local sewers.

I propose that, instead of passing through Victoria Park, Hackney Common, and through streets where sewers already exist, the sewer should be constructed along Wick-lane, on the incline south of Wick-road, to and through Water-lane, and along the course of the brook from Bridge-street, Homerton, to the Hackney Station.

The following branch connecting sewers should also be constructed in conjunction with the works, in order completely to divert the sewage flowing into that portion of the brook from which the main current would be diverted, otherwise a more serious nuisance than now exists would result from the stagnation of the sewage matter along the bed of the brook.

Should, however, the suggestions herein contained be adopted, the last three lengths, making 2,200 feet, would not be required.

Pembury Road	160 ft.	of 18 ft.
Down's Road to Rectory Road	500 „	3 ft. 9 in. by 2 ft. 6 in.
Newington Common	1,100 „	1 ft. 6 in. „ 1 ft. 6 in.
Stapleton's Dairy to Stamford-hill	600 „	1 ft. 6 in. „ 1 ft. 6 in.
Lordship Road	600 „	3 ft. 9 in. „ 2 ft. 6 in.
Park-street	500 „	1 ft. 6 in. „ 1 ft. 6 in.
Amherst Road and Terrace, along the bed of Brook	1,400 „	1 ft. 6 in. „ 1 ft. 6 in.
Berger's Factory to Church-street	1,000 „	3 ft. 9 in. „ 2 ft. 0 in.
	600 „	3 ft. 0 in. „ 2 ft. 0 in.
	600 „	2 ft. 3 in. „ 2 ft. 0 in.
Total length	7,060	

The reduction of the Low Level area, north of Clapton-square, can be effected by constructing about 680 feet in length 4 feet by 2 feet 8 inch sewer; but the Homerton and South Hackney drainage should be taken up by the High Level sewer, and the means herein suggested would divert the whole.

I am, &c.
James Lovegrove, Surveyor.

9 April 1857.

(3.) HOLBORN DISTRICT.

1. MINUTES of EVIDENCE given by Mr. *L. H. Isaacs*, Surveyor.

Meeting of Referees, 29, Great George-street, Saturday, 9 May 1857.

Mr. Isaacs attended by appointment.

In answer to a question Mr. Isaacs said, that he did not believe it would be possible to carry out effectually the complete separation of rainfall from house drainage.

The expense of at first effecting connections with new drains would be, Mr. Isaacs considered, at least 10 *l.* per house, and in first class houses considerably more.

Mr. Isaacs thought the Piccadilly branch of the Middle Level Intercepting Sewer would be of insufficient size to carry off the drainage of the district it was intended to serve. It would intercept in its course four large existing sewers.

Mr. Isaacs also thought the Aldgate branch too small, and of very insufficient fall (1½ foot per mile).

Mr. Isaacs would prefer that the sewage of the districts now proposed to be drained by the Piccadilly branch should be allowed to flow into the Low Level sewer, rather than intercept it by a sewer insufficient to convey it, and which would result, at times, in the flooding of the district; as it was desirable, however, to relieve the Low Level sewer of as much of the upland waters as possible, he thought the Piccadilly branch a very desirable one, if made sufficiently large.

In answer to a question, Mr. Isaacs said there was a good deal of deposit during dry weather in the sewers of his district.

Mr. Isaacs traced out on the large Ordnance Map the limits of his district.

Mr. Isaacs wished to call the attention of the Referees to the serious interruption to public traffic which would be occasioned by the construction of these sewers. The High Level sewer would traverse a district suburban in character, and would not probably occasion much inconvenience; the Middle Level sewer would be more open to objection on this score; but the obstruction to traffic that would be caused by the construction of the Low Level along the route indicated would be very serious.

Having regard to the loss that such obstruction would entail, to the danger that might arise to buildings from the depth at which the necessary excavations would have to be made, to the circumstance that the whole of the existing sewers south of the proposed Low Level intercepting main would have to be taken up and reversed, and feeling convinced that the construction of the intercepting sewers would have an almost inappreciable effect in improving the appearance of the Thames, Mr. Isaacs thought it was matter for grave consideration whether the Low Level sewer should not be carried out in conjunction with an embankment of the Thames.

In support of this view, Mr. Isaacs called the attention of the Referees to the abstraction of the large volume of water now conveyed to the river by the existing valley lines, and which the proposed scheme would intercept, and only restore to the river at a point where it would scarcely be needed.

Mr. Isaacs considered the result of such abstraction would be an enlargement of the existing mud-banks, and an increase of shoals, whereby the scour of the river would be materially lessened, and he feared this would continue to so serious an extent, that it would soon be found that the embankment of the Thames was a work of absolute necessity.

In reference to the interception of the Fleet, Mr. Simpson explained how the junction with the intercepting sewer was proposed to be made.

Mr. Isaacs thought the matter of such importance, that more than a passing allusion should have been made to it in Mr. Bazalgette's report.

In answer to a question, Mr. Isaacs said that the consequence of the flooding of the Fleet sewer in 1846 was very serious to private property.

He thought flooding would now be prevented in that line by the works executed by the late Metropolitan Commissioners of Sewers.

Mr. Isaacs said that, notwithstanding all the precautions taken, it was found that detritus from the streets found its way into the sewers to a very great extent.

In answer to a question, Mr. Isaacs said that he averaged the expense of abolishing cesspools, and connecting the privies with the public sewers, at from 8 *l.* to 10 *l.* per house, where there was no water supply to the closet, and where water was laid on with proper appliances to supply the closet at from 12 *l.* to 14 *l.*

Mr. Isaacs promised to supply the Referees with statistics as to the number of the cesspools filled up, and connections made with the sewers in his district, since the Metropolis Local Management Act had been in operation, with particulars of cost.

Mr. Isaacs said the alterations from cesspools to water-closets, having connections with the sewers, was still going on very largely in the Holborn district.

In answer to a question, Mr. Isaacs said, that though he tried in every way to prevent the offal from slaughter-houses going into the sewers, it nevertheless was often thrown in, and the sewers became obstructed in consequence.

Mr. Isaacs said there were a large number of rats in the sewers, but the proportion of animal matter which they consumed was probably not more than one-twentieth of that which found its way into the sewers.

Mr. Isaacs, in answer to a question, said, that hair often coagulated in sewers which were deficient of fall, and proved one of the most serious obstructions with which he, as a surveyor, had to contend.

Mr. Isaacs, in answer to Captain Galton, said he had no means of preventing the silt and roadstuff from his lateral sewers passing through the main sewers, and ultimately lodging in adjoining districts.

Mr. Isaacs thought the dilution of the storm waters, which Mr. Bazalgette proposed to pass into the Thames by means of storm overflows, would be such that little or no nuisance would arise.

When a large volume of rain was received into the sewers, the deposit in them would be cleared out before any overflow into the Thames could begin.

Mr. Isaacs said there was not a large amount of pipe-drainage in his district. He did not approve, nor permit, the employment of pipes less than six inches in diameter, for connecting the houses with the public sewers.

Letter from Mr. Isaacs.

2. Letter from Mr. *Isaacs* to Mr. *Saunders*.

Board of Works, Holborn District.

Surveyor's Department, Little Gray's-Inn-lane,
15 May 1857.

Sir,

I forward you herewith the evidence given by me on the subject of the main drainage of the Metropolis on Saturday last corrected, and also enclose particulars of the cost of filling up cesspools, and laying down drain pipes, with and without water supply. I find that the number of cesspools so filled up in this district since the passing of the Metropolis Local Management Act is 192.

I have, &c.
Lewis H. Isaacs,
Surveyor to the Board.

Herbert C. Saunders, Esq.
29, Great George-street, Westminster.

(Enclosure in above Letter.)

Estimate for Draining a House into Sewer without Water Supply to the Closet.

	£.	s.	d.
Empty and fill up cesspool	1	2	–
Entry of drain into the sewer	–	4	3
55 ft. run of 6 in. main pipe drain, 1 *s.* 6 *d.*	4	2	6
No. 3 junctions into 6 in. pipes extra, 8 *d.*	–	2	–
6 ft. run 6 in. curved pipe extra, 4 *d.*	–	2	–
20 ft. run 4 in. branch drains, 1 *s.*	1	–	–
6 ft. run 4 in. curved pipe extra, 3 *d.*	–	1	6
Closet-pan and syphon trap, fixed complete	–	10	–
Refixing seat, riser, and floor of closet	–	6	–
No. 2 traps and sink stones in area and yard, 5 *s.*	–	10	–
£.	8	–	3

All the above, and with water supply to the closet.

	£.	s.	d.			
Slate cistern to hold 100 gallons, and fixing	2	–	–			
20 ft. run ¾ in. lead pipe to supply cistern and pan, 9 *d.*		15	–			
Ball-cock, valve, and apparatus complete	1	–	–			
				3	15	–
£.				11	15	3

L. H. J.

(4.) LAMBETH DISTRICT.

Minutes of Evidence given by Mr. *H. M'Intosh*, Surveyor.

Meeting of Referees, 29, Great George-street, Wednesday, 13th May.

Mr. M'Intosh attended by appointment.

In reference to a passage in the letter which he had addressed to the Referees, Mr. M'Intosh said that the high level and low level sewers, the want of connection between which he had alluded to, were the Effra and the Earl; that there were only two connections between the former sewer and the low level drains, and that both of these were artificial, and effected by penstocks.

There are many parts of Lambeth without sewage proper; in fact, all proper sewers cease at Vauxhall Bridge; beyond, the Effra prevents sewage works being carried out. There is a very good sewer in the Kennington-road, which is flushed from Nine Elms.

Mr. M'Intosh said that though the law forbids any soil being thrown into an open watercourse yet practically the law was constantly evaded.

Mr. M'Intosh thought the Effra was now so polluted that it would be impossible ever to restore it to a pure state.

Mr. M'Intosh said that there was a large number of cesspools in his district, particularly in the Brixton-road. The inhabitants of the houses with large gardens use the contents of the cesspool as a manure. The soil is gravelly, so that the ground is a great deal impregnated with night-soil; but Mr. M'Intosh did not apprehend that much of that reached the Effra, as filtration went on to a great extent in the ground.

Mr. M'Intosh agreed with the referees that it was a misnomer to apply the name "watercourse" to the Effra, which is contaminated up to its very source.

Mr. M'Intosh advocated large reservoirs in the high level districts for the reception of storm waters, if it were admitted as a principle that storm waters should be stored up, thinking it better to have *bonâ fide* reservoirs than to construct large sewers, which are under certain circumstances to act as reservoirs.

The low level sewers Mr. M'Intosh would relieve by pumping.

In answer to a question Mr. M'Intosh said that he had not gone into the details of the reservoir system sufficiently to give an opinion as to the necessary size of them off-hand, but would* prepare a written opinion upon the subject.

Mr. M'Intosh would construct a reservoir at Peckham Rye, and would arrange them generally in the way best adapted to receive the watershed of each particular district.

If the storm waters of the high level district were kept separate from the low level, there would be no necessity to construct reservoirs for the rainfall of that district by itself, the outflow at Deptford Creek Mr. M'Intosh considering to be sufficient, when aided by the pumping he proposed.

Mr. M'Intosh, in answer to a question from Mr. Simpson, said that there was great difficulty in keeping the surface waters of his district clear, and, in fact, from soakage and other causes thought it almost impossible to do so. With

* No communication on the subject of these reservoirs has been received by the Referees from Mr. M'Intosh.

With regard to the amount of rainfall, Mr. M'Intosh could not help thinking, though he did not wish to pledge himself to the amount, that a more than sufficient provision for rain-waters had been made by Mr. Bazalgette.

In answer to Mr. Simpson, Mr. M'Intosh said that the tidal waters flowed up the Effra as far as the levels would allow, without any obstruction. Mr. M'Intosh related the details of a flood in Clapham-road which had been caused by an imperfect flap-gate; Mr. M'Intosh said that works were about to be carried out which would for the future effectually prevent floods in the Clapham-road.

Mr. M'Intosh said that floodings had been greatly diminished of late years by improved drainage in two respects—1st, by the increased capacity of the new sewers; 2d, by the straightening of lines formerly curved, &c.

In answer to Mr. Simpson, Mr. M'Intosh said that the late Commissioners of Sewers had laid down not only a good many pipe sewers, but also a large proportion of brick sewers in his district.

In answer to a question from Mr. Blackwell, Mr. M'Intosh said he was not aware that there was a great deal of absorption in the Effra sewer; but with regard to some gaugings made by the Referees stated that their results might possibly have been effected by a sluice gate at the Vassel-road, which might have diverted some of the waters into the Camberwell sewers before they reached the second gauging board, and after having passed the first or higher one.

Mr. M'Intosh said, that there was a great deal of building going on at Brixton, and promised to mark on a map the parts in course of being, and lately built over.

Mr. M'Intosh, in answer to Captain Galton said, that the rates, with the exception of the poor-rate, were by no means high in Lambeth.

Mr. M'Intosh said, there were a good many short sewers which discharged on to the shoal of the river between Westminster and Vauxhall Bridge.

Mr. M'Intosh, in allusion to the stricture at Deptford Creek, said, he considered that it was intended to be the gauge of the quantity that should be conveyed into the extension line, the remainder being discharged in the creek, and he doubted the necessity of carrying on the flood waters to that point; but thought they might be discharged at points higher up the river.

Mr. M'Intosh did not see why the storm waters of the S. W. and S. districts should not be discharged into the river by the Effra, instead of being carried all the way to Deptford Creek through a large sewer.

Mr. M'Intosh thought there would be practically no objection to throwing storm waters into the river when the volume was increased five times, the dilution being then very great.

In answer to Mr. Blackwell, Mr. M'Intosh said that he found deposit generally collected in the main rather than in the lateral sewers.

Mr. M'Intosh thought two feet per mile was scarcely sufficient fall for the new main sewers; but was aware that no calculation would prove exactly the rate at which sewage would flow in the existing sewers; the circumstances in almost every sewer and every part of a sewer varying; and the rate of flow being thereby affected.

Mr. M'Intosh said, that the deposit in his sewers was mainly road-drift, which even the most careful arrangements could not altogether prevent from finding its way into the sewers.

The amount spent by the Lambeth District Board annually on flushing was 800 *l.*, while the Metropolitan Board spent, perhaps, as much again.

With reference to an opinion in his report that Dulwich would not spread, Mr. M'Intosh said that that opinion would be materially modified by the fact, which Mr. Simpson communicated to him, that Dulwich College had now got an Act of Parliament, by which they were empowered to grant building leases.

Mr. M'Intosh wished to lay great stress on the alteration of the low level sewer, which he had proposed in his letter, so as to economise the new drainage works necessary for Lambeth. His reasons for proposing it were, 1st, because the proposed "Effra overflow" need not be constructed if this deviation of the line be made; and 2dly, on account of the levels.

The sewers in the Lambeth district are only ventilated by the ordinary street gratings; but the large amount of water acts as a very efficient means of purification independently.

Mr. M'Intosh urged the postponement of the construction of the high-level sewer, believing that the low-level sewer would be found to do more for carrying off the sewage than was expected now by the most sanguine.

In answer to Mr. Simpson, Mr. M'Intosh said that he believed, as things existed now, that no effectual separation of the house and surface drainage could be carried out, but thought that in the intervening time between the completion of the deep low-level drainage, and determining the provisions necessary for the high-level districts, the principle he proposed might be adopted, so far as to extend the sewers provided for the low-level districts, so as to provide for soil drainage, but to maintain the existing lines for flood waters, and not connect them with the new sewers.

Mr. M'Intosh said, that it was a popular fallacy that the upland waters flooded the low districts; this was not so, but the floodings were caused by heavy rains falling at a time when the sewers could not get the average amount of relief, owing to the state of the tide, or from a prevailing wind keeping the water high in the river. Floodings have also frequently occurred from the water rushing from the river at high tide over the bank, or through some opening, along the surface and into the sewers.

Mr. M'Intosh thought it undesirable to construct a high-level sewer, even though the drainage of the high districts would have to be pumped after flowing down into the lower districts.

(5.) NEWINGTON DISTRICT.

THE Surveyor of Sewers' Report upon Mr. *Bazalgette*'s Plan for Sewage Interception and Main Drainage of the Districts South of the *Thames*.

To the Chairman and Vestrymen of Saint Mary, Newington.

29, Trinity-square, Newington,
30 April 1856.

Gentlemen,

IN accordance with your instructions, I have carefully examined Mr. Bazalgette's design for the sewage interception and main drainage of the districts south of the Thames; and having attentively studied his Report thereon, I have now the honour to submit the following brief remarks for your consideration.

In order that the plan may be fully comprehended in its principles and leading features, I think it only due to the Engineer that I should describe it in his own words. (*See* the printed copy of his Report.)

It will be seen by this Report, then, that with reference to the improvement of the drainage in your own particular parish, it is intended to connect all the present main sewers with the proposed new branch low level sewer at St. James's Church, Bermondsey; and that, with the aid of steam power, a continuous and unintermitting flow to the main sewer at Deptford, and ultimately to the reservoir at Plumstead Marshes, will be produced; and consequently the great evil arising from the sewers being pent up by the tidal flow, will be entirely removed, the generation of the noxious gases will he in a great measure prevented, and the annual expense of cleansing the sewers will be considerably reduced. Besides this, the existing sewers will also be greatly relieved of the rain-fall and storm waters due to nearly 15 square miles by the proposed high level intercepting sewer.

It appears that only a small portion of the low level sewers will pass through your parish, and that portion will be at the extreme south end, at the intersection of the Albany-road with the Camberwell-road.

No other of the proposed sewers will pass through your parish.

As your surveyor of sewers, I feel it incumbent upon me to state my opinion upon the subject, although I do so with great diffidence, and not until I have given much consideration to the subject, being fully alive to its importance, and aware that much difference of opinion may probably exist upon several of the "points involved in the scheme."

For myself, I think the plan proposed is well calculated to accomplish all that is required to effect the drainage of the districts south of the Thames; and judging from the immense labour and care which seem to have been bestowed by the Engineer in obtaining all the information necessary to enable him to grapple with the subject, and from the great amount of engineering experience which has been brought to bear upon it, it seems almost impossible not to have full confidence in the plan, or to fail to be impressed with the great ability of the Engineer.

It must be satisfactory to you to know that the principle laid down by Mr. Bazalgette has had the entire concurrence of Sir William Cubitt, and Robert Stephenson, Esq., who, in their Report, stated "that the effect of the proposed plan would be the same as if the land on the south side were raised 20 feet higher." And on another occasion Mr. Stephenson stated "that he was prepared to be personally answerable for the soundness of the principle and the accuracy of the details of Mr. Bazalgette's former plan," which (we are told by Mr. Bazalgette himself) "resembles the present scheme in its main features."

With regard to the estimate, it would appear at first sight that the contemplated outlay is large; but when it is considered that the area to be drained by the proposed plan contains 26,720 square acres,—that the difficulties to be overcome are of no mean character,—and that the object to be accomplished is almost unparalleled, and of incalculable benefit, not only to the present, but to future generations, we shall cease to be surprised at the amount named.

In thus giving my unqualified approval of the principle which governs Mr. Bazalgette's plan, I feel it important to notice a subject in connexion with it. I allude to the oft-repeated suggestion of applying the refuse of the sewage to agricultural purposes, and beg respectfully to express my surprise at the absence of any allusion to it in his Report.

It may be that he considers that its value will not compensate for the difficulty and expense of removing it to different parts of the country. If this is the case, it would have been satisfactory to know it.

I believe the matter is now engaging the attention of the Metropolitan Board; and as I have no doubt the public will watch with lively interest their proceedings in investigating the matter, it will be for your Vestry to determine if you will take any steps in expressing an opinion as to the necessity of ascertaining the practicability of applying the sewage

Appendix VII.

Information on District Drainage.

Surveyors' Evidence and Reports, &c.

Newington.

matter to the purposes of fertilising the land, rather than allow it to be discharged into the river.

I would submit, that as it is more than probable the proposed reservoir would be required in either case, the inquiry into this matter would not of necessity delay the adoption and carrying out so much of Mr. Bazalgette's plan as relates to the construction of the sewers.

I have, &c.

Henry Jarvis,
Surveyor of Sewers.

Paddington.

Report by Mr. Merry.

(6.) PADDINGTON DISTRICT.

REPORT on Sewerage and Drainage Works. By *William Merry*, Surveyor.

Gentlemen,

I BEG respectfully to present the following concise statement of the Sewerage and Drainage works, which have been executed and completed within the Parish of Paddington, during the year ending 31st December 1856, which are as follows, namely:—

356 feet of 3 feet by 2 feet half-brick sewer in James-street Mews, in lieu of defective 12-inch pipes; 168 feet of 18-inch half-brick sewer in Berkeley Mews; 260 feet of 18-inch half-brick sewer in Westbourne Park Villas Mews, in lieu of defective 12-inch pipes; 1,920 feet of 3 feet 9-inch by 2 feet 6-inch whole brick sewer in Titchborne-street, Upper Porchester-street, and Connaught Terrace, in lieu of old defective brick sewers.

In addition to which, the following sewers have been applied for by private parties, and partly constructed along proposed new roads and streets:—

763 feet of 12-inch pipe sewer in Inverness Terrace;
150 feet of 12-inch pipe sewer in Newton Mews;
1,200 feet of 3 feet by 2 feet half-brick sewer along three new streets, between Hereford-road south and Garway-road;
400 feet of 3 feet by 2 feet half-brick sewer in Hereford Mews;
400 feet of 3 feet by 2 feet half-brick sewer, and 200 feet of 15-inch pipes, along the south side of Queen's Gardens.
200 feet of 3 feet 9-inch by 2 feet 6-inch whole brick sewer in St. Stephen's Crescent;
1,200 feet brick sewer in Stanraer-road;
900 feet " in Stanraer Crescent;
900 feet " in Warwick-road North;
600 feet " in Warwick-road West;
700 feet " in Cirencester-street;
800 feet " in Spencer-street; and
1,200 feet " in Delamere Terrace.

The exact length of work completed is as follows, *viz.*:—Brick sewers, 8,000 feet run; pipe sewers, 1,000 feet run; 46 new street gullies, 1,000 feet run; 230 new house drains, and 70 old ones reconstructed, the total length of which is 22,000 feet run of drain pipe. The grand total of sewers, drains, and gullies, is 32,000 feet run. The approximate cost of the above-mentioned works is 7,450 *l.*

Jobbing works have been executed, such as repairing and cleansing sewers, with other works incident thereto, amounting to about 1,000 *l.*; and I may also add, that 162 complaints have been received and attended to, either by removing or suggesting a remedy for the various evils complained of

As this is the first annual report under the "Metropolis Management Act," a short description of the sewerage of Paddington, together with some observations thereon, may not be altogether without interest.

The parish of Paddington is bounded by St. Marylebone on the east, by St. Mary Abbott's, Kensington, on the west; by Willesden on the north, and by Hyde Park and Kensington Gardens on the south. It contains an area of about 1,234 acres, two-thirds of which is covered with houses. Its form is exceedingly compact, its general surface is undulating, and its altitude varies from 50 to 103 feet above Trinity high water mark. The ground forming the present surface of the streets is artificial to a depth of from 3 to 16 feet, being made of earth, rubbish, and road scrapings. The subsoil consists of clay, gravel, and sand; the latter being of a very superior quality.

There are about 24 miles of brick sewer, and four miles of pipe sewer, together with about 1,500 street gullies, two-thirds of which are untrapped. From 1815 to 1846 the sewers were put in piecemeal, as the streets were formed, without any regard to the requirements of the adjoining streets. They vary in size from 4 feet to 5 feet 6 inches in height; the inverts are flat, and the side walls are upright.* From a personal examination of their construction, I am

* The majority of the brick house-drains connected with these old sewers are exceedingly defective in their construction: the bottoms are very uneven, and they are partly choked with foul and offensive matter; in fact, they are no better than elongated cesspools; and it is only when the rats have made their way through into the lower part of the house, that the occupiers are made sensible of the imminent danger to which their health is exposed by living in an ill-drained house.

I am convinced, from practical observation, that a great amount of sickness is caused by an accumulation of noxious deposit under houses; and therefore, whatever works the vestry may carry out for the improvement of the existing sewers, will avail little unless the house-drains are put into good and efficient working order.

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am led to believe that a uniform gradient was not considered of any importance, as the inverts are a continuous series of hills and hollows, which retards the flow of sewage, instead of affording the means of conveying it away immediately it enters the sewers. Hence, deposit is constantly accumulating, from which foul and offensive effluvia passes through the untrapped gully grates, to the great annoyance of pedestrians, and especially to those persons who occupy houses immediately opposite to an untrapped gully grate.

In 1846 the oval or egg shaped sewer was introduced, which possesses an advantage over the flat-bottomed one, by the increased scouring action derived from the greater velocity of the stream, which prevents the accumulation of deposit to the same extent as in the flat-bottomed sewers. In addition to which the cost of construction was reduced about 50 per cent. In 1849, stone-ware pipe sewers were introduced for the drainage of courts, alleys, and short streets. If they had been confined to the drainage of these localities, for which they are admirably adapted, the inhabitants of Paddington would have been saved from considerable expense and annoyance, by the stoppages and breakages which have occurred, as the following statement will prove:—

In 1849, a 12-inch pipe sewer was laid down in Bayswater Terrace, at an expense of about 130 *l.* Two stoppages have occurred, the removal of which cost 50 *l.* At the present time the pipes are half full of deposit, and therefore further expense will shortly be incurred.

In 1850, a pipe sewer was laid down in Connaught-square mews, at a cost of 70 *l.* 16 *s.* 9 *d.* Four stoppages have occurred, the removal of which cost 51 *l.* 7 *s.* 8 *d.*

In 1850, a 12-inch pipe sewer was laid down in James-street Mews, at a cost of about 80 *l.*; the removal of three stoppages, together with its entire re-construction, cost 189 *l.* 5 *s.* 6 *d.*

In 1850, a 12-inch pipe sewer was laid down in Westbourne Park Villas Mews, at a cost of 56 *l.*; the removal of two stoppages, together with its entire re-construction, cost 80 *l.*

During the past year about 30 gullies have been connected with pipe sewers; and at each opening we found the 12 and 15-inch pipes were broken, and nearly flat.* Before leaving this part of the subject, I beg distinctly to say, that from the first introduction of pipe sewers, I objected to their being used in squares and first-class streets.

Having travelled through the sewers of Paddington, it appears to me, after due consideration, that the following alterations and repairs are requisite to place them in a thorough efficient state:—

The present head walls, of which there are about 40, where foul gases more or less accumulate, should be destroyed, by forming a proper connection with the collateral or cross lines, by which means the sewers will be continuous throughout the parish; and thus the water from one sewer may be made available for flushing the adjoining one. The present uneven bottoms of the old sewers should be contracted, by which means the scouring power of the water will be increased, which will render it almost impossible for any kind of refuse, capable of suspension in water, to accumulate; in addition to which a rapid stream would carry with it a current of air, which would obviate the necessity of ventilating the sewers through the street gullies, which, at the present time, is a source of great annoyance to the public.

The present contract price for cleansing and keeping the sewers clear of deposit for one year, is 480 *l.*† If the above works were carried out, the cost of cleansing would not exceed 150 *l.* per year.

The following is an approximate cost for effecting the improvements set forth in this Report:‡

	£.	s.	d.
11,000 feet of 3 feet 9-inch by 2 feet 6-inch sewer - -	6,655	–	–
10,000 feet of new invert to old sewers - - - -	2,000	–	–
1,000 gully traps, to supply and fix the same - - -	500	–	–
40 air shafts - - - - - - - -	200	–	–
£.	9,355	–	–

In humbly submitting this my first annual report, I have laid before your Committee a true statement of the condition of the sewers, together with some suggestions for their improvement; and should it be deemed advisable to execute the same, it will be my earnest desire to see that the works are done, not only efficiently, but economically.

I am, &c.
(signed) *W. Merry,*
Surveyor.

To the Highway Committee.

21 January, 1857.

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* These pipes are in Bayswater Terrace, Cleveland Gardens, Cleveland Square, Westbourne Park, Sunderland Terrace, Cumberland Terrace, and Durham Terrace; the total length of which is about 3,000 feet run.

† About 16 miles of brick sewer, in which the deposit varied in depth from 3 to 16 inches, have been thoroughly cleansed by flushing, and the remaining eight miles will be completed about the latter end of March 1857.

‡ The works recently completed in Titchborne-street, Upper Porchester-street, and Connaught-terrace, may be considered a fractional part of the improvements. Instead of the foul sewage remaining almost stagnant as it formerly did, there is now a constant flow of water through these and the adjoining old sewers, for a length of about 5,000 feet; and by means of flushing boards, a vast body of water from the main line in the Grand Junction Road can be turned through them, and thus accumulation of foul matter will be impossible; in addition to which, 11 head-walls, where foul gases accumulated, have been destroyed.

(7.) ROTHERHITHE DISTRICT.

REPORT by *George Legg*, Surveyor of Sewers and Drainage, to the Vestry of the Parish of St. Mary Rotherhithe, Surrey.

5 February 1856.

Gentlemen,

ON my appointment as the Surveyor of Sewers and Drainage for the parish of Rotherhithe, having the superintendence of nearly 15 miles of open sewers and ditches, and about four miles of known covered sewers, and many lengths of drainage that are not shown on the plans furnished by the late Commissioners of Sewers, and exclusive of the streams and the main sewers placed under the Central Board, I turned my attention to the most urgent works required, and found many of the street and road gullies were full. I therefore deemed it my first duty to remove the flooding of the several public thoroughfares, and have already cleared upwards of 140 thereof, commencing at the upper part of the parish, and hope, in the course of another week, to complete the clearance of the whole. I propose, by a periodical and systematic cleansing at the proper seasons, to prevent the occurrence of the same for the future. I should here observe, that about half of the gullies are not trapped, and have to request your authority for the trapping thereof, in compliance with the Act; and in others communication with the sewers is required.

Engagement of Labourers.

For the execution of the above works I have engaged two labourers, one formerly in the employment of the Commissioners of Sewers, an active intelligent man, at 24*s.* per week, possessing a good knowledge of the locality; and a hard working labourer, at 21*s.* per week; and have also made a temporary contract with Mr. A. T. Hobman, of the Plough-road, for the supply of teams and drivers, and the removal of such matters as may be required, at agreed prices, which I submit for your approval and confirmation; and request also your order for the supply of the necessary tools and utensils, planks, and other necessary apparatus for the use of the workmen, with barrows, trucks, and the formation of a depôt for the same.

The next work I propose to put under execution will be the flushing and clearance of the high level sewers, and putting the slides and penstocks in working order.

The most urgent works of covered district drainage appear to me to be—

1. That for the houses in Albion and Adam streets.
2. Lower Queen-street and Silver-street.
3. Coburg-street.
4. York-street.

I should mention that part of the old covered sewer to the second has broken in, and will require immediate temporary repair or reinstatement, and on my survey I requested Mr. Record, in whose premises it has taken place, to keep the same covered over till after the meeting of the Board. The water supply has been stopped by the filling in of part of the sewer on the east side of Lavender-lane.

In all four of the above cases I have given directions for the maintenance of the soil and filth in as fluid a state as the scanty supply of water will permit with the use of the slides.

Cleansing of Main Sewer.

The next subject I have to draw your attention to is the cleansing of the principal main sewer from the upper part of the parish to the Earl sewer at Deptford, and to request your authority for the opening of the same in several places, to ascertain the best means of cleansing, whether by flushing, or otherwise, as the circumstances may require.

I am informed that this sewer contains considerable deposit that may probably require bringing to the surface of the road for removal, and I would suggest that if such should unfortunately be the case, the present season would be the best for that work, and would require additional labourers for the purpose, without a sufficient supply of water can be economically obtained from the Water Company, or unless the West Mill Stream (under an arrangement with the owner) might supply sufficient for that purpose.

District Drainage.

I would suggest, that under the direction of the Board, the Inspector of Nuisances should undertake the inspection of the several blocks of houses, seriatim, (where the sewers have recently been made in your parish by the late Commissioners) to obtain the effectual drainage of the property, and the water supplied thereto, and that he should distinguish the numbers of the several houses or premises respectively, that have been drained in each street, and obtain the removal of the several cesspools or offensive drains where requisite, and that he be directed to require the proper supply of water to the several closets that have communication with the main drainage, and that such closet be provided with a hinged flap to the seat, and external ventilation, otherwise, I fear, that the vestry will find that these districts will not long receive the benefit that might be expected from the recent works.

House

House Drainage.

I find a general disposition on the part of the owners to avail themselves of proper drainage, and to adopt the suggestions of your officers; but in some cases it is necessary that the necessity for the same should be pointed out by the service of notices by the inspector to make the drainage in each locality complete.

Applications.

Applications have already been made mostly in the west district of the parish, for house drainage, and the parties applying have had notice that on payment of the respective estimates at the offices of the vestry, the drainage in the public thoroughfares would be executed by the contractor in the employ of the vestry, as a general rule, although in cases where builders of good reputation are executing the private works, it will be necessary that I should be allowed to exercise my discretion as to their execution of the portion in the public way, they having first paid the amount of the estimate, then being allowed to have the same refunded, subject to the deduction for making good of surface on execution of works.

Tenders for House Drainage.

I have applied to, and obtained estimates from sundry parties, for the execution of the house drainage in the streets and the necessary junctions with the sewers, and reinstatement of materials, and have ordered the work to proceed where the payment has been complied with.

I will reserve mentioning the amounts of the tenders in case any of the Board should suggest that any other builders should receive the particulars to tender for the works.

Applications for Drainage Unfulfilled.

I shall need the direction of the Board for my guidance where application has been made for drainage, and the same has not been carried out, although highly necessary for the general health of the neighbourhood, and "prevention of diseases."

Junctions of House-drains.

Application has been made for house-drainage into sewers under the control of the Metropolitan Board, and under these circumstances I submit that it is necessary that an arrangement should be made with that Board as to the course to be adopted in such cases for securing the local management thereof, otherwise much unnecessary trouble and inconvenience will arise in consequence of the local authorities not being in possession of the knowledge of which houses are drained, and the public inconvenienced by the want of knowledge as to where the respective jurisdictions cease. I have, therefore, communicated with some of their officers on the subject, and it appears to me the best course to be adopted as none has been yet decided upon. It will also be necessary that there should be an understanding between the respective Boards as to the size of the sewers, where the consent of the Central Board is to be obtained prior to execution by the vestry.

New Districts.

The several new neighbourhoods in course of formation will require each to be considered with reference to the particular locality and contiguity to the existing sewers, and the sufficiency of the water supply, and governed by the plan of laying out for building purposes, and class of erection proposed thereon.

Notices have already been given for the drainage of houses in the new streets on the east side of the Deptford-road, and for their communication with certain pipe-drains of a small class stated recently to have been inserted by the owners or lessees, but as the same are not indicated on the maps, I have requested the particulars from the surveyor of the sewers in whose district the same was situated.

The vestry will next have to consider the formation of the streets and drainage, and, where the houses are already erected and occupied, to require the proper drainage and formation of surface without delay.

Commercial Dock Company's Works, near Lavender-lane.

I have to report that the Commercial Dock Company have recently commenced filling up a sewer on the south side of Lavender-lane, and I have requested Mr. Burges, their officer, to give directions for the cleansing and reinstatement of the same; but he replies, that "the ditches had been complained of, and that the Commissioners were desirous of getting them filled in, and they gave permission to have them filled up." Under these circumstances I have applied to the surveyor to the Central Board of the district, for the particulars of the arrangement, as it affects the drainage of a portion of the parish east of such work.

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Ventilation of the Sewers, and Removal of Gratings from Carriage-ways.

I should suggest that compliance with the Act can be obtained by the use of gas in a shaft in the street, or by side shafts and ventilating flues carried up, at small cost, without injury to the general effect, with the fronts of houses in new neighbourhoods, and then that the removal of the ventilating gratings in the carriage-ways can be effected.

Cost of Drainage.

I deem it right to mention that the parish of Rotherhithe, owing to the general level thereof, cannot be drained on such economical terms as certain other districts may be, as it will be necessary in many cases (until after the completion of the great intercepting drainage), to provide to a certain extent, for the brief storing of storm waters.

Stoppage of Supply of Water in Mill Stream.

I have to report, that it is stated that no water has been admitted for the last three weeks or a month into the mill-stream on the east side of the Deptford-road; and you will decide whether the present might not be deemed the best opportunity for obtaining the clearance of both the mill-streams in the parish. I am unable at present to ascertain how far the stoppage will affect your sewers and drains.

I have, &c.
(signed) *George Legg*, Surveyor.

To the Vestrymen of the Parish of Rotherhithe.

(8.) ST. MARTIN-IN-THE-FIELDS DISTRICT.

St. Martin-in-the-Fields.

Report by Mr. Burstall.

REPORT upon the Sewerage of the Parish. By *R. K. Burstall*, Surveyor, April 3, 1856.

Gentlemen,

THE resolution of your vestry, dated February 21, 1856, instructs the surveyor to "report on the state of the sewerage of the parish."

In drawing up the following report, I beg to observe that the only guide I have had is the map of the parish, supplied to your vestry, as mentioned in a following paragraph. The officers of the Metropolitan Board of Works have informed me that the district sewers were in a good state of repair on December 31, 1855, from which period the above Board have had under their charge and control the main sewers only, the district sewers being vested, by the "Act for the better Local Management of the Metropolis," in the respective Vestries and district Boards of Works.

If any information be required at a future period with respect to the general construction and date of building of any of your district sewers, a communication from your vestry to the Metropolitan Board of Works would, no doubt, obtain the required data. All documents and plans connected with the various defunct commissions of sewers are now in the custody of the said Board.

The Commission of Sewers, which expired December 31, 1855, supplied to your vestry in January last, a map of the parish, to a scale of five feet to one mile, showing the various main and district sewers, with the levels of the inverts marked in blue, and the levels of the natural surface of the various streets and places in black. These levels, in feet and decimal parts of feet, are calculated from a datum line, which is 12½ feet below Trinity high-water mark. A smaller sized map, to a scale of 12 inches to one mile, showing at one view the general course of all sewers in this parish, was received at the same time.

On examination, I find that there are many sewers that are not drawn on the above plans. I have therefore prepared a map, to a scale of 12 inches to one mile, upon which I have made several corrections. The main sewers are coloured green, with their distinguishing names lettered, and the district sewers are coloured red. The arrows indicate the general course and fall of the sewer. The outlets into the River Thames are marked and numbered the same as will be found lettered on the river wall or upon the walls of neighbouring houses. I have likewise shown the five districts adjoining this parish, giving to each district a distinguishing colour.

To enable me to make the necessary corrections and probable additions, upon a large and working scale, I have purchased Ordnance plans, to a scale of five feet to one mile, upon which I am engaged in making a copy of the sewers, whether main or district, drawn upon the original plans. I propose, likewise, to show the connexion of all house or other drains into the sewers, as I obtain the knowledge of their locality.

In entering into the subject of the sewerage of this parish, I have considered it advisable to make the following divisions, namely:—Main Sewerage, District Sewerage, House Drainage, and Surface Drainage.

Main

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Main Sewerage.

Under this head it may be objected that the following particulars are unnecessary; but I do think that it is not possible for your vestry to obtain a knowledge of the general outline of the branch or district sewers unless at the same time an acquaintance be made with the course of the trunk or main sewers.

The main sewers running through this parish, under the charge and control of the Metropolitan Board of Works, are ten in number, and are distinguished thus:—

	Estimated Length.
Northumberland-street Sewer (western branch)	767 lineal yards.
Northumberland-street Sewer (eastern branch)	508 "
Northumberland-street Sewer (main line)	337 "
Regent-street Sewer (main line)	779 "
Victoria-street Sewer	335 "
Savoy-street Sewer	167 "
Norfolk-street Sewer	328 "
Essex-street Sewer (western branch)	57 "
King's Scholars' Pond Sewer (Pall Mall branch)	430 "
King's Scholars' Pond Sewer (main line)	736 "
	4,444

The Northumberland-street Sewer (western branch) runs under roadway in Princes-street, Panton-street, the south part of the Haymarket, the north side of Cockspur-street, the north side of Charing Cross, and West Strand, where it joins the Northumberland-street sewer (main line). The following district sewers are in connexion with this main sewer:—

Spur-street.	Haymarket (north part only).
Oxenden-street (north part only).	James-street (west part only).

The Northumberland-street sewer (eastern branch) runs under roadway in Upper St. Martin's-lane, St. Martin's-lane, St. Martin's-place, the east side of Trafalgar-square, and West Strand, where it joins the Northumberland-street sewer (main line). The principal tributary sewers in connexion with this main sewer are the following:—

Langley-street (north part only).	Chandos-street (west part only).
Mercer-street (north part only).	Bear-street.
Castle-street, Long-acre (west of King-street).	Leicester-square.
Long-acre.	Castle-street, Leicester-square.
Great Newport-street.	Green-street.
Cranbourn-street.	Hemming's-row.
New-street, St. Martin's-lane.	Duke's-court.
	Church-passage.

The Northumberland-street sewer (main line) runs under roadway in West Strand and Northumberland-street, and discharges its sewage into the River Thames at the river wall of Northumberland wharf. The following are the principal district sewers in connexion with this main sewer:—

Bedfordbury.	Bedford-street.
Chandos-street (east part only).	Hungerford-street.
King William-street.	Strand (west of Exeter-street).
Adelaide-street.	Great Scotland-yard (east part only).
Duncannon-street.	

The Regent-street sewer (main line) runs under roadway in Pall Mall, the south side of Cockspur-street, the west side and south part of Charing Cross, and Great Scotland-yard (south part only). It discharges its sewage into the River Thames, opposite Percy wharf, below low-water mark, by means of two 3-feet iron-pipes. The following are the principal district sewers in connexion with this main sewer:—

Orange-street.	Pall Mall East.
St. Martin's-street.	Warwick-street.
Blue Cross-street.	Spring-gardens.
James-street, Haymarket (east part only).	New-street Gardens.
Whitcomb-street.	Spring-gardens Terrace.
Dorset-place.	Spring-gardens Mews.
Suffolk-place.	Buckingham-court.
Suffolk-street.	Admiralty sewer.
	Trinity-place.

The Victoria-street sewer runs under roadway in Whitehall Yard, under the gardens to the eastward of the United Service Institution, under roadway in Middle Scotland Yard, at the easternmost end, and under roadway of Great Scotland Yard Wharf. It discharges its

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sewage into the River Thames opposite Percy Wharf, below low-water mark, by means of two three-feet iron pipes. The following are the district sewers that are in connexion with this main sewer:—

Middle Scotland Yard.	Whitehall Place.
Whitehall.	

The Savoy-street sewer runs under roadway in Hanover-street, across Long-acre, down Bow-street, Upper Wellington-street, Wellington-street North, and the Strand, and discharges its sewage into the River Thames at Savoy-street. The following district sewers are in connexion with this main sewer:—

Castle-street (east of King-street and Hanover-street).
Little Russell-street.
Exeter-street.
Burleigh-street.
Southampton-street.
Strand (from Southampton-street, eastward).
Catherine-street.

The Norfolk-street sewer runs under roadway in Drury-lane, from its junction with the Essex-street sewer (western branch), opposite Great Queen-street, and follows the course of the Lane into Wych-street, Newcastle-street, the Strand, and discharges its sewage into the river at the foot of Norfolk-street. The following are the district sewers in connexion with this main sewer:—

Long Acre.	Marquis-court.
Broad-court.	Cross-court, Russell-court.
Cross-court, Broad-court.	Russell-court.
Duke's-court, Broad-court.	White Hart-street.

The Essex-street sewer (Western Branch) runs under roadway in Drury-lane, Great Queen-street, Great Wyld-street, Vere-street, Gilbert-street, Clement's-lane, Pickett-place, the Strand, and it discharges its sewage into the river at the foot of Essex-street. The following are the only district sewers in connexion with this main sewer:—

Charles-street (south part only).	Wilson street.

The King's Scholars' Pond sewer (Pall Mall branch) runs under roadway in Pall Mall, Cleveland-row, under the Green Park, across to Buckingham Palace, where it joins the main line. The following is the only district sewer in connexion with this main sewer:—

East of Sutherland House.

The King's Scholars' Pond sewer (main line) runs under roadway in Piccadilly, opposite White Horse-street, across the Green Park, thence to the east and south of Buckingham Palace, the Victoria road, and thence in a southerly direction to the River Thames, where it has its outlet at the Equitable Gas Works, about 700 feet above Vauxhall Bridge.

In the Appendix (page 20) I have given an alphabetical list of the streets in which the main sewers are situate.

The preceding particulars will give an idea of the connexion of the various district sewers into groups, or network, so to speak. A reference to the small map will further explain this part of my report.

The middle, northern, and eastern portions of the parish lying at a high level above the river, and at the same time with a gradual rise northwards, causes a very good fall in the sewers to be obtained, which is very desirable, as a scour is thereby created to carry away the sewage. The south-western portion of the parish, in the neighbourhood of Spring Gardens, Whitehall, Great Scotland Yard, Northumberland-street, and Charing Cross, lie at a low level, comparatively speaking, especially Northumberland-street, where the tidal water frequently inundates the kitchens of the houses on either side. In Great Scotland Yard and the south part of Charing Cross, to prevent the back sewage entering the houses and doing damage, a man has to walk into the Regent-street sewer, between every tide, to examine the flaps. The sluice gates of this sewer and the Victoria-street sewer are closed before high water, and the sewage received from the various district sewers tributary to these main sewers, frequently, and in many parts, at the low levels, always rises to the crown of the arch. On the withdrawal or opening of the sluice gates about two or three hours after high water, the whole passes into the river below low-water mark.

The parish of St. Paul, Covent Garden (which is part of the Strand district), is encircled by this parish; the necessity, therefore, arises that as there is only one main sewer running through the former parish, namely, the Savoy-street sewer, the greater part of its sewerage is connected with the district sewer in Bedford-street. The whole of the house and surface drainage westward of the market is received at the above-mentioned sewer. The other outlets or connexions take place at Southampton-street, and Catherine-street.

The total length of the main sewers running through this parish is about 4,444 lineal yards, equal to 2¼ miles and 44 lineal yards, the measurements being made from the plans.

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District Sewerage.

All sewers, not main sewers, or private drains, in this parish, are vested in your vestry, and are under your sole authority, charge, and control, as regards the cleansing, keeping in repair, rebuilding, and constructing, &c.

You will observe, on reference to the small map, that there are several district sewers that have their outlets into the River Thames. They are as follows:—

No. 12. Outlet at Fox-under-the-Hill, with flap.
13. „ under Sant's Wharf, Adelphi, with flap.
14. „ under Robert-street, with flap.
15. „ west of York Buildings, with flap.
16. „ east of Villiers-street, with flap.
17. „ at Hungerford Wharf.
18. „ from gully in Brewer's-lane.
19. „ from Craven-street with flap.
21a. „ from drain east of Old Almonry House.
21b. „ from the Old Almonry House, with flap.
22 „ from drain west of Old Almonry House.

This list gives 11 outlets, seven with flaps or penstocks, and four without. Since January 1st, 1856, the Metropolitan Board of Works have taken charge of these said outlets, the flap-keeper being employed by the said Board. It will be necessary to make permanent arrangements connected herewith as soon as possible.

The district sewers in the Green Park, St. James's Park, St. James's Palace, the Admiralty, and other Government property contiguous to the parks, I do not suppose will be under your authority, as the Commissioners of Woods and Forests no doubt have charge of them as private sewers and drains. I have not, therefore, taken any notice of them.

In the Adelphi district, very little is known respecting the existence of sewers and gully drains, or their locality. Under Sant's Wharf, near the Fox-under-the-hill, there is an outlet into the river, numbered 13. It is very probable that this sewer will have its course at the east end of the Adelphi, under Adam-street. I am informed that there is an old sewer which commences in Durham-street, is then continued in William-street, where it is joined by an old sewer to the eastward of George-court, and takes its course under the houses near Robert-street, opposite which it has its outlet into the river, and is numbered 14. It will thus appear that there are two sewers, one at the east, and the other at the west, end of the Adelphi, by which the sewage and surface drainage escapes to the river. No positive evidence being obtainable at present, I shall not take any further notice of this portion of the parish, as it will be more convenient to look upon the block of buildings constituting the Adelphi, as a private estate, with sewers and drains, both vertical and horizontal, in connexion with the above and other old sewers. The following is a list of the streets and places that are included in the Adelphi:—

Adam-street.	James-street.
Adelphi Terrace.	John-street.
Adelphi Arches.	Robert-street.
Adelphi Wharf.	William-street.

The district sewer in the Strand is an old one, and its size from opposite Exeter-street to Agar-street is 4′ 9″ by 3′ 0″, and west of Agar-street to Northumberland-street 5′ 6″ by 3′ 0″; its fall westward is about one foot in 86 feet. There are several tributary sewers that run into this sewer from streets lying north, a short sewer from Hungerford-street being the only one that is connected on the south side. The fall of the natural surface being very great south of the Strand, there are several district sewers having outlets into the river. These sewers I shall divide into two classes, viz., street sewerage and back sewerage.

Street Sewerage.

Cecil-street	Numbered 11
Craven-street	Numbered 19

Back Sewerage.

West of Cecil-street and East of Salisbury-street	Numbered 12
Under the Adelphi, at the east end	Numbered 13
Under the Adelphi, east of George-court, and under Robert-street,	Numbered 14
West of York-buildings and east of Buckingham-street	Numbered 15
West of Buckingham-street and east of Villiers-street	Numbered 16
West of Villiers-street and East of Hungerford Market	Numbered 17

From Southampton-street there is a separate sewer in connexion with the sewers from Covent Garden Market, which runs eastward to the main sewer opposite Savoy-street. The sewer from Burleigh-street is in connexion with the above.

The Drury-lane district is very well sewered, many pipe and brick sewers having been constructed at different periods during the last few years. At the present time the only courts

courts in this locality that are without sewers are Bedford-court, Eagle-court, and Red Lion-court.

The district sewer in Long Acre was built about ten years since; its size is 3′ 10″ by 2′ 4″, and its fall westward towards St. Martin's-lane is about 1 foot in 100 feet. The outlets are made opposite each street on the north and south sides; but at present only connexions are complete with Hanover-court, Conduit-court, Rose-street, and Angel-alley. Mercer-street and Langley-street have each a sewer at their northern ends only, communicating with Castle-street. King-street is without a sewer, and Charles-street has a sewer at its southern end only, in connexion with Wilson-street.

In Bedfordbury there is a sewer throughout its length; north of May's-buildings its size is 1′ 8″ by 1′ 0″, and south of May's-buildings to Chandos-street it is 5′ 0″ by 2′ 6″. Its fall is about 1 foot in 30 feet. There are many courts branching right and left; the following have pipe or brick sewers either in connexion with this one or the main sewer in St. Martin's-lane:—

Davey's-buildings.
Goodwin's-court (north of).
Hop Gardens.
Great May's-buildings.
Little May's-buildings.
Shelton-court.
Turner's-court.

In the following courts I believe no sewers have been made:—

Brewer's-court. Chymister-alley. Pipemaker's-alley.

The district from St. Martin's-lane westward to the Haymarket is well sewered, with the exception of three courts in Castle-street, Long's-court, in St. Martin's-street, the central part of James-street, and the southern part of Oxenden-street. The sewer in St. Martin's-court, I believe, is an old one.

The district south and west of Trafalgar-square is completely sewered, the houses in Craig's-court, no doubt, having back drainage to the sewer running from Trinity-place.

It is very probable, at a future time, that proper conveniences will have to be constructed to give facilities for flushing pipe sewers, where flushing boxes are not provided.

The district sewers in the following streets are partly in this district and partly in the Strand district:—

	Length in Feet.
White Hart-street	180
Exeter-street	446
Burleigh-street	200
Cecil-street	340
Strand, from Southampton-street to Burleigh-street	360
„ from Cecil-street eastward	170
Spur-street	130
Bear-street	250
Castle-street (north of Bear-street)	276
Great Newport-street	274
	2,626

Equal to 875 lineal yards.

The only district sewer that is partly in St. Giles's district and partly in St. Martin's, is the one in

	Length in Feet.
Castle-street, Long Acre	1,116

Equal to 372 lineal yards.

The only district sewer that is partly in St. James's district and partly in St. Martin's, is the one in the

	Length in Feet.
Haymarket (north of Panton-street)	340

Equal to 113 lineal yards 1 foot; say 113 lineal yards.

The district sewer in Coventry-street will, no doubt, be under the charge of St. James's district, as there is a special Act of Parliament respecting the paving of the south side of this street by the said parish.

The following is a summary of the length of the district sewers partly in two districts:—

	Lineal Yards.
St. Martin's and Strand districts	875
St. Martin's and St. Giles' districts	372
St. Martin's and St. James' districts	113
	1,360

Equal to ¾ mile and 40 lineal yards.

In

In the Appendix (pages 21–27), I have given an alphabetical list of the district sewers, together with their estimated size, length, and fall, which I have endeavoured to make as nearly correct as possible.

The following is a summary of the estimated measurements of the different district sewers:—

	BRICK.	PIPE.
	Lin. Feet.	*Lin. Feet.*
Measurements from original plans (*see* page 28)	25,474	2,248
Measurements obtained at the Sewers' Office of the following sewers, not drawn upon the original plans:—		
Angel-alley	- -	100
Arundel-place	- -	200
Bedfordbury (north part)	302	—
Bull Inn-court	232	—
Crown-court	220	—
Davey's-buildings	- -	100
Langley-court	- -	90
Little May's-buildings	103	—
Martlett's-court	130	—
Shelton-court	100	—
Turner's-court	240	—
Whitcomb-street	170	—
Estimated measurements of old sewers, *not* drawn upon the original plans:—		
Cecil-street	340	—
Cecil-court	260	—
Great May's-buildings	240	—
St. Martin's-court	480	—
St. Martin's-street (north of Orange-street)	120	—
Back sewerage under William-street and Robert-street, and east of George-court, numbered 14	820	—
Back sewerage between Villiers-street and Buckingham-street (north part to Duke-street), numbered 16	250	—
TOTAL Feet	29,491	2,738

By the above statement it will be seen that there are of—

Brick sewers	29,481 lineal feet,	equal to	9,827 lineal yards;	and of
Pipe sewers	2,738 „	equal to	912 „	
TOTAL	32,219 „	equal to	10,739 „	

Equal to 6 miles and 179 lineal yards of district sewers.

Note.—The above includes all district sewers, including those on the boundary line of the parish, but exclusive of those in the parks, &c.

The following is the total estimated length of main and district sewerage:—

Main sewers	4,444 lineal yards,	equal to	2½ miles 44 lineal yards.
District sewers	10,739 „	equal to	6 „ 179 „
TOTAL	15,183 „	equal to	8½ „ 223 „

The estimated measurements of streets and places not sewered, so far as can be ascertained, exclusive of the Adelphi (*see* Appendix, pages 29–30), are the following:—

Streets without sewers	7,936 lineal feet,	equal to	2,645 lineal yards.
Streets without sewers, but with a back sewerage	1,718 „	equal to	573 „
TOTAL	9,654 „	equal to	3,218 „

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House Drainage.

The "Act for the better Local Management of the Metropolis," gives Vestries and District Boards important and controlling powers connected with drains, cesspools, &c. In the numerous courts and alleys that are in the neighbourhood of Drury Lane, Long Acre, Bedford Bury, and the Strand, the houses in which are principally inhabited by the poorer classes, and very densely occupied, it is very desirable that the house drainage should be in good condition. Sewers have been built in the majority of these courts and alleys during the last few years; and I should presume that at that time, or since, drains, either brick or pipe, would be constructed to connect the houses with the sewers, so as to carry away all sewage.

Previous to the connexion of any private drain with the district sewer, notice has to be given by the owner, and the consent of the vestry obtained.

With respect to new drains from houses being connected with the main sewers, I am givan to understand that the Metropolitan Board of Works will only require notice to be given by the respective District Boards and Vestries, that their officers may attend to inspect the works so far as the connecting of the new drains with the main sewer is concerned; the same being, as I have mentioned in the former part of my report, the property of the said Board.

To speak upon the general state of the house drainage of the parish, whether in good or insufficient coudition, is a matter that is almost impossible; no plans being in existence, that I am aware of, that give an accurate survey; in fact, I should say that there are very many drains of which no survey or account has ever been made. As nuisances arise, inquiry will then become necessary; and I shall in all cases draw upon the plans the locality of all drains or sewers that may be discovered. Owners of freehold property that have drawings of the drains laid down on their estate plans, will, very probably, allow me to inspect them, when it is found advisable to request their permission.

Any general inquiry that might be made of the occupiers of houses respecting drains would only cause a state of alarm, and probably a feeling of animosity against the working of the present Act of Parliament.

At the offices of the Metropolitan Board of Works, there are the notices filed of all house drains connected with the sewers during the last few years, but the said Board have no plans showing the various connexions in any particular district. No division of these or other documents relating to the districts, as set out and defined by the Act of Parliament, have yet been made to facilitate reference. To search these files of notices from all parts of the metropolis would be a labour that I could not undertake.

Surface Drainage.

I beg to report that there are 422 gully holes, a detailed list of which is given in the Appendix, pages 31-43. I do not see, at the present time, that any further gully holes are requisite, as the surface drainage runs away very quickly. These gully holes have been cleansed and kept in order since January 1st, by Mr. Thirst, agreeably to the orders of the vestry. This arrangemement expired March 25th.

The 71st section of the "Act for the better Local Management of the Metropolis," directs that proper traps are to be provided to prevent the effluvia of sewers from exhaling through gully holes, gratings, &c. I shall endeavour to obtain a correct list of the gullies that are trapped; and I do not know of any gully holes that require traps at the present time.

The 88th section of the said Act, directs that public conveniences are to be provided and maintained where deemed necessary. I have prepared the following list of urinals that are at present under your charge; together with those that are private property, but used by the public.

Public Urinals.

Castle-street, near Orange-street	6 divisions.
Duke's-court, St. Martin's-place	4 „
Castle-street, corner of Mercer-street	2 „
Vinegar-yard, by Drury-lane Theatre	8 „
Whitcomb-court, Princes-street	3 „
Thatched House-court	1 „
	24 „

Private Urinals.

Great Scotland-yard, opposite police barracks	2 divisions.
Adelphi-wharf, by Fox-under-the Hill-lane	2 „
Fox-under-the-Hill-wharf, by stairs	1 „
Banbury-court	1 „
Langley-court	1 „
	7 „

At

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At a future period, it is desirable that your attention be given to the erection of urinals, &c., in such localities as will secure the convenience of the public, without giving any annoyance to the residents of neighbouring houses.

No flushing nor cleansing has been executed since the district sewers have passed into your charge; and although I do not anticipate that any very great accumulation of sewage has taken place, still it is most important that arrangements should be made, and a contractor appointed to attend to these very necessary works. The long continuance of the late dry weather has precluded the flushing of the sewers by a heavy rush of waters from the natural surface drainage; and although the atmosphere is now very dry and cold, upon a change to summer heat, unaccompanied by heavy rains, effluvia might arise from the sewage through the gully holes and gratings. I beg to draw your attention to this matter as early as possible.

In conclusion, I have to apologise that this Report has extended to so great a length, but upon a subject, hitherto unknown to the general public, I have felt desirous that the members of this vestry should receive from me as complete and as clear a statement as possible, to enable them to obtain a knowledge of, and form an opinion upon, the various requirements of this important subject, so immediately connected with the general sanitary condition of this parish.

I remain, &c.
(signed) *R. K. Burstall,*
Vestry Surveyor.

(9.) SHOREDITCH DISTRICT.

Shoreditch.

Report by Mr. Freebody, C.E.

Report on the Sewage Interception and Main Drainage of the Metropolis, and its effect on the Sewers under the Control of this Vestry. By *William Yates Freebody*, C. E., Chief Surveyor to the Vestry.

Gentlemen, 37, Hoxton Square, 23 Nov. 1857.

In obedience to the resolution come to at a special meeting of the vestry, held on Tuesday, the 22nd day of July 1856, viz.,—

> "That the chief surveyor be requested to watch the matters in connection with the drainage of the metropolis, on the north side of the Thames, so far as regards this parish, and report to the Sewers Committee, from time to time as he may consider necessary,"—

I beg to submit for your consideration at this juncture, the desirability of making some attempt to investigate the main bearings of the question in relation to the intercepting sewers. It being apparent that the weight of your collective opinion can only usefully bias the judgment, or gain the requisite attention from the Board above, during the period of transition between the thought, the plan when defined, and the order for the actual work that has to be done.

It seems evident that this is about the proper period to have the question fairly mooted before you, inasmuch as your representatives appear either to tacitly acquiesce in the propositions laid before them, or pronounce in favour of the adoption of the main and most expensive part of the plan for fixing the point of the discharge at Sea Reach; on the basis, that the public would not object to the cost of a scheme that will effectually drain the metropolis, and carry the sewage a distance of 40 miles from the city. At all events there is not that kind of opposition to the proposed measure, in districts where from local circumstances, it might be fairly looked for. Knowing the arduous and responsible duties that devolve on your representatives at the Metropolitan Board, I trust it will not be deemed want of proper respect to their position and authority, if, in the discharge of my professional duty as the chief officer of your vestry, charged to attend to the sewerage, I am obliged to adduce statements that may tend to invalidate any conclusions they may have come to, or have allowed to be promulgated.

You are probably aware of the enormous interests that are indirectly affected, of the magnitude of the operations concerned, and of the arena for controversy, whenever such important matters are brought under discussion; but when thoughts and opinions are about to be resolved into actual deeds, when works of costly structure, amounting to several millions sterling, are about to take the place of mere words, it behoves all persons concerned either as ratepayers, owners, or resident inhabitants, to look deliberately at the conclusions, and weigh well the ultimate utility of the great outlay about to be incurred.

When matters relating to this comprehensive question come to be carefully or studiously examined, you readily perceive some of the difficulties with which it is beset. The main drainage of London is really a great question; and to act with skilful prescience or forethought, may indeed be difficult, but to delay action is almost suicidal.

The 135th section of the Metropolitan Local Management Act sets forth "that the Metropolitan Board of Works shall make such sewers and works as they may think necessary for preventing all or any part of the sewage within the metropolis from flowing or

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passing into the River Thames in or near the metropolis, and shall cause such sewers and works to be completed on or before the 31st day of December 1860."

Any one sufficiently presumptuous to pronounce a doubt as to the practical usefulness of the enormous works these intercepting sewers involve is at once triumphantly directed to the words quoted above, from the Act of Parliament, and, if not subdued, his energies sink beneath the immensity that then opens before him. The subject widens, and definite ideas become almost lost in the ramifications which the question must necessarily take.

But allow me to remark here, that Acts of Parliament have heretofore been obtained for works of almost equal magnitude with these now under your review; in those Acts of Parliament they quietly remain, for a fitting time must elapse before they can usefully emerge from that embryo. The means at hand cannot always compass the end proposed.

Happily, the terms of your resolution set free the chief difficulty, for we have to look at the bearings of this measure only so far as regards this parish. In that phase, it may indeed be truly remarked that the question comes home to us; affecting alike your pecuniary interests and material welfare, and any examination of the measure rationally and intelligibly entered on may prove instructive to many and interesting to some.

Grant for a moment that the works for these intercepting sewers (as if by a wave of the pen) are effected, that the thing is done and in positive action, and then let us regard our position. Will any one now be sufficiently bold to guarantee that the public health then, will be in any way appreciably ameliorated, or, is it likely that the sewage flowing steadily in these long lines of intercepting drains will be less innoxious than its mode of transit now is?

For London generally, I entertain a strong opinion that the outlay necessary for the construction of these long lines of intercepting sewers, in their entirety, will be an injudicious expenditure, and I hesitate not, looking at the position I hold in regard to this vestry, to express, that I cannot but view it as a disastrous circumstance, in degree, for the metropolis at large whenever the day shall come to sever the town drainage from the Thames outlets altogether. I greatly question whether it be practicable, and as reasonably question whether, if practicable, its utility would be at all commensurate with its cost; but looking at the drainage area under the control of this vestry, the relative altitude of that area above its present natural outlet, and the available fall it has for a natural drainage towards that outlet, I deem it my duty to assert plainly, that the design proposed for the sewage interception and main drainage of London, is of no essential service to the system of drainage required for your parish; indeed, the conclusions to every experienced mind must be perfectly convincing; and I consider he must be a bold engineer who shall attempt to demonstrate from the plans and data at present published, that any appreciable benefit will hereafter accrue to the drainage of this parish, upon the execution of the measure now under your attention; indeed, I have endeavoured, but fruitlessly, to gain a clear knowledge of the exact grounds for any advantages that would be peculiar to this district, from carrying out the proposed works. Its sternest advocate has either not ventured, or hitherto has failed, to bring before the general public, the reason for any valid advantage that the proposed intercepting system gives to those portions of the metropolis that now enjoy ample natural altitude above the present outlets, and it does seem hard that the localities having these natural advantages, should bear the like proportion of burthen as those districts for whose amelioration such gigantic works are deemed necessary.

It is probable that the leading remarks recently made public in the "Times," have not wholly escaped your attention; in a lively sketchy article the whole drainage question is touched off with a few rounded sentences, which savour more of doing the work somehow, or anyhow, than considering the effect of the works when done. "If (says the writer) it is possible at an expense, not absolutely unreasonable and ruinous, to carry the refuse of this metropolis down to the sea, by all means let it be done. The property of the metropolis can bear it, and, if not, seeing that the state is exacting millions of money from our houses, it may well be called on to give us some of it back again for a purpose of national, as well as local importance."

The writer allows "that a man may be more anxious to quench his thirst, than to cleanse his cottage or purify the air he breathes; but when bad drainage and consequent bad air induce disease and shorten life, it is in the long run as much a question of life and death as the supply of pure water;" but the bare question as to intercepting sewers is in no way mixed up with that other important question of supplying London with pure water, because the Legislature has taken care that the future water supply of London shall not be taken from sources within the tidal influence. But the concomitant effect of long lines of ten feet sewer flowing steadily through the very heart of the most densely populated portions of the metropolis, at the rate of about two miles and a quarter per hour, is nowhere made very apparent, nor will it in my opinion very readily tend to purify the air in its vicinity. "All experience (we are told by the same article) is against half measures, and make-shift schemes," that "London is an immense city," and that "on an occasion like this we are to beware of little works." Now to my mind, London has a better drainage, enjoys a better means of drainage generally, than any other capital city in the world, with which it admits of comparison. But its drainage facilities may very easily be tampered with, and a small proportion of failure would become not only disastrous, but dangerous. Sewage in minute streams is comparatively innoxious, but proceed to centrate the contents of a number of these sewers and lead the enormous mass, by artificial means at great depths, and at almost infinite cost, for a length of many miles, through the most populated portions, and it will enable this metropolis to boast of having a great drainage work; but it still remains equally

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equally questionable whether such an expenditure be laudable, or whether the utility is commensurate with the cost incurred, and certainly it is quite as questionable whether such an outlay will in any way tend to benefit the public health, or ameliorate the sanitary welfare of the resident inhabitants in the immediate vicinity of such immense moving masses of sewage matter.

We have next to deal with the question of figures, for it is only just towards the rate-payers and owners of property, to have a concise, but a proper review of the present position of the measure, in regard to its financial aspect. I feel it somewhat difficult to be brief, and yet render clearly to your minds the exact financial bearings of the question; or in other words, what portion of cost this parish will probably have to contribute ultimately towards the expenditure; for my views purpose only to point your attention to results in order to spare any array of figures, or the details of minute calculations.

In the report presented to the Metropolitan Board of Works, on the 26th September last, by their engineer, Mr. Bazalgette, it appears from the comparative estimate, that the total expenditure represented as capital necessary for the formation, with probable annual working expenses capitalized—of the main drainage, if extended to Sea Reach, will amount to 4,718,400 *l.* Since that period the amount of total expenditure has been modified and curtailed, and it is probable a subsequent revision will bring out like results; therefore I need not here weary your attention with the data I have employed to arrive at a fair criterion as to what portion of this 4,718,400 *l.* will have to be obtainable in aid of these works, from the parish of St. Leonard, Shoreditch; but to those anxious for such information, reliable data will be found in the statement, that the rateable annual value as per county-rate assessment, or other fair estimate, for St. Leonard, Shoreditch, is 251,548 *l.*, whereas the rateable value of all the parishes and districts within the metropolitan area will be found to be about 11,152,000 *l.* You will thus perceive we shall be about right in assuming that the charge, or portion of the outlay set down in the comparative estimate, that will probably have to be raised at the cost of the property and industrial labour of this parish, will amount nearly to one forty-fourth of the gross amount;—that is to say, of the sum of 4,718,400 *l.* to be raised by the Metropolis generally, the actual amount chargeable to the parish Leonard, Shoreditch, will be 107,236 *l.*

Should it be deemed desirable that this sum of 107,236 *l.* be raised, so as to become liquidated, principal and interest, within a period of thirty years; the amount of sewer rates necessary for the purpose of defraying your proportion of cost, for the sewage interception and main drainage works, alone, will be about 8,000 *l.* the first year, gradually lessening in amount to about 4,000 *l.*, in the thirtieth year; or, in other words, an amount of rate will have to be paid equal to eight-pence in the pound, in the first year,—diminishing by ratios proportioned to the capital annually repaid—to four-pence in the pound in the thirtieth year, for the especial purposes, be it remembered, of this system of intercepting sewers, wholly irrespective of the usual current expenses of maintaining or improving the existing local means of sewerage, under the control of this Vestry.

If therefore in the sequel it should be deemed apparent that the opinion I have ventured to express be surely founded; and, if no appreciable benefit be obtainable for this locality generally, it will become demonstrative that this matter is one well deserving your most serious attention.

You will have perceived that the figures I have rendered above, imply going to Sea Reach, and appear to be the extreme amounts, although I am not sanguine as to the sufficiency of the precise estimate afforded for the objects proposed.

Plan B* has to a certain extent been sanctioned, and under date of December 1st, 1856, the engineer to the Metropolitan Board of Works reports, that "the total estimate for the Metropolitan drainage as now designed will be 2,836,600."

Instead of the 107,236 *l.* required above, the amended actual amount founded on the plan B* report, as chargeable to the parish of St. Leonard, Shoreditch, will be 64,468 *l.*, and if this latter sum be raised in like manner, so as to become liquidated principal and interest, within thirty years, the annual amount of rates required for the purpose will be 5,350 *l.*, the first year, lessening—by ratios of the capital paid back—to 3,200 *l.*, in the thirtieth year. However, it is not absolutely necessary to burthen your attention, or this report, with the lesser estimate in consequence of the recent application of the Metropolitan Board of Works to the Government, to obtain a loan of four millions sterling, on the security of the rateable value of the property of the Metropolitan area; which was increasing from 300,000 *l.* to 400,000 *l.* a year. The present power of assessment extends over an area, the annual value of which amounts to 11,150,000 *l.*, and a rate at 3⅜*d.* in the pound will be sufficient to pay the interest and principal in fifty years. If this latter statement be at all correct—the matter, in its financial aspect alone,—really demands, on our part, a more careful and lengthened attention that I am now enabled to give.

It still remains to consider what must be done in relation to this question. There exists, without doubt, much that stands in need of improvement, and it is essential to have many things done, that will involve very great cost, but I feel that your proper proportion of the expenses will be cheerfully borne, if the utility and validity of the objects proposed by the present measure are clearly and satisfactorily demonstrated.

Having in this report ventured somewhat to question the usefulness, or in some degree to detract from what has been proposed; to a certain extent I feel it incumbent on me to suggest something in lieu thereof; and I have no desire even to flinch from the responsibility due to this portion of the question, difficult though it may at first seem.

I have long considered, that the chief work of improvement most needed for an

amelioration of the public health of London, is the river Thames itself, in its course throughout the metropolitan area. By the protracted litigation of the Government authorities on the one hand, and by the contention of the City authorities on the other, the bed and channel of that river in the vicinity of London, has been suffered to fall into so negligent a condition, as actually to become a positive disgrace to the age in which we live.

When by the Act of Parliament the Metropolitan Board of Works was formed, it appeared to be just that kind of authority that the Government and the City would both eagerly recognize, so as to allow everything to be done that the public good or the public health of the metropolis demanded; that, in fact, the parties hitherto contending for so long a period, could, at length, merge their respective differences in a responsible body, and yet exercise a wholesome veto upon the proposed works, without compromising the rights, interests, or dignities of either; and, that the river should undergo that thorough improvement it has for many years so much needed.

In August 1849, I laid a report before the then Commissioners of Sewers, as to the sewerage amelioration and river improvement, wherein I brought before them a design for flushing the river, and ridding it of sewage impurities during the summer months, in precisely the natural way, by imitating the action of the downfall flood currents, which this portion of the river receives from the upland districts generally during the winter months. Other works in connection therewith are equally necessary:—the sectional areas of the river require to be regulated almost throughout its entire length:—the dredging operations should be placed under the control of scientific persons:—the various and valuable reclamations require granite embankments to be constructed in the most substantial and best manner:—various minor outfall sewers that now ooze over the exposed banks, would have to be united into one common covered channel, and conducted downwards to a convenient discharge point:—and the trading and transit facilities duly provided for.

Under able control, and with proper persons appointed for that purpose, there seems no difficulty whatever in guaranteeing the proper cleansing of the river, in the perfect and effectual manner demanded under the present civilised requirements. I am prepared to assert that it is quite practicable so to arrange the whole *régime* of the River Thames in its course through the metropolitan districts, as to preclude the deposit of offensive matter in appreciable quantities, and am confident that no hydrographer or hydraulic engineer is prepared to refute that opinion, unless he neglects to observe the equable summer flow which this river so pre-eminently gives.

Looking at the natural capabilities of the tidal waters, and to the beneficial action of the down-fall current—always in excess—there seems no solid reason to doubt that ultimate success must follow the works intended for the river improvement. Indeed any sum of money judiciously expended for such a purpose, will never be expended in vain. The flushing operations occasionally necessary for cleansing that portion of the river in the vicinity of the metropolis, will certainly require structural works of no ordinary kind, but to my mind the whole thing may be arranged to work as effectively, as simply, and as safely, as if the river had but one-tenth its present size and volume.

It has, lately, become almost a fashion with those who have, perhaps somewhat superficially, written or spoken on this question, to allude in glowing terms to the state of sanitary perfection we shall arrive at, when we give back to the Thames in the vicinity of London, that chance of regaining the bright waters that the many impurities have of late years banished from its course. It would be superfluous to combat harmless enthusiastic notions of this kind, but looking at the natural phenomena and geological conditions that affect the river throughout its tidal course, it seems impossible ever to concede that blissful state of things. In several instances I have been called on to report professionally, and, from time to time have examined closely into the state and condition of several of the most important tidal rivers of this, and other countries, and I see grave reasons for forming the deliberate opinion, that the waters of the Thames in the vicinity of London never have been, and never can be, bright, for any period of long duration. The most successful instances of hydraulic or drainage improvements are to be found in the rivers of our fen districts, but the operations—however well designed—always fell short of affording bright waters. With every increase of tidal lift at any given point, more fresh water was generally attainable, but, although less brackish—it was never bright. Judging therefore from analogy, aided by practical and personal observations, of various tidal rivers—from the Tagus in Portugal, to the Amstel in Amsterdam—my experience leads to the conclusion, that the earliest Roman citizen who ever inspected or resorted to the shores of the river near London, would, at certain seasons, have found the waters nearly as turbid, and often as offensive, as we now observe them; and the banks and sides, perhaps, nearly as deplorable.

Another seeming fallacy, in regard to this question, deserves to be presented to your attention. Many persons, at present, appear to feel, and argue, as if the contents of the sewers, when once discharged into the Thames, remained for ever there incapable of change: forgetful alike of the effect of the beneficial action, chemical and mechanical, constantly in progress in a river possessing such magnitude of volume. The effect due from atmospheric agency or influence, is alone of great consequence—although the *modus operandi* has hitherto eluded research—but, when the immense volume of tidal water, and its mechanical action, comes to be considered conjointly with the cleansing action of the downward current, having the overwhelming tendency of constantly removing to seaward, even particles of the soil and finer gravel of the very bed over which its waters flow—we gain an approximate idea

idea of the power that will be lost to the sanitary arrangements of London, if this natural means for its amelioration be allowed to remain altogether neglected.

The next main feature that deserves your serious consideration, is the probable effect that the construction of these long lines of intercepting sewers will have, in preventing attention from being directed towards the deodorization of the sewer contents of various districts. Railways compete successfully with water transit—electricity is chained to do our bidding:—gaslight has become of nearly universal use—and steam-power supplies water to town inhabitants, more readily and more cheaply, than it can be obtained by the most primitive means. With these things accomplished, who shall attempt to deny a sphere of further usefulness to the scientific man, who realises the endeavour to utilize the refuse of town districts? From the present advanced state of chemical and mechanical science, it seems but reasonable to infer, and believe, that the day is not far distant, when it will be demonstrated with commercial certainty, that the contents of our sewers will no longer be suffered to run to waste, but will be utilized; and, that works practically having that desirable tendency, will eventually become sources of profit to the promoters, and confer lasting advantages to the vast communities of mankind, who so constantly have their periods of life shortened, from being obliged to dwell in the midst of such malaria-giving influences.

On this head, probably the most reliable remarks at our command, are to be found in the following extract from the Report, dated September 25th, 1856, presented by their Engineer to the Metropolitan Board of Works, viz.—

"The substitution of deodorizing works for reservoirs at Barking Creek and Plumstead Marshes involves the smallest expenditure of capital, but the largest annual outlay. The capital would not, therefore, be irrevocably sunk; and the plan presents the following advantages, viz., that if the sewage manure should be found to be of commercial value, it would be available for sale: or should any mode hereafter be discovered by which it could be rendered more profitable, or deodorized more economically, advantage could hereafter be taken of any such improvements. On the other hand, should it appear that the solid manure is altogether valueless, a considerable saving might be effected in the manufacture by merely precipitating, deodorising, and barging it away, and thus dispensing with the drying process and preparation for sale. This process would, I conceive, entirely remove the sewage from the river in a practical point of view; and by presenting the sewage in a dry, inoffensive, and portable condition, it would test the very prevalent opinion that the Metropolitan sewage can be thus profitably applied to agriculture."

A further saving of probably half a million might, however, be effected by terminating the sewers and establishing deodorising works nearer to London, say in the Greenwich Marshes on the south side of the river, and the West Ham Marshes on the north side, which would in my judgment accomplish the object desired without creating a nuisance."

These observations thus quoted, claim your complete attention, and deserve it: although a kind of misfortune seems inseparably connected with the consideration bestowed. We seem to wonder—if these things be so—why the principle has not been more studiously applied in some defined practical manner. With half Bermondsey, reeking with manufacturing impurities far worse than any deodorising works could by any possibility be, we are presented—even for the south side of London—with expensive modes for the sewage transit, by reason of its having first to be pumped up here, then, by gravitation, flowing there, reservoired at this place or about to be passed under the river Thames at that; until it becomes not only tedious, but difficult to understand the necessity for such perpetual transit, if—as we are led to believe—it can, and may very safely be deodorised, without positive nuisance to any, and a chance of ultimate profit to all.

If our present experience be defective, on a point so important as the commercial value of sewage manure; it is obviously manifest that the risk to attain success is well worthy the experiment. The public mind has a right to demand and to obtain more exact information on a subject so closely connected with life and property. One great fact is rendered undeniably clear, and there arises the advantage resulting from practical works, to prove beyond cavil that sewage waters may be deodorised without creating a nuisance in the locality where the operation is performed; and, that the water may by this means, be rendered clear and inoffensive.

Another source of harm appears consequent to the sewers under the control of this vestry, and to the systems of various other district drainages, resulting from the construction of these intercepting sewers. The upland waters that occasionally flow to the existing sewers in some localities, are found to act very beneficially in diluting, disinfecting, and removing the more dense portions of the sewage matter, and often serve as the best means that can be adopted to carry off, promptly and cheaply, the offensive *debris* that is generally so deleterious. In several localities the proposed sewers of interception are so designed as to be placed many feet below most of the existing sewers; and, from the geological structure of the strata generally, the intercepting sewers will have a tendency to abstract the most useful portions of the water, that heretofore have been of such advantage. It remains however open to doubt, whether the quantities thus abstracted from the old sewers, will be attainable in sufficient volume for the requirements of a system so mechanically artificial as the one proposed; but it should be kept in view, that the evil of this abstraction will be permanent, because the general falls of the existing sewers are towards the natural valleys, which trend, or range, about from north to south; whereas the main direction of the lines of proposed intercepting sewers are designed to traverse nearly from west to east. It is often apparent, more especially during hot and dry seasons, that a much greater supply of water for sewer purposes is required, and should be strenuously contended for.

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But in order to render the working of the intercepting sewers familiar to your minds, I purpose next, to adduce—chiefly from reliable data, and dimensions, afforded by the official documents accompanying the design;—what is likely to be the mode of working. For this purpose we take the main middle level intercepting sewer, which is proposed to commence at the Harrow-road, near Kensal-green, and to terminate at a junction with the main high level sewer, at a point between the Victoria Park and Bow. Its purpose is to drain, by gravitation, about 17 square miles, chiefly town district, on which the population of the greater portion has probably reached its maximum density; in other and more plain words—as many persons are there located as ever the area will possibly admit with common regard to convenience. This main sewer is designed to intercept the sewage flow of King's Scholars' Pond sewer, at Duke-street, Grosvenor-square; the Regent-street sewer, at Regent-circus; the Piccadilly branch (two miles in length) falls to a junction with this main line, at Gray's Inn-lane and King's-road. The sewage from the Fleet Valley sewer, will be conveyed, by a short branch, into this main middle intercepting sewer, and the whole has to be passed through a brick barrel-shaped sewer nine feet in clear diameter, to and under Golden-lane; at which crossing point, the invert is 39 feet below the surface of that street. The main sewer, falling eastward—at an inclination of one in 2,640,—then proceeds across a portion of your parish, and, at the High-street, Shoreditch, its internal diameter becomes enlarged to 10 feet in the clear, and the depth to the invert, at that spot, is 27 feet; being about 14 feet below the existing main sewer, which has now its outlet near London Bridge.

Nothing that I can bring before you verbally, will so vividly impress your attention, in regard to the after working effect, that will ensue to the public health on the construction and use of these intercepting sewers, as proceeding to contrast the present and the proposed rates of inclination. Take the Fleet sewer as an example: from the point of interception. to the outlet near Blackfriars Bridge, the length is about 1,540 yards; the average rate of inclination is one in 239 nearly, or, over this particular length the actual rate of fall may safely be taken at 22 feet per mile. Having detailed above what the main middle level sewer has to intercept, receive, and conduct away, previous to crossing the Fleet Valley, let us now solely confide to the mind, what must often result to the residents throughout its entire route, from the taking up by this main sewer the contents of the Fleet Sewer; and, without any defined means for diluting its, often at present, most offensive condition, and then preparing to convey it for a length of four miles, through densely populated districts, at an inclination of one in 2,640, or exactly two feet per mile. The case will at once be resolved by your judgment without requiring any definite computations. The different velocities attainable by the sewage currents, respectively due to the given rates of inclination, effectually settle the question, and I need not weaken your conclusions by any further remarks on this head.

It is evident that it behoves the residents, not alone of your district, but of the whole metropolis, to look carefully and thoroughly into the primary investigations relating to these or any other proposed alterations; in order to be certainly assured that the ultimate effects due to those alterations will be really salutary to the public health. London cannot afford to retrograde in its sanitary arrangements.

In the event of the construction of any intercepting sewers being determined on, it seems very desirable—so long as there remains absolute room only for a doubt as to their ultimate tendency to prejudicially affect the public health—that the formation of the northern high level sewer should be the real work first set about. The line of sewer is well designed, has ample fall, and will, in after time, be of real service to the localities it traverses. Its drainage area includes about 10 square miles of land, that is now in process of being rapidly covered with buildings, and, under the circumstances, the money expended on its construction, and that of its prolonged outfall, would probably be well laid out; especially if its successful working tended to show that other intercepting sewers, in more densely populated districts, could be safely proceeded with, without that risk of danger to the health of the community arising from some of the causes above alluded to.

But it must steadily be remembered, that sewage is sewage; and, so long as its inherent properties remain unchanged by any agency that tends to nullify its pernicious impurities, the owners of property may expend capital in transferring its baneful action from one locality to another, but the amount will have been expended in vain; for no real good can ever be expected to result. Not one of the main outlets should ever be stopped until this vital question is satisfactorily settled, viz.: can we safely allow these masses of sewage to be collected and poured across and under the metropolis, without resorting to any disinfectant. If the public health of London suffers from sewage malaria now, let it be a permanent duty to amend that evil, rather than make works that shall tend either to increase or perpetuate its worst consequences.

In regard to the proposals lately made to the Metropolitan Board of Works by Sir Morton Peto and others, for conducting the sewage of London to the German Ocean, by way of the river Crouch, I beg leave to state that my examinations as to that measure have not yet been sufficiently extended to warrant recording my opinion as to its utility; formed as they ought, and probably will be in due time, by properly investigating the documents deposited with Parliament, and viewing the line of country over which the works are proposed to extend.

I cannot conclude this report without again alluding to the sewer arrangements under the control of this vestry. As an integral part of the metropolis you will readily endeavour to meet your fair share of the burdens that may be necessary for any amelioration; but I reiterate that in the matter of intercepting sewers, the result has first to be mentally conquered;

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quered; it is for the most able, an intensely difficult problem; although one well worthy of your matured attention; for the best interests of many of your fellow-parishioners are involved in its consideration, by this chief reason, that health to an industrial population is the all important condition of their prosperity.

If in arranging these facts and remarks I shall have tended to lighten the labour of your future inquiries, and succeeded in awakening your energies to a just view of this difficult subject, by having placed this important matter in a clear and more comprehensive view, than has hitherto been attempted, I shall consider my care and labour rewarded; and

I have, &c.
(signed) *William Yates Freebody*,
Chief Surveyor to the Vestry.

(10.) WANDSWORTH DISTRICT.

Wandsworth.
Evidence of Mr. Young.

1. Minutes of Evidence given by Mr. *D. W. Young*, Surveyor.

Meeting of Referees, 29, Great George-street, Friday, 15 May 1857.

Mr. Young attended by appointment at 12 o'clock.

Mr. Young, in answer to a question, said that he thought the sewer at Putney two feet too high; this would not be the case if the intercepting sewer from Richmond was intended to be at a lower level than the one now proposed by the new Board of Works. If this sewer were lowered two feet, Mr. Young said he could drain his whole district, as far as the Putney Cemetery, into it.

Mr. Young thought that the High Level Sewer ought to be extended beyond Park-road, Clapham, but was not prepared to say how far. He believed, however, it might intercept the Falcon Brook Sewer, south of Battersea-rise.

Mr. Young said that cesspools had been abolished to a very great extent in the Wandsworth district; and the refuse of those houses thrown into the Wandle, and other natural streams.

In answer to Mr. Simpson, Mr. Young said that he considered the expense of making new connections, if it were proposed to separate surface from house drainage, would be at least 10*l.* per house.

Mr. Young, for many reasons, did not consider it practicable to keep surface water separate from house water, so as to preserve the former in a clear state, and entirely free from sewage.

Mr. Young said that what were streams formerly for surface water in his district, were now of a most filthy character.

Did not believe it possible to maintain the separate systems.

Thought the loss of means of flushing the sewers, by the abstraction of surface water, would have a very injurious effect.

Did not think any vigilance would prevent sewage finding its way into the surface drains.

Building is now going on in the Wandsworth district, and Mr. Young anticipates that it will very largely increase.

Road sweepings get largely into the sewers, but any collection of it is prevented by men being kept to cleanse the sewers.

Mr. Young said that there was not a natural watercourse in his district unpolluted.

In answer to a question, Mr. Young said that the prison was drained by a cesspool in a gravel soil, with a covered overflow drain into the Wandle.

2.—Report (pursuant to the order of the Board, of the 25th March, 1856) upon the Nature and Extent of the Open and Covered Sewers vested in the Board, and upon the New Sewage required for the District; by *David William Young*, the Surveyor to the Board, dated 10th December 1856.

To the Board of Works for the Wandsworth District.

Bolingbroke Grove, Wandsworth Common,
10 December 1856.

Gentlemen,

In compliance with the orders of your Board of the 26th March last, I have prepared the following statement, supplying, so far as I am at present able, the information which those orders call upon me to lay before you.

I am fully aware that my report falls short, in many points, of the letter of your instructions; but its imperfection is, for the most part, the result of necessity. The ordinary business of your Board has hitherto so engaged my time as to leave little leisure for the pursuit

pursuit of inquiries, which, if fully and satisfactorily pursued, would demand close and long-continued attention. Such information as your Board has called upon me to prepare, could not, moreover, be effectually collected in the space of a few months, without incurring considerable additional expenses; a course for which I should neither have had the sanction of my own judgment, nor the expectation of your approval.

The task which you have required me to perform can, in some of its points, be speedily accomplished only by costly and specially directed efforts; but it may, if steadily kept in view, be accomplished gradually, in the regular working of your ordinary business. I trust that these explanations will secure your indulgence for the deficiencies which may be noticeable in this report.

Existing Covered Sewers.

Following the arrangement of your orders, the first subject upon which I have to report is "the nature, extent, and state of repair of the covered sewers vested in your Board."

In the Metropolis Local Management Act, the word "sewer" is evidently used in a very wide and comprehensive sense. There can scarcely be a doubt upon this point; but I may state that my own opinion has been confirmed by a consultation with your clerk as to the interpretation clause, and other sections of the Act. The Legislature has so defined the word "sewer," as to make it include not only what are commonly called sewers, but also almost every description of drain; and has thus brought the minuter details, no less than the other lines of drainage, within the control of vestries and district Boards.

The Act would indeed have failed to secure its chief purpose, the establishment of a systematic and thoroughly efficient drainage, if it had not given to the corporate authorities it created, powers of a large and searching character. To have left a margin for the discretion of private individuals would have been the surest way to destroy unity of plan, to impair efficiency of working, and to open up grounds for endless complaints and litigation.

The Legislature has therefore so interpreted its own language as to make almost every case fall within its meaning. In section 68 it is enacted, that all sewers made, or to be made, except sewers vested in, or to be vested in, the Metropolitan Board of Works, are vested in the vestries and district Boards; and by the interpretation section, 250, of the word "sewer," which defines it to mean and include "sewers and drains of every description, except drains used for the drainage of one building only, or premises within the same curtilage, and made merely for the purpose of communicating with a cesspool or other like receptacle for drainage; or with a sewer, into which the drainage of two or more buildings or premises, occupied by different persons, is conveyed; and shall also include any drain for draining any group or block of houses by a combined operation, under the order of any vestry or District Board."

Now, such being the meaning assigned by the Act to its own language, and such the extent of your powers, I could not possibly in so short a period of time, and with the ordinary means at my disposal, prepare a complete account of the nature, extent, and state of repair of the covered sewers vested in your Board. To examine thoroughly and describe in minute detail the whole drainage of your district, is a task which I have not as yet, had time or opportunity to accomplish; and if its accomplishment was intended to be made a special and immediate object, I should have required for a much longer time than I had, the temporary assistance that your Board granted me for this object.

I did not however anticipate that you wished me thus to hurry on your investigation; and I therefore propose, with the sanction of your Board, gradually to add to your Plans the course of the various sewers upon which you have directed me to report: and concurrently with this addition, I propose to prepare a register of all such collateral information as may be deemed necessary.

For convenience of reference, and to avoid needlessly occupying the time of the Board, I have drawn up tabular forms, exhibiting in detail some important features of the information I was directed to prepare. By a reference to these forms, appended to the plans, it will be seen that the lengths in each parish, and the total length of the covered sewers as at present known to your officers, vested in the Board, are as follows:

	Miles.	*Fur.*	*Poles.*
In the Parish of Battersea	5	0	38½
„ Clapham	13	4	8½
„ Putney	2	4	15½
„ Wandsworth	9	1	30½
„ Streatham	4	6	6½
„ Tooting	1	1	37½
Total £.	36	3	16

or 36½ miles.

Uncovered

Uncovered Sewers.

I now pass on to the second subject upon which I was directed to report, viz., "As to the extent and present condition of any uncovered sewers vested in this Board, the localities in which they are situate, and the estimated expense of converting them into covered sewers."

The remarks already made in this report respecting the meaning assigned to the term "sewer" in the Metropolis Local Management Act, apply, in a great measure, to open as well as to covered sewers; and therefore, though it is unnecessary to repeat those remarks, I beg respectfully to draw the attention of the Board to them.

In table 2, exhibited on the plans, I have collected and arranged details of information, from which it will be found that the lengths of open sewers vested in the Board, as at present known to your officers in the several parishes, and the total length of such sewers in the district, are as follows:—

	Miles.	*Fur.*	*Poles.*
In the parish of Battersea	3	4	18½
„ Clapham	1	2	12½
„ Putney	1	3	37½
„ Wandsworth	3	3	36
„ Streatham	10	1	5½
„ Tooting	0	6	26½
Total	20	6	16

or nearly 21 miles.

The approximate cost of converting the present open into temporary covered sewers by laying 12-in stone pipes, and retaining the existing ditches for storm water, I estimate, according to the very favourable prices lately tendered to your Board for this description of work, at 320 *l.* per mile, or about 1 *s.* 2½ *d.* per foot forward.

Assuming, however, that certain portions of these sewers, situated in close and densely populated localities, where a dry ditch might become as much a nuisance as an open running foul stream, and would require a sewer large enough to take both the ordinary flow and the storm water, I am of opinion that 400 *l.* per mile, or about 1 *s.* 6 *d.* per foot forward, should be taken as an approximate estimate of the rate of cost. The total cost for the several parishes in the district would, at this rate, be as under:—

	£.	*s.*	*d.*
In the parish of Battersea	1,408	10	–
„ Clapham	510	–	–
„ Putney	592	2	6
„ Wandsworth	1,380	15	–
„ Streatham	*4,016	5	–
„ Tooting	330	–	–
Total £.	8,237	12	6

New Sewerage.

The next matter to which my attention has been called by the orders of your Board, and upon which I was directed to report, was, "as to what additional sewers are required for conveying the sewage from every part of the district to the main sewers."

I apprehend the meaning and intention of your resolution to be, that I should report "as to the additional sewers which will be required" when the intercepting drainage to be laid down by the Metropolitan Board of Works shall have been provided.

A few months since, when I had the honour to make a report to your Board on the new sewerage required for the parish of Putney, I took occasion to state, that High-street, Putney, was the only portion of your district, having an efficient sewer. Such being the fact, it follows, that new sewers will be generally required; but, with a few exceptions, these cannot be built, until the outlet sewers are provided, by the Metropolitan Board of Works.

Some general questions will, however, always present themselves for consideration in connection with the subject of new sewers, and, with the permission of the Board, I will repeat a few brief remarks offered to your notice in a former report, to which I have already referred.

"Before carrying into effect any system of sewerage, various preliminary questions present themselves for the attention and decision of the Board."

"The

* This amount would be considerably reduced by some diversions of the soil drainage, which could easily be effected.

"The first of these, and that which has the most direct bearing upon cost and efficiency, relates to the size of the sewers: Are they to be large enough for men to enter, and if they are, what are the minimum dimensions to be allowed?"

"Secondly. There is the question of house drainage. It is necessary to determine to what extent the 74th section of the Metropolis Local Management Act, as to combined back drainage, shall be carried out, since the decision of the Board may or may not impose the necessity of constructing a sewer to every road, court, and alley, public and private, throughout the district."

"Thirdly. The extent of the sewers, though involved in a great degree in the question last indicated, will require a more distinct consideration. Is sewerage to be provided by the Board, with a few special exceptions, to within one hundred feet of every house in the district?—this being the limit prescribed by the 73d section of the Act, which furnishes the Board with compulsory powers for the enforcement of drainage on the part of owners."

"Fourthly. There is the question of the depth at which the sewers ought to be laid down. The advantages of depth in sewers are very obvious, and can hardly be too highly estimated. A rapid inclination is given to house service drains, the liability in the case of any stoppage occurring in the sewers to the flooding of basements is lessened, and the general water level of the district is reduced: a result tending greatly to increase the healthfulness of the neighbourhood."

In the plans which I submit to the Board along with the present report, I have assumed that the main sewers referred to in the resolution of the Board, are those proposed to be built by the Metropolitan Board of Works, as shown and described in the report and plans by J. W. Bazalgette, Esq., M. Inst. C. E., their Engineer, on the southern portion of the Metropolis drainage, dated 3d April 1856, a copy of which was sent to your Board; and not those sewers already existing, and in the Metropolis Local Management Act called main sewers. I have also assumed, (a few special cases alone excepted,) that it is necessary, in long lengths, and in main roads and streets, for the sewers to be large enough for men to enter; and that the minimum size of such sewers should be 3 ft. 3 in. high, and 2 ft. wide.

For convenience of reference, I have prepared a general plan for each parish in the district; and in the tables appended to the plans will be found the detailed account of the information, as far as can be at present afforded, that I was directed to lay before the Board, as to the additional sewers which will be required in the district, exclusive of the parish of Putney and the hamlet of Roehampton, already reported upon. The following is a brief abstract of the lengths and sizes.

	3.9. × 2.6 ft. lineal.	3.3. × 2.0 ft. lineal.	12-in. Pipe. ft. lineal.	Total length ft. lineal.
In the Parish of				
Battersea - - - - -	14,630	20,130	21,560	56,320
Clapham - - - - -	23,360	19,275	11,785	54,420
Wandsworth - - - - -	23,880	11,930	7,610	43,420
Streatham - - - - -	23,910	8,830	16,940	49,680
Tooting - - - - - -	620	—	400	1,020
	86,400	60,165	58,295	204,860

From this it will be seen that the total length of new sewer reported as necessary for the complete sewerage of the district, exclusive of the parish of Putney, and the hamlet of Roehampton, already reported upon, is *38 M. 6 F. 15 R.; the approximate cost of which, including the requisite number of side entrances, manholes, ventilating and flushing shafts and gullies, I estimate at present prices, as under:—

	£.	s.	d.
For the Parish of Battersea - - - -	20,275	–	–
„ Clapham - - - -	24,662	–	–
„ Wandsworth - - - -	21,435	–	–
„ Streatham - - - -	24,005	–	–
„ Tooting - - - -	463	–	–
TOTAL - -	†90,840	–	–

ABOLITION

* The total length, including Putney and Roehampton, would be 45 M. 3F. 32 R.
† The total cost, including Putney and Roehampton, would be 111,840*l.*

ABOLITION OF EXISTING SEWERS.

THE plans now proposed contemplate the abolition of nearly all the existing sewers. When these sewers were built, they were not designed to carry off the whole of the soil drainage from houses, but merely the surface water. Thus they came to be constructed in a careless and irregular manner, little regard being paid to workmanship, depth, size, shape, or levels. They were often laid down piecemeal, at the caprice of the several owners, through whose grounds they ran; and, therefore, as might be expected, they present great variety of forms, and have scarcely any feature in common, but in their inefficiency.

The Legislature in former days, with respect to drainage, was altogether calculated to produce results, the very opposite of those which our present Legislature is aiming to achieve, unity of plan and system; application of principles were not attempted, no authorities were constituted for the enforcement and supervision of drainage in the detail, and some sewers were protected from any large influx of unclean solid matter by an Act, inflicting the penalty of a fine upon any person who should run a drain directly without an intervening cesspool into a public sewer.

In examining and cleansing, under the general directions of your Board, the numerous sewers which have from time to time been noticed in my ordinary reports, various shapes and sizes have been found even in the same line of sewer. The bottoms have also been frequently found to be flat, with a wood covering for the top; sometimes the bare ground between the side walls forms the bottom, and in many cases the direction of the fall has been discovered to be away from, instead of towards, the outlet.

CESSPOOLS NOW BEING ABOLISHED.

Your compulsory powers have been freely exercised for the abolition of cesspools in close and thickly populated neighbourhoods, where the cesspools have been in dangerous proximity to wells used for domestic purposes. By removing these cesspools you have thrown into the existing sewers an amount of soil drainage which they are not perfectly adequate to carry off; but you have decided, and no doubt wisely, that this is an evil of far less magnitude than that which you have abolished.

It is likely, moreover, to be of no lengthened duration, your Board having, on several occasions, expressed your settled intention to carry into effect, so soon as the main outlet sewers shall be provided, a complete system of new sewerage for the complete draining of your district.

Your designs for general and systematic improvement are, at present, kept in abeyance; and so long as this is the case it must necessarily be a work of time and difficulty to reduce a complete knowledge of your district into the shape of orderly and well digested information. Hereafter will be an easier task, as all new drains, of whatever kind, being constructed under the superintendence of your officers, and the whole being now exactly registered on your plans.

GENERAL PLAN OF DISTRICT REQUIRED.

In drawing the attention of the Board to the plans now submitted, I would urge the necessity that exists for having lithographed a general plan of the district, showing in block the position and details of the houses and properties.

I would suggest that the plan should be prepared in skeleton, from the Ordnance Survey, the general correctness of which is universally admitted. The details might be reduced from the tithe survey; and proceeding upon this method I could, should the Board think fit to authorise me, prepare such a plan; a specimen of which, showing the parish of Tooting, and a portion of Streatham, I beg to submit to the notice of the Board.

Each parish in the district might be laid down upon a separate plan, the whole taken together exhibiting the general plan.

The importance to the Board of having such a plan for reference in the discharge of its various and important duties will, I think, be obvious; if, moreover, the plans were published and sold at a price proportionate to the expense incurred, some return might reasonably be expected of the outlay. At present Clapham and Tooting are the only parishes in the district having a published map. The general plan proposed would be to the scale of one foot to a mile.

I have, &c.
(signed) *D. W. Young*,
Surveyor to the Board.

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Westminster.

Evidence of Mr. Arntz.

(11.) WESTMINSTER DISTRICT.

MINUTES of EVIDENCE given by Mr. *R. R. Arntz*, Surveyor.

Meeting of Referees, 29, Great George-street, Saturday, May 9.

Mr. Arntz attended by appointment.

Mr. Arntz confirmed what Mr. Hughes had said* with regard to the depression in the bottoms of several of the sewers in the Westminster District, which caused a stagnation of the sewage and consequent deposit.

In answer to a question, Mr. Arntz said that many parts of Westminster were below high-water mark, and that Millbank Row was flooded several times in the year.

Mr. Arntz said that the bottom of the invert of the lateral sewer ought to be at least four feet below the basements of the adjacent houses. Mr. Arntz believed there had been no floodings in the line of the Victoria-street Sewer, though that sewer had been, on more than one occasion, fully charged.

Without reference to basements, Mr. Arntz thought the sewers proposed would be at a sufficiently low level to catch the other drainage of the district.

Mr. Arntz said that there had been some flooding in the Vauxhall Bridge Road; that the flaps had not been left open, but that, on the contrary, the mischief had resulted from the necessity for their being closed, storms having come on during the time that the King's Scholars' Pond Sewer was tide-locked.

Mr. Arntz did not think there would be any advantage in separating the surface from the house drainage; while the scour in the sewers, caused by the rush of water after a heavy fall of rain, would be lost. Mr. Arntz thought means might be taken to prevent the road-filth that now accumulated in the sewers, from passing into them to a sufficient extent to render it unnecessary to separate house and surface drainage; with this end in view, and further, that if the question was solely one of cost in the removal, it did not appear to be material whether such removal took place from one system of sewers or another.

In answer to Mr. Simpson, Mr. Arntz said that he considered 10 *l.* per house would be a moderate estimate of the average cost of altering the existing house drains, with a view of separating the surface water from the excretory matter of the houses.

In addition to the reasons against attempting such a separation on account of the expense, Mr. Arntz thought it was the fact that in many of the low districts of London, much vegetable and animal matter would reach the river from the streets, while even, in some degree, fœcal matter would also find its way immediately into the Thames.

With regard to flushing, Mr. Arntz said that he never flushed his pipe sewers, having accidentally found out that there was no necessity for so doing, one in his district having, by chance, been left unflushed for several months; and that neither stoppages nor inconvenience of any kind had resulted from the course at present pursued.

In answer to Mr. Blackwell, Mr. Arntz stated that he had some miles of pipe sewers under his charge.

Mr. Arntz did not, in fine, think it would be possible, without a very expensive system of police, to carry out effectually, and to maintain, the separation of surface and house drainage.

In answer to Mr. Blackwell, Mr. Arntz thought 12-inch to be the safe and useful limit of pipe sewers; above that size Mr. Arntz would wish to make further experiments to prove their capabilities, if called on to use them, but did not think that beyond 12 inches in diameter, they were likely to prove better than brick sewers.

In answer to Captain Galton, Mr. Arntz said that from his experience in excavation, he could state that the water rose and sunk in the ground adjacent to the river with the rise and ebb of the tide.

City of London.

Answers to Questions from Mr. Haywood.

(12.) CITY OF LONDON.

1. ANSWERS to Questions, by Engineer to the City Commission, *W. Haywood*, Esq.

1. *Q.* The length of covered sewers in the City of London?—*A.* Forty-eight and a half miles.

2. The length of open sewers in the City of London, and the estimated cost of re-constructing or covering the same?—There are none.

3. The

* *See* Appendix X., page 446.

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City of London.

3. The length of streets and places other than uncovered sewers, which require to be drained, exclusive of the main drainage lines proposed to be carried out by the Metropolitan Board of Works?—All are drained.

4. A list and description of the sewers falling into the Thames (if it can be furnished)?—The main sewers are 11.

	Size at Outlet.				
	Ft. In.		*Ft. In.*		
Irongate	—		—		
Tower Dock	1 3	×	1 3		Iron culvert.
Wool Quay	9 2	×	6 9		*
Custom-house, east	5 9	×	3 6		semi top and bottom.
Custom-house, west	5 9	×	3 6		semi top and bottom.
London Bridge	10 0	×	8 0		ellipse.
Dowgate Dock	8 0	×	4 7	†	semi top and bottom.
Hambro' Wharf	4 4	×	3 6		semi top and bottom.
Paul's Wharf	7 7	×	5 6		semi top and bottom.
Fleet	19 0	×	12 0		semi top and bottom.
Whitefriars Dock	5 0	×	3 0	‡	egg shaped.

The outlet of the Irongate Sewer is in the county; the size may be obtained from the Metropolitan Board of Works, but the sewer was gauged by the City Commission, the largest portion of its length and drainage area being within the City. There are, in addition to these, 175 small outlets draining very small areas, and frequently only taking off the sewerage from one or two houses or W. Cs.; the area of the City which drains in this way is 24 A. 2 R. 11 P.

5. Results of Observations on the flow of sewage.
What is the flow of each sewer at the outlet?

(*a*) Minimum.
(*b*) Ordinary or mean.
(*c*) Maximum.
(*d*) Maximum in floods.

(*a*) (*b*) (*c*). The discharge in dry weather of each sewer at the outlet in 1853 was:—

	Maximum. Cubic feet per minute.	Minimum. Cubic feet per minute.	Mean. Cubic feet per minute.
Irongate	170·18	30·02	100·10
Tower Dock	11·05	0·86	5·95
Wool Quay	15·54	2·46	9·00
Custom House, East	25·61	3·87	14·74
Custom House, West	55·03	21·33	38·18
London Bridge	1,457·98	422·04	940·01
Dowgate Dock	87·67	14·67	51·17
Hambro' Wharf	14·17	2·14	8·15
Paul's Wharf	167·72	30·74	99·23
Fleet	1,648·98	463·95	1,056·46
Whitefriars	65·43	17·49	41·46

I have as yet no perfect account of the discharge since that date.

(*d*). The information I possess as to flood discharges is but slight, and will be found in an Appendix.

6. The normal flow of sewage to be passed off by the intended main drainage channels?—The total dry weather discharge was for the main City sewers in 1853, 3,255,840 cubic feet per diem, and the maximum rate of discharge was 3,501 cubic feet per minute.

7. The amount of flow at which, according to observations, flood waters may be taken to commence?—Whenever, from any unexplained cause, the mean rate of flow in any sewer exceeds its average, the flood waters have commenced.

8. The state of the water in the sewers when effective scour commences?—The effective scour commences directly a sufficient velocity is obtained to remove any substances deposited.

9. Whether

* In some parts 5 ft. 9 in. only. † In some parts 4 ft. only. ‡ In some parts 2 ft. 9 in. only.

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City of London.

9. Whether the main drainage, as proposed by Mr. Bazalgette, meets your approval in all respects; and whether it will pass off the water efficiently from the lowest sewer in the city?—I have only generally gone into Mr. Bazalgette's scheme, and therefore can yet offer no opinion upon its details. Its principles are, I believe, the same as are laid down in the Reports of Mr. F. Forster, with whom I was associated in the preparation of a scheme in 1850, in the Reports upon the Great London Drainage Company's Plan in 1852, and the design for Sewage Interception of the Northern Districts of the Metropolis, prepared by Mr. Bazalgette and myself in 1854; and in the correctness of those general principles I still believe.

10. General description of the state of drainage in the city, with descriptions of floodings which may have occurred from defects of the present outfall sewers?—I have no description to give further than may be conveyed by a plan of the City sewers herewith sent, which will, I think, sufficiently explain. I never heard of floodings in the City, excepting from the Fleet upon a few occasions, and those parts which are subject to be affected by the tides upon the line of Thames-street.

11. Whether any objections are likely to arise to passing the sewage from the western districts through the city and eastern districts, and what your opinion may be as to the practical result of such a measure?—I am not aware of any objections that can be made, excepting that it is an additional sewer, and would cause much inconvenience in its construction.

12. Your opinion, with reference to your personal observation of Sewage Manure Works, whether it is probable that the establishment of manufactures of this description would prove a nuisance in the City of London?—Not if properly constructed, and a reasonable distance be preserved between them and the adjoining premises. The first Sewage Manure Works which were formed for the conversion of sewage water into dry manure were erected in the City of London; but no nuisance was said to have arisen from them. They were, however, a failure, and scarcely got beyond experimental operations.

Sewers' Office, Guildhall,
8 April 1857.

William Haywood.

Evidence of Mr. Haywood.

2. Minutes of Evidence given by *W. Haywood*, Esq.

Meeting of Referees, 29, Great George-street, Wednesday, April 1.

Mr. Haywood attended by appointment at 12. 15. P. M.

Mr. Haywood had not entered fully into Mr. Bazalgette's scheme as it at present stands, but believed it was materially the same as that recommended by himself and Mr. Bazalgette in 1854, the main principles of which were the same as those enunciated in Mr. Forster's original plan in 1850, which he (Mr. Haywood) assisted him to prepare.

With regard to the levels of the sewers and streets in the city, Mr. Haywood stated that only Thames-street and Farringdon-street were liable to inundations from tidal waters, and Farringdon-street in a very small degree.

The tidal waters enter only two main sewers in the City to any extent, viz., the Fleet and the London-bridge sewer (the old Walbrook sewer), but also flow into the smaller sewers throughout the line of Thames-street.

Mr. Haywood did not at all object to the carrying the drainage of the west of London through the City.

Thought that great inconvenience, and some risk, might possibly arise from the cutting a sewer through the City, especially in the neighbourhood of the Fleet and Fleet-street. Under St. Paul's there is a bed of gravel and sand above the blue clay, but the depth at which the sewer was proposed to be built would prevent any danger arising to that edifice.

The most difficult part of the City to pass through will be that near the Fleet sewer, where the soil is a silty clay.

Mr. Haywood's reason for thinking there would be no probability of the sanitary condition of the City being affected by the carrying all the London sewage through the City, was that it is a generally believed effluvium arises in proportion to the evaporating surface, which would not be materially increased by the proposed scheme in a sewer properly constructed.

The areas drained by each sewer are very accurately defined in the City.

The areas drained through the City are 10¼ square miles.

Mr. Haywood stated that he considered the quarter of an inch of rainfall running off from over the whole surface of the metropolis as purely an arbitrary quantity, and thought it should rather be spoken of as 1-100th of an inch per hour, or thereabouts.

Mr. Haywood had no observations which would show the cleansing effect of the scour produced by storm waters on the sewers. No deposit had been allowed to accumulate for many years in the City sewers.

Mr. Haywood thought there would be no difficulty in erecting solid sewage manure manufactories, or deodorising works, in the metropolis without creating a nuisance, if a proper space were secured between them and the surrounding buildings.

Mr. Haywood was perfectly aware that the profitable conversion of sewage water into solid manure was a failure, and felt certain, long ago, that it must be so; and that no solid manure

manure of agricultural value could be made of sewage water, in the present state of chemical knowledge with regard to the mode of treating it.

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Mr. Haywood thought the precipitated matter from sewage water, as a basis for dry manure, nearly valueless; and that it was only the addition of foreign substances which rendered the manure of any marketable value.

Mr. Haywood believed that dry sewage manure would always be beaten out of the market by the highly concentrated artificial manures now manufactured.

With regard to Paris, Mr. Haywood stated that its condition was daily getting worse, and that the River Seine was being constantly poisoned by the influx of sewage water into it, which increased every year. The result would be, Mr. Haywood believed, that the Parisians would shortly have either to construct intercepting sewers, or diminish their water supply and prevent its application to water-closets.

In answer to a question, Mr. Haywood said that there were 175 outlets of a private description into the Thames, within the City, while there were only 11 main outlets; and that these small discharging drains were a great nuisance.

General Information.

Evidence of Mr. Donaldson.

(13.) GENERAL INFORMATION—Mr. *Donaldson*.

1. Minutes of Evidence given by *G. Donaldson*, Esq., C. E.

Meeting of Referees, 29, Great George-street, Friday, April 3.

Mr. *Donaldson* attended by appointment.

In answer to a question, Mr. Donaldson informed the Referees that he had not personally made any experiments as to the velocity and flow in sewers, but had gone very minutely into Mr. Roe's and Mr. Forster's observations, and those of John Phillips.

Mr. Donaldson had been employed between seven and eight years in the capacity of assistant district surveyor under the Metropolitan Commissioners of Sewers. He had also been long connected with Mr. Smith of Deanston, and had had experience in the application of sewage water as manure.

Mr. Donaldson believed, and his inquiries at Fulham and other places confirmed his opinion, that the sewage was very useful as a manure for grass crops, and generally for heavy crops, but not for market-gardens, &c. Thought no deodorising or utilising process could be commercially profitable; for the sewage of London, after having passed, as it must do, through miles of sewers, loses by evaporation and decomposition, and the elimination of gas, its most valuable properties. Mr. Donaldson considered, although the matter suspended is valuable, that it could never be successfully extricated so as to become available in a dry state as a manure; and left a Paper, with an article containing his views as to the value of sewage manure.

Mr. Donaldson thought the solid might be deposited by lime, and removed away at the expense of the rate-payers, but considered it desirable to get the sewage out of London before commencing this process. Thought deodorising works might be carried on without any nuisance or smell, but considered it advisable to remove them from London, as an accumulation of material might ferment, and become injurious to health.

Mr. Donaldson preferred lime to sulphate of alumina, as proposed by Mr. Stothert, on account of its cheapness.

Mr. Donaldson thought a copious flooding of cold water would be as good a deodoriser, together with the action of the oxygen in the atmosphere, as it would be possible to provide.

Mr. Donaldson had discovered, by analysis made in 1848, 1849 and 1850, that, on an average, 1,000 gallons of sewage water contained 14 lbs. of solid matter. These analyses had been made by Brande, Cooper, Phillipps, and others.

With regard to Richmond, Mr. Donaldson stated that the house drainage was there separated from the surface drainage.

Mr. Donaldson was aware that the dead ends of pipes, &c., through which sewage water had to pass, would get clogged up with a hard substance composed of oxide of iron, road-grit, &c.; and related a mode which had been adopted near Glasgow, of irrigating fields by tin tubes fixed in lengths into one another, in order to do away with leather hose, which soon gets destroyed and useless.

Mr. Donaldson thought it would not be possible, or desirable, effectually to separate the surface from the house-drainage. One great difficulty would arise from the vast number of pipes already in existence under every street.* Another reason for objecting to this plan was, that the present drains are so saturated with filth and fæcal matter, that the surface-water would for many years be polluted.

Mr. Donaldson did not believe it would be possible to construct subways under that part of London which now exists, to hold all the pipes (gas, water and sewer) of every kind. Knew that

* *See* Sections of Roadway in Parliament street, Regent Circus, and Charing Cross, showing the gas, water, and telegraph pipes, &c., Appendix XIII., Plates 1, 2 and 3.

that explosions of gas took place in the sewers, but did not know whether that gas had been wholly generated in them, or had escaped from the gas-mains; and was of opinion that it would be impossible to maintain a system of subways in London, or indeed in any new town, without the most perfect system of ventilation, from the vast quantity of gas which would accumulate.

With regard to the Report made by Messrs. Grant and Cresy, in opposition to one drawn up by himself with Mr. Bazalgette, Mr. Donaldson believed that the recommendation of the latter as to fall was founded on an arbitrary conclusion as to the flow in sewers. Knew that a great number of the pipes laid down by Mr. Cresy at Lewisham and Lee had become filled with sediment.

With regard to construction, Mr. Donaldson did not approve of mortar or cement for the joints of pipes, but thought, in most cases, a good clay, well tempered, most likely to be durable.

Mr. Donaldson thought pipes, if used, ought to be imbedded in concrete, unless laid in soils suitable for them, as gravel, &c.

Mr. Donaldson was an advocate for the high-level sewer, so as to catch as much water as possible without the necessity of pumping it. Mr. Donaldson thought very little expense would be saved by the construction of one instead of two intercepting sewers, from the nature of the ground, which would have to be excavated to a greater depth for the enlarged sewer; compensations would also have to be increased.

In reference to some excavations in Rotherhithe, Mr. Donaldson related that the line of friction was equal to 9 feet in from 16 to 32 feet, but it was from a bed of gravel through which the water passed freely that the water found its way into the trenches.

In answer to a question from Mr. Simpson, Mr. Donaldson said, that there was no doubt the low districts in the time of a rain-fall would be very seriously flooded if the proposed high level main intercepting sewer were done away with, and their condition be worse, the flood beginning earlier, and lasting longer, than with the high level intercepting sewer.

A system of combined drainage could never be so effectual for carrying off the storm-water, and preventing flooding, as one which carries off the high waters apart from the low.

Mr. Donaldson considered it would be very injurious, in a sanitary point of view, to allow the high waters to pass down into the low districts, and the effect would be very much worse in the case of constant rain, when the ground has been previously saturated.

The effect of the up-land waters coming down the main sewers might occasionally be to block up, and, to a certain extent, injure the lateral sewers.

Without the upper intercepting sewers, occasional floodings of the lower areas would be unavoidable, and in some rainy seasons would be frequent; and, so far, the benefit of efficient drainage would not be given to the lower areas.

Few if any of the existing collateral sewers would be sufficient to carry the storm-waters from the upper area to the low-level deep sewer, and the additional expense of constructing suitable collateral sewers for that purpose would go far to cover the cost of the high level intercepting sewer. From the lowest contour of the higher grounds to the line of low-level sewer, the ground is very flat; consequently, the retardation of current for want of fall would necessitate large sewers, or else the water would be forced up the house-drains by the rapid current of the high grounds, retarded on the level ground below.

Mr. Donaldson remarked that an important consideration which he had not seen yet adverted to was, that a large extent of the area to be drained is full of cesspools charged with decomposing fæcal matter; these are seldom cleared out or emptied so long as there is room to make a new one, and consequently there are many places in Bermondsey, Rotherhithe, Deptford and Greenwich, the ground of which is quite honeycombed with them. The ground being at present highly charged with water, all this foul matter is kept constantly saturated; but immediately the deep drainage is completed, and the ground generally laid dry to the depth of 12, 14 or 15 feet, the gases from these putrid cesspools will rise to the surface, and escape into courts and alleys, and into the houses, and this in parts where there is little ventilation, so that serious consequences may result.

Mr. Donaldson believed this was the cause of the severe outbreak of cholera immediately after the construction of some new sewers in the vicinity of Broad-street and Poland-street some years ago.

The emanations from these cesspools laid dry will continue for a time, and then cease to be offensive or hurtful so long as the ground is kept dry, but let a flood occur, and the ground become saturated again with water, again there will be an emanation of foul gases, first by evaporation from the ground, and then by the fermentation which would result from the contents of the cesspools being saturated with water, and then slowly drying again; and every severe flooding that takes place this evil will be repeated, and no doubt fevers will be engendered from it.

Such a soil once laid dry must be kept dry, or else it had better be allowed to remain as it is, thoroughly and permanently saturated with water.

Mr. Donaldson said he would urge upon the authorities the necessity of causing every cesspool to be emptied before the main drainage be completed, otherwise he feared serious results would arise from the emanation of gases from these putrefactive matters when drained dry.

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2. Minutes of Evidence given by *George Donaldson*, Esq., C.E.

Meeting of Referees, 29, Great George-street, Friday, May 15.

Mr. *Donaldson* attended by appointment.

Mr. Donaldson said that he apprehended great danger from the cesspools when the water is removed from them, and that he should not be surprised if fever for some year or two were the result of carrying out the proposed drainage plan, unless all cesspools were emptied and filled up.

Mr. Donaldson knew that cesspools had been abolished to a great extent, but could not think 80,000, as estimated by some people, had been closed within 10 years.

In answer to a question Mr. Donaldson said that he should be inclined to average the cost of altering the houses to the present system, besides what has been spent in sewers rates, at not less than 10*l.* a house.

Mr. Donaldson did not think it possible, or desirable, on account of the expense, to establish a separate system in London. With regard to Richmond, Mr. Donaldson said that sewage-matter used to get surreptitiously into the surface drains, but he believed it did so no longer now.

Estimated the probable cost of effecting the new connexions for a separate system at more than 10*l.* per house, and probably double that amount for the new drains in the streets.

Another reason for objecting to the separate system was, that the great complication of existing pipes would render it almost impossible to carry it out efficiently, if at all; the same or greater difficulty would exist at the crossing of every street, more especially, as in Regent-street, where there is a sewer on either side of the road.

Even in a new town Mr. Donaldson would consider it a waste of money to carry out the separate ystem of drainage.

To carry it out at all, the surface-water sewers must be much nearer the surface of the ground than they are now, and the result of this would be, that in case of leakage, or their becoming barred or locked, the water or sewage would infallibly make its way into the basements of the houses.

In answer to a question, Mr. Donaldson said that he had thought much of Mr. Bazalgette's plan since his last visit, and the result was, that he was still more firmly persuaded of the necessity of the high-level intercepting sewers to prevent floodings in the low districts.

The size of Mr. Bazalgette's sewers Mr. Donaldson considered well estimated, but thought the expense of enlarging them, if calculation proved it necessary so to do, had been very much exaggerated, the fact being that the brickwork of a sewer eight feet in diameter is nothing like double that of one four feet in diameter.

Thought there would be no difficulty in dredging and carrying on works in the proposed main sewers, judging from the present practice in the King's Scholars' Pond and other large sewers.

Mr. Donaldson stated that he knew no place in which the sewage travels such a distance as in London, or where it undergoes so much chemical decomposition as it does while passing through the London sewers.

In answer to a ques ion, Mr. Donaldson said he had no reliable data as to the relative discharge of rainfall from a soil either purely or partially agricultural, or altogether urban.

(14.) ST. MARYLEBONE—Mr. *Freeth.**

Minutes of Evidence given by *Charles Freeth*, Esq. Senior, Member of the St. Marylebone District Board of Works.

Meeting of Referees, 29, Great George-street, Friday, 19 June 1857.

Mr. *Freeth* attended by appointment.

Mr. Freeth said, that the sewer to which he wished to call the attention of the Referees was that part of the King's Scholars' Pond Sewer, where it crosses the Regent's Canal, in the Park-road, St. John's Wood, by means of an iron trough above the canal and under the carriage-way of the road.

Mr. Freeth detailed the nature of the objections which he had to the stricture in this sewer, in consequence of there being a great quantity of sewage which must necessarily pass through it, where it is contracted at the bridge over the Regent's Canal; and he said that he anticipated even more serious results than at present exist from the defective state of the sewer, when the freehold property of Sir Thomas Wilson, known as the Manor Farm, and the estates belonging to Eton College, and other parties, are built upon, which would probably be the case within the next few years.

Mr. Freeth said, that the evil was admitted by the late Commissioners of Sewers; and that he had been chairman and spokesman of a deputation to the Metropolitan Board of Works

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* *See* Letter from Mr. Freeth, page 263.

Appendix VII.

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St. Marylebone.

Mr. Freeth.

Works on the subject, when Mr. Bazalgette stated that plans had been prepared and were then in the office, for carrying the sewer under the canal, at an expense of 10,000 *l.*; and the Chairman of the Board said that it would be one of the first matters to be attended to, but yet nothing had been done in the matter.

Mr. Freeth related the way in which London, north of the canal, had risen up since the construction of that work, which prevented the efficient drainage of the districts north of the canal, in Marylebone and Hampstead, unless the sewers were carried under the canal.

Mr. Freeth said, that he had heard that it was impracticable so to enlarge the sewer in the arch of the bridge, as it at present exists, to remedy the evil complained of; and he believed the only way in which the defect could be remedied was by passing it under the canal, more particularly as the sewer on the south side of the canal must be lowered to drain a large tract there, at present not properly drained.

Mr. Freeth said, that many of the sewers in the district were very badly constructed, having in many cases an inclination in the wrong direction; and that if it were not for the rainfall and occasional storms, which cleared the sewers of their deposits, many of the sewers would be unbearable.

In answer to Mr. Blackwell, Mr. Freeth said, that there were a great many cesspools in Portland Town still, though attempts were being made to abolish them as much as possible. Mr. Freeth did not, however, think the powers given to Boards for the abolition of these nuisances were sufficiently strong for the purpose: and stated that local influence sometimes prevented that promptitude of action which was necessary to remove nuisances, or to effect improvements; and he suggested that in all such cases the Government should be authorised to step in and perform such works as the district board neglect.

In answer to Mr. Simpson, Mr. Freeth said, that he thought it would be a hardship to call on people to return to the cesspool system, so much having been already spent on alterations for the supply of water to the houses.

Mr. Freeth explained the reasons which, in his opinion, rendered it very difficult for the district boards to insist on the owners of houses carrying out drainage works, even at so small an expense as 3 *l.* or 4 *l.* a house. The Act gave them the power to insist on the owners (that is, as the Act provides, persons receiving rack-rents of houses) carrying out the necessary works at their own expense; but that in many cases it was manifestly unjust to require persons, simply because they received the rack-rents (and without reference to what might really be their beneficial interest in the premises), to carry out these compulsory powers; and in other cases it was difficult to find out the persons receiving the rack-rents, so that the powers were practically of no use. Mr. Freeth thought the Act required alteration in this particular, and that Government ought to have the power of carrying out these works where they were not otherwise done, and at the public expense.

In answer to Mr. Blackwell, Mr. Freeth said, that the present condition of the sewers was very bad, if he might judge from the frequent applications made to the district board for traps to be put to the sewers.

Mr. Freeth said, that the St. Marylebone district was formerly under the Westminster Commissioners of Sewers.

Mr. Freeth alluded to two very defective parts of the sewerage in Marylebone; one in and near Union and Nassau-streets, behind the Middlesex Hospital; the other near Seymour-place, Molyneux-street, and other streets west of Bryanstone-square: and said that he had heard that a great many of the sewers in Marylebone were in a very bad condition, and would require large sums of money to place them in effective condition. Mr. Freeth said that he had found this a very vexed question; the owners of large estates had had sewers built by themselves, or their builders, and after a certain number of years these sewers, as in the cases last alluded to, became so much out of repair (being originally ill built or otherwise ineffective), as to require a rebuilding at a great expense, and all this expense, by the Act, now falls upon the ratepayers generally, whereas there was a strong feeling that the expense of such rebuilding or re-instating such sewers should be borne in part by the owners of the soil, or others beneficially interested in degree; and he thought that this matter required earnest consideration.

Mr. Freeth stated that the leases of a large district south of the Regent's Canal, St. John's Wood, would fall in in about eight years, and some scheme of drainage for that district would then become absolutely necessary, as the present sewer in Park-road was not at present of sufficient depth to drain the district referred to.

With regard to the ventilation of sewers, Mr. Freeth said, that he knew of no other mode of destroying the noxious gases than that which has been suggested, of burning them in furnaces, under shafts. He held the present mode of trapping the sewers in many cases to be most injurious to the public health, from the gases being thus thrown into the houses through the drains. From the 71st clause of the Metropolitan Local Management Act, Mr. Freeth said he inferred that the Legislature meant to induce scientific people to turn their attention to providing "proper ventilation" for the sewers; but although the subject had been much discussed at the Marylebone Committee of Sewers (of which he was a member), and although a correspondence with Dr. Dundas Thomson, the Officer of Health of Marylebone, and Mr. Bazalgette had arisen in consequence, no satisfactory opinion had, up to this time, been elicited.

APPENDIX VIII.

Appendix VIII.

Information on former Condition of Local Drainage.

Reports by John Rennie, Esq., C.E.

INFORMATION on former Condition of Local Drainage.

1. Reports made by *John Rennie*, Esq., C.E., in 1807 and 1808, on the King's Scholars' Pond Sewer.

A.

A Report presented on the 27th May 1807, to the Commissioners of Sewers for the City and Liberty of *Westminster*, and part of the County of *Middlesex*, suggesting Means for the Improvement of the Drainage of that District now drained by King's Scholars' Pond Sewer. By *John Rennie*, Civil Engineer.

Gentlemen,

Were it merely a question, what is the best line of a sewer to carry away all the water that falls on that district of land which now drains into the river Thames by King's Scholars' Pond Sewer, the question would be easily solved; but this question involves in it so many other important considerations, that I candidly confess I have felt more difficulty in deciding what line, under all the circumstances of the case, is the best, than in almost any other subject of much more natural difficulty than this appears to be.

The present King's Scholars' Pond Sewer, I believe, is admitted by all that have examined it, not only to be laid down in a very irregular direction, but so imperfectly executed, in such bad repair, and to have so bad an outfall into the Thames, that it would be only wasting money to attempt to render it perfect.

Many places of it are, besides, so much covered with houses, that the expense would become enormous. It is, therefore, advisable, that this sewer should not become the principal source by which the water, soil, &c. of so important and increasing a part of the metropolis as it now has to drain, should be discharged into the Thames.

Independent of its bad direction and imperfect construction, its outfall into the Thames is so low, and this low or flat land continues to such a distance backward, that were even the higher parts of the sewer perfect, this alone would be almost sufficient to condemn it. Water draining from an extensive tract of ground, covered with houses, where much mud and soil is to be carried off, becomes so pregnant with this kind of matter, that whenever a stagnation takes place, it deposits its contents, and chokes up its channel; although, therefore, it is possible to raise the banks of the low flat between the Queen's Palace and where it discharges the water into the Thames, yet it would not be practicable to occasion such a current through this flat (unless by the destruction of much valuable property), as to prevent a very considerable settlement of mud taking place in its channel; and this by degrees would raise the bottom to such a height as to overflow many valuable houses in Pimlico, and even Her Majesty's Palace itself. No doubt, that by keeping people constantly employed to clean it out, this might in some measure be remedied; but a sewer that is to perform its work by constant attention and repairs, is not fit for the Metropolis of the British Empire.

A perfect drainage can best be effected by a perfect outfall, that will keep itself clean without the constant assistance and superintendence of your surveyor. Such an outfall should therefore be found, not in the low and flat marshes lying between Whitehall and Chelsea, but in some place where the ground is sufficiently high to admit of a sewer being laid, with a declivity capable of clearing away its own mud and soil, and of discharging its water fully and freely into the Thames.

On examining the shores of the river with much attention, I have not been able to find any place, within a moderate distance, where such an outfall could with advantage be made higher up the river than Scotland-yard. Here, no doubt, the ground is lower than could be wished close by the Thames; but this low land extends but for a short way backwards. At Charing-cross it is high, and the rise from thence is rapid; but from about the end of Craig's-court to the Thames at Scotland-yard it is but little above the high water of an ordinary spring tide. The distance however is short, and therefore there can be little doubt that the current from the sewer above will be sufficient to keep the outfall clear. At the same time, I have no hesitation in giving it as my opinion that it will be better if the declivity can be maintained quite to the verge of the Thames itself. For this purpose it may be a matter worth consideration, whether it would not be better to make the outfall at the bottom of Northumberland-street, where the declivity of the ground extends quite to the Thames, than to pass through any low land at all.

There appear to me three lines from Charing-cross that may be followed.

The first is to pass from Charing-cross along the main street towards Whitehall, as far as the Land Revenue Office, and thence turn to the east, through Middle Scotland-yard, to the Thames, at the Lime Wharf. By this line the whole of the sewer would be, in the wide streets, easy of access for execution, as well as to receive any repairs that hereafter may be wanted.

The second is to pass through Craig's-court, and from thence to the Lime Wharf above-mentioned, nearly in a straight line; but here there must be some houses pulled down on the south side of the court.

The third is to pass up part of the Strand, and turn down Northumberland-street, and enter the Thames by Wood and Co.'s Coal Wharf.

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The first will be by far the easiest done; the streets are wide, and the ground low. It does not interfere with the plans that are in contemplation by the Crown for building on their lands; but the distance is 80 yards longer than the second, and the ground is lower than could be wished.

The second is more difficult of access; the entrance to Craig's-court is narrow, and the depth of cutting would endanger the houses on each side of the entrance while the work was in hand. This narrow entrance is about 30 yards in length. The houses on the south-west side of the square are valuable; and the line from thence to the Lime Wharf in Scotland-yard would interfere, in some degree, with the plans of the buildings intended by the Crown. The line of sewer is besides 80 yards shorter than the other, and the ground is also higher and more regular in its declivity. Were it not, therefore, for the obstacles in question, I should greatly prefer this line to the former.

The third line is on higher ground than either of the two former; it is shorter than the first by 33 yards, but longer than the second by 47 yards. The entrance to Northumberland-street is, however, narrow for about 16 yards, but not so much as that to Craig's-court.

From the whole of these circumstances taken together, I am inclined to prefer the line by Northumberland-street; though, were the obstacles in Craig's-court removed, I should prefer that line.

On the supposition that the honourable the Commissioners will sanction the outfall to be at or near where I have stated, I will next proceed to deliver my opinion respecting the various projects that have been laid before them for the best line of sewer from the high grounds north of St. Marylebone to Charing-cross; and afterwards describe another line which has occurred to myself.

There is a district of ground covered with houses, of not less than 1,027 acres, as well as a district of 962 acres not yet built upon, but which, at no very distant period, is likely to be covered in part, if not entirely, with houses; all the water from which, as well as what is supplied for the use of the inhabitants from the New River and Chelsea Waterworks, drains through the present King's Scholars' Pond Sewer; and this sewer has been carried along the bottom of the valley into which the district above described drains.

The bottom of a valley is no doubt the natural channel to which the water on each side of the valley should come, and had the main sewer been laid down in a proper manner, and of sufficient capacity and declivity to carry off the whole water, mud and soil, and that it could have been readily got at to repair, there is no doubt that it would have been the best line for the said sewer that could have been devised, its entrance to the Thames excepted. The entrance, however, might be a proper one in the original state of the Thames, although very much otherwise now; but so far as this line, namely, the bottom of the valley, can conveniently be followed, it ought to be done in whatever is now to be executed, as the drainage of the whole naturally tends that way.

Several lines have been laid down for the sewer to drain the extensive district already mentioned, by various members of your Honourable Board. All these lines, one excepted, commence at the same point, namely, at the head of Baker-street; which, in my opinion, is the best place that could have been chosen, as the whole water of the district above the New-road, and which is at present little built on, declines on that part. The lines they propose to follow from this place to the Thames are, however, various.

The first plan is to begin at the head of Baker-street, to pass along that street, Orchard-street, North Audley-street, and South Audley-street, to Mount-street, along part of the said street to the lower end of Davies-street; then to cross Berkeley-square, and along Berkeley-street to Piccadilly; then to turn eastward along the said street, to the head of St. James's-street; then to turn down St. James's-street to Pall-mall; there to take in the Pall-mall sewer, and run along this street and Cockspur-street, to Charing-cross, and from thence to the Thames.

The line of the above sewer is no doubt a very straight one, and passes through streets of great width, by which it could not only be easily made, but readily got to whenever repairs are wanting; but it seems to me that the line from the lower end of Orchard-street to Berkeley-square lies too near the west side of the valley, and leaves too much to be done by the old sewer, which now in crossing Brook-street, Lower Grosvenor-street, and Bruton street, passes under many houses, and I fear would be still apt to overflow them; besides, it could not well be got at for repairs, and sewers or branches from the east side could not be readily brought into it, as the ground rises to the westward.

The sewer in Pall-mall is too low, and if such a quantity of water as would come from the above district were brought down to such a level as this street lies in, I should fear mud would settle in it, and the houses in Pall-mall would frequently be overflowed.

The second plan is to make a sewer from Oxford-street, along Bond-street and Piccadilly, to the head of the Haymarket, and down this street to Cockspur-street, and from thence, by Charing-cross, to the Thames.

This line of sewer is what I should much prefer to the former, was it not for the very great depth of cutting from the end of Bruton-street, along Bond-street, Piccadilly, to near the Opera House, for although a good deal of this ground is not so high as the upper part of Bond-street, yet as the sewer should have a regular declivity, the cutting becomes deeper and deeper until it reaches the head of the Haymarket, where it is upwards of 42 feet deep.

By borings which have been made at the lower end of Bond-street, at the Brown Bear, Piccadilly,

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Piccadilly, and at the head of the Haymarket, it appears that at the first there is six feet made earth, six feet gravel, and afterwards clay, downwards to at least 38 feet deep; a sewer with a regular declivity would here be 38 feet to the bottom, and as the brickwork of the sewer itself would require to be at least 10 feet high above the bottom, it would come within 11 feet of the top of the clay.

At the Brown Bear, Piccadilly, there is eight feet of made earth, 10 feet of gravel, and afterwards clay; the sewer would therefore be here about 38 feet deep, so that its top would be about 10 feet under the top of the clay.

At the north end of the Haymarket, there is seven feet of made earth, five feet of gravel, and afterwards clay; the bottom of the sewer at this place would therefore be about 42 feet under the ground, so that there would only be about 22 feet of clay above its top.

In making a sewer through such a line, it becomes a serious question whether it should be done by cutting the ground open to the top, or by tunnelling. If the whole of the ground had been strong clay to the surface, there is no doubt that tunnelling would have been by far the best mode; but as the depth of clay above the tunnel is only in the deepest place 22 feet, and in others not more than 10 or 11 feet, with a bed of gravel above, in which there is a good deal of water, I should fear that tunnelling would be a very dangerous operation indeed, and such as I should be little inclined to advise being undertaken. Cutting open to the depth of from 30 to 42 feet, I also conceive a very serious undertaking, and should not be done if it is possible to avoid it. It therefore appears to me, that making a sewer in this line would be a measure too expensive and hazardous to be adopted.

The third plan is to follow the first line from the head of Baker-street to South Audley-street, through Seymour-place, Hamilton-street, across Constitution-hill, and by the north-west wall of the Queen's Palace-gardens, across Grosvenor-place to Bloody-bridge, and from thence to Grosvenor-row, Chelsea, where it is proposed to communicate with the creek that turns up from the Thames at Ranelagh Stairs.

This line I think very objectionable on two grounds—First, on account of its length, being nearly two miles and a half to the crossing of the road at Grosvenor-row, Chelsea, which is above a quarter of a mile longer than the second plan, and of course the fall per mile is proportionably less.

Secondly, on account of its being on the verge of the parish, and distant from the greater part of the ground to be drained, and any side sewer that may be brought to it must be made on ground rising to this line; these reasons are sufficient in my mind to set this plan aside.

The fourth plan begins at the top of Baker-street by the New-road, and continues along this street to the corner of Blandford-street, along this street, South-street, and Marylebone-lane, to Oxford-street, which it crosses, and runs along Bond-street, to the corner of Vigo-lane, into which it turns, and passes through Glasshouse-street, Marylebone-street, Shug-lane, and the Haymarket, to Charing-cross. The author of this plan proposes also to continue down Bond-street, to Piccadilly, in place of passing by Vigo-lane, and to go along Piccadilly to the Haymarket, and so on to Charing-cross, as before. A third change is also proposed, namely, to pass along Bond-street, across Piccadilly, down Duke-street, and along Jermyn-street to York-street, down that street, and across St. James's-square, along Charles-street, and into the Haymarket, and down the Haymarket into Cockspur-street, and along the said street to Charing-cross, where it joins the former line.

The author of these plans has taken great pains to examine the ground, and he has certainly pointed out several good lines; but there is a great quantity of deep cutting between the end of Vigo-lane and the lower part of the Haymarket by the two first mentioned of these lines, and the last is also objectionable on similar grounds, though not to such an extent as the former. Had tunnelling been advisable, I should most likely have preferred one of these lines.

The fifth plan proceeds upon the principle of catching or intercepting the water in its course towards the Thames by three several lines of sewers, crossing the valley to be drained, transverse ways, and embracing a much larger district of country than either of the others.

This plan consists first of a line of sewer to commence at the end of Portman-street, in Oxford-road, and running westward to discharge itself into the Thames, either by the line of Bayswater, or some other sewer near to Hammersmith.

The second line is proposed to commence near Lord's Cricket Ground, and to pass through Church-street and Paddington-green, to the tunnel under the Paddington Canal.

The third, or eastern branch, is proposed to commence near to Holles-street, in Oxford-street, and to continue in a straight line eastwards till it meets Holborn; from this it is proposed to be in the best line to the sewer begun by the proprietors of estates to the west of St. Clement's Inn. By these lines the branches which now in heavy rains overload King's Scholars' Pond Sewer would be cut off, and that sewer relieved from a great part of the drainage it has now to perform, and it is imagined that it would be sufficient to drain what would then remain to fall into the main sewer.

Were the district of country to be sewed very extensive, and that there would be great difficulty in constructing a sewer sufficiently large to take the whole of the downfall water, as well as that brought in for the use of the inhabitants, a plan on the catchwater system might be adviseable, and something of this kind would then become necessary. But as I apprehend if a short line with a regular fall was adopted, a sewer of moderate dimensions would be equal to the object, I am of opinion that it will be better to follow a short and direct line

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line of sewer, with such a fall as can here be got, than to follow a line more circuitous, where the fall per running yard must of consequence be much less; on this account, therefore, it appears to me that the plan above described is objectionable.

The sixth plan is, first to follow the old sewer until it crosses Baker-street, but there to depart from it and pass along Baker-street in a straight line to the west end of Curzon-street, then to turn to the east along Curzon-street, until it meets the old sewer at the north end of Half Moon-street, where it is proposed to join and pass to the Thames by the old sewer.

Secondly.—To make a new sewer from the head of High-street, Marylebone, until it joins the old sewer at the crossing between South-street and Bulstrode-street; then to follow the old line to the end of Avery-street, from thence to go along Grosvenor-street into Bond-street, and by a new line of sewer along Bond-street, Marylebone-street, Haymarket, and Cockspur-street to Charing-cross.

In the first place, it appears to me that there is a much greater extent of sewer by this plan, than is necessary. Secondly, following the old sewer from the crossing of South-street and Bulstrode-street to the lower end of Avery-street, is exceedingly objectionable, because in this line the sewer passes under many houses, and the streets in general are very narrow, which renders it difficult of access either to do new work or make repairs, the ground from Vigo-lane to near the lower end of the Haymarket is all high, and will render the expense of the work very great; under these circumstances, I must give my opinion against this plan.

On considering attentively these different plans, it appears to me, that the one least objectionable is that described in the fourth article, where it commences at the head of Baker-street, and continues along that street to Blandford-street; along this street, South-street, St. Marylebone-lane, Bond-street, Piccadilly, Haymarket, Cockspur-street, Charing-cross, and so on, to the Thames; and I fairly confess I feel some difficulty in deciding, whether the plan I mean to propose is much less objectionable than this. I shall, however, state my reasons why I prefer the plan, and leave it to the discretion of the honourable Commissioners to decide.

The plan which, under all the circumstances of the case, appears to me the best, is as under:—

I would commence the new sewer at the head of Baker-street, and from thence pass down this street and Orchard-street to Oxford-street; at Oxford-street I propose to turn to the east, and pass along that street to the head of Davies-street; then turn to the south along this street, and across Berkeley-square to the head of Berkeley-street. Here the old sewer may either discharge its water into the new one, or may cross it; the former seems to me the best. The new line of sewer should then run along Berkeley-street to Piccadilly. So far the whole line of this sewer will pass through wide streets, and where the depth of cutting is seldom more than what is just necessary for the depth that it ought to be made under the surface of the streets, to afford a complete drainage to the district of houses through which it passes, except a very short distance where it crosses the old sewer at the bottom of Hay-hill; here, I propose, that the ground should be raised from two to three feet at the lowest place: this will, no doubt, occasion an inconvenience to the lower houses at the head of Berkeley-street; but as it will improve the access to Berkeley-square, and to Hay-hill, I am of opinion that it would, on the whole, be of advantage to the public.

At the lower end of Berkeley-street, where it joins Piccadilly, the difficulties commence. Were the sewer to pass along Piccadilly, and down the Haymarket, most of the depth of cutting, before stated as an objection, will still exist; and if it was to go along St. James's-street, and down to Pall Mall, the objections against the lowness of the ground before made, would, by this line, equally apply. Something like a middle course should, therefore, if possible, be adopted. Jermyn-street, unfortunately, is only about 10 feet lower than Piccadilly and St. James's-street, at the end of King-street is only about two feet higher than Pall Mall; so that whichever of these lines be followed, objections, to a certain extent, will exist. But I despair of being able to propose any line that is entirely unobjectionable, and therefore that which is the least so ought to be adopted; if wide streets, not being the great thoroughfares of Westminster, could be found to carry a sewer along, these, in my opinion, ought to be followed in preference to others through which the thoroughfare is great. There are scarcely any streets in London more frequented than Piccadilly, St. James's-street, and Bond-street; the first is the great thoroughfare to the westward, the second between the King's Palace, the Houses of Parliament, and all the extensive and populous district north of Piccadilly; and the latter includes most of that above Oxford-street; so that any long interruption which a sewer might occasion in these streets, would be a serious inconvenience to the public.

The streets I have named between the New-road and Piccadilly are much less objectionable in this respect; so far as the proposed line goes along Piccadilly and St. James's-street, it is equally objectionable; but the short distance it passes along Piccadilly, being only about 130 yards, cannot occasion a long interruption. Although, therefore, the line of streets through which the sewer is here proposed to pass were equally high and equally expensive in cutting open to build the sewer in, yet I am decidedly of opinion that it would occasion much less inconvenience during the execution of the sewer than if it passed through Bond-street, Piccadilly, and the Haymarket; but it so fortunately happens that they are not so high, and that part between the south end of Berkeley-street and the head of St. James's-street, is from two to three feet lower than the south end of Bond-street, and the distance

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distance is only about 130 yards; from this to the end of Jermyn-street the distance is only about 40 yards, and there is a fall of 10 feet; but Jermyn-street rises something to the eastward, and therefore it cannot well be reckoned more than averagely about 10 feet lower than Piccadilly. I propose, therefore, that the line of sewer shall run from the south end of Berkeley-street, along Piccadilly to the head of St. James's-street, along that street to the west end of Jermyn-street, and along the said street to the head of York-street, taking in the sewer that crosses St. James's churchyard, then turn to the south down York-street into St. James's-square, across an angle of that square into Charles-street, along the said street into the Haymarket, and from thence by Cockspur-street, Charing-cross, through Northumberland-street, and into the Thames, near Wood & Co.'s coal wharf.

The end of Jermyn-street, next St. James's-street, is narrow for about 40 yards, including six houses; these belong to the Crown, and I have little doubt they would be willing to consent to their being taken down, if necessary, and rebuilt in a better manner. There are also some houses between Charles-street and the Haymarket, which are proposed to be taken down, they also being the property of the Crown, for the purpose of making a wide opening into Haymarket; no material obstacle is therefore likely to arise there. But should even an obstacle arise at either of these places, the former may be avoided by continuing the sewer along Piccadilly to Duke-street, and turning down this street into Jermyn-street; the latter, by turning down St. Alban's-street into Pall Mall. But I trust neither of these deviations will be found necessary.

The length of sewer between the head of Baker-street and Charing-cross by this line is about 3,982 yards; by the line of Bond-street, Piccadilly, and the Haymarket it is about 3,772 yards; but in this latter, although 210 yards shorter than the former, there is about one-seventh more of excavation, and this is in deep cutting, which generally runs from 30 to 40 feet in depth. Although, therefore, the line of sewer I have pointed out is longer than the other, yet, under all the circumstances of the case, it appears to me preferable, and such, therefore, as I beg leave to recommend to the Honourable Court of Sewers to be adopted.

Having now given my opinion respecting the line of sewer which, under all the circumstances of the case, seems to me preferable, the next material object that arises is, respecting its dimensions and fall.

The total fall from the head of Baker-street, at the New-road, to the level of half flood of an ordinary spring-tide, at the foot of Northumberland-street, is about 88½ feet; but deducting from this 12 feet for the depth of the sewer under the street at the beginning, will leave a fall of 76½ feet, or a little above two-tenths of an inch in a yard if the fall be regular, which, as all the ground, except from the middle of Berkeley-street to about the middle of York-street, a distance of 760 yards, admits of its being very conveniently done; and no part of this 760 yards being above eight or ten feet deeper than could be wished, I am, therefore, decidedly of opinion the sewer should be made to have a regular fall from its commencement to Charing-cross, there I would advise it to descend a little quicker until it enters the Thames. No doubt the fall might be further varied so as to save some expense in the execution, but it would by no means be so complete, and in a work of such importance as this it will be found, in the end, by far the greatest economy to do it on the best plan that can be devised, although the expense should be greater.

In respect to the size of the sewer it will be necessary that it be made of different sizes, according to the extent of surface it will have to drain, and whether what is to be drained be covered with houses and paved streets, or meadows and arable land; in the former case the rain cannot be absorbed as it will in the latter, and consequently will run off more suddenly; the sewer should therefore be of sufficient dimensions to take off the water as quick as it may fall. In the 1,027 acres covered with houses and streets, it will run off immediately; in the 962 acres not covered with houses and streets, it will lie for some time; but as it is not unlikely that at no very distant period a great part of what is now meadow and arable land will also be covered with houses, I am of opinion the sewer should be made sufficiently large to take the whole of the water even on that supposition; now taking the greatest quantity that ever falls in one day at 2$\frac{1}{10}$ inches perpendicular over the whole surface, say, 1,989 acres, I am of opinion it will require the sewer to be 8½ feet wide at the lower end, diminishing towards the top, where, at the New Road, it should be about six feet wide; it is here made larger in proportion from the rise being less per yard upwards than downwards.

If the water came regularly into the sewer as it advanced in its course, the diminution in size should be regular; but, as this will not be the case, as it will come in a particular place where the side branches of sewers join the main line, its diminution ought to take place near these junctions; I cannot at present say where, but if the extent of ground drained by each branch be furnished to me, and the places where they join, I will calculate the dimensions of the sewer accordingly; no diminution should however take place where there is any bend in the sewer, but always above the bend, as more room is wanted where the turns are than anywhere else.

As to the form of the sewer, I have no hesitation in saying, that it ought, in my opinion, to be made like a canal tunnel; the bottom should be an inverted arch, the sides curved, and the top a kind of ellipsis, approaching nearly to a parabolic form, having the longer axis upwards; the pressure is generally the most irregular at the top, there being so much loose earth above, and therefore the form should be suited to sustain that irregular pressure.

As to materials, there is no doubt good stone is the best, but the expense of stone would exceed all reasonable bounds, and as well burnt brick, laid in good mortar, will last for

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ages, I have no hesitation in advising that brick be adopted. Great care should be taken in obtaining the best lime and sand; the lime should be brought as fresh as possible from the kiln, ground to a powder, and water kept from it until it be about to be used, and if a small proportion of pozzolano or tarras was mixed with the lime and sand, so much the better; the joints of the brickwork should be fine, and where the water is to be let soon into the sewer, should be made with Roman cement.

If the sewer be required to be executed in a short period, it must be begun in different places at once; this will render drainage difficult to be obtained, and I fear, from the great extent of the bed of gravel which lies on the clay, there will be a good deal of water to pump in some situations; proper machinery should therefore be provided in due time; the quantity of water likely to annoy the work may probably be obtained from an examination of such wells as have been made in the course of it, and from them the machinery may in in some measure be ascertained.

The fall being great, the water will run rapidly through the sewer, and as running water accumulates air, proper wells or shafts should be left to carry off this air, otherwise the work will be apt to be blown up; these shafts will also be of use for enabling workmen to go down frequently to examine the state of the main sewer. Particular care should be taken to make such branches as communicate with the principal sewer, to enter in a proper manner, the easier the curve and the less fall they have, the better. Some stone-work may probably be wanted at these junctions; this stone should be of the hardest kind, neither Portland nor Purbeck, in my opinion, would be proper; the hard Yorkshire or Scotch stone would be greatly preferable for such purposes.

I am, &c.
(signed) *John Rennie.*

London, 27 May 1807.

DESCRIPTION of the PROPOSED LINE, as by Section, showing the several Lengths and Depths of Cutting.

	Lengths.	Bottom of Sewer, under the Surface of Pavement.
	Yards.	*Ft.* *In.*
North end of Baker-street	- -	12 0
From thence to Dorset-street	335	13 0
„ to South end of Baker-street	407	20 9
„ to Oxford-street, end of Orchard-street	353	25 0
„ to end of James-street	275	17 6
„ to North end of Davies-street	60½	19 6
„ to Chandler-street	88	17 0
„ to Brook-street	143	20 0
„ to Grosvenor-street	137	26 6
„ to Berkeley-street	187	28 0
„ to Berkeley-square, end of Davies-street	363	15 0
„ to Berkeley-square, North end of Berkeley-street	319	29 6
„ to Piccadilly, South end of Berkeley-street	137½	33 0
„ to North end of St. James's-street	71½	25 0
„ to West end of Jermyn-street	280	30 0
„ to North end of York-street	104½	17 0
„ to North side of St. James's-square	71½	16 9
„ to West end of Charles-street	264	24 9
„ to the Haymarket	121	20 0
„ to Cockspur-street	159	18 0
„ to Charing Cross	104½	20 0
„ to North end of Northumberland-street	93½	24 0
From Northumberland-street to the River	264	9 8
TOTAL to the River	4,338½	

A REPORT

Appendix VIII.

Information on former Conditien of Local Drainage.

Reports by John Rennie, Esq., C. E.

B.

A REPORT presented on the 18th of March 1808, to the Commissioners of Sewers for the City and Liberty of *Westminster*, and part of the County of *Middlesex*, respecting a different Plan for the Improvement of that District now drained by King's Scholars' Pond Sewer, from that recommended in a Report of the 27th of May, pursuant to a Resolution of the Court, dated the 21st of August 1807. By *John Rennie*, Civil Engineer.

Gentlemen,

IN the Report I presented to you on the 27th of May last, I described the different plans that had been proposed for your consideration, and submitted to me, for the purpose of improving the sewers in your district, which is now drained by King's Scholars' Pond sewer, and described a line for a new sewer, which, under all the circumstances of the case, appeared to me the most advisable to be adopted.

Objections having, however, been made to the plan proposed by me, on account of the expense that it would probably cost, on account of the interruption that would probably be given to the intercourse in some of the streets through which it would pass, and on account of the inconvenience that the inhabitants would experience while the work was in hand, you have been pleased, by your Resolution of the 20th of August last, to request my attention again to this very important subject; and I have had submitted to my consideration another plan for effecting the object in question, at a less expense, and with, it is said, less inconvenience to the inhabitants than would have been experienced had the line I proposed been carried into execution. Engagements of a public nature, which could not be set aside, and absence from London, have hitherto prevented me from reporting on this new proposal; I shall now, however, state what occurs to me on that subject, with my opinion, and leave the decision to you.

The new plan is proposed to be done in the following manner, namely, to remove the breakwaters and contractions in the present sewer south of Oxford-street, and in various places near to Berkeley-square, and to make a new sewer from it in Bruton-street to near Shepherd's Market, passing along Bruton-street, Berkeley-square, Charles-street, Queen-street, and under the gateway at Shepherd's Market, and from thence to pass along Half-moon-street (but not to communicate with the present sewer there), cross Piccadilly and through the Green Park, either in the course of the present sewer, or a new one to be made, as shall be deemed most advisable; from the bottom of which it is proposed to follow the most direct line to the River Thames at the Horseferry-road.

Since the above proposal was made another view has been taken of the ground and present line of sewer north of Bruton-street, and it has been judged more advisable, in consequence of the old sewer being in many places in bad repair, and in others passing under houses and along narrow streets, to make a new line of sewer from the old line in Oxford-street, and passing along Davies-street to Berkeley-square, there to join the line above described; thus the principal difference between this plan and the one that I have proposed, will lie between Berkeley-square and the river Thames, this line being proposed to enter the Thames at the Horseferry-road and that proposed by me at the bottom of Northumberland-street.

The total fall that could conveniently be given to a sewer between the north end of Baker-street and the south side of Berkeley-square, is 41 feet; from thence to the River Thames at the bottom of Northumberland-street, at the level of half-flood, there will be 35½ feet; the fall from south side of Berkeley-square to half flood at the Horseferry-road, will not be correctly, though nearly the same as the other, the difference is scarcely worth noticing; I will therefore call it the same.

The distance between the north end of Berkeley-street and the Thames at the bottom of Northumberland-street, is 1,991 yards; if the fall is made regular, this will give a little more fall than 2-10ths of an inch in a yard; to obtain this regular fall, however, the sewer must be laid in some places deeper than what is necessary for the mere covering of it and drainage of the houses, but the fall may be varied, and still leave a sufficiency of depth of covering for the sewer and fall to drain the houses; and this could be done without any material disadvantage, as stated in my former report, and thereby a considerable sum of money, as well as time, in the execution would be saved. On the whole, however, I prefer its being made with a regular declivity.

The distance between the north end of Berkeley-street and the River Thames at Millbank, in the line of the Horseferry-road, is 2,894 yards, of which 1,804 from the Thames is level; but as the spring tides rise higher than the general height of the ground in this line, as far up as 1,804 yards, the top of the sewer must be made considerably under the level of high water, or the ground must be raised; into this level sewer the other must come; the length is 1,090 yards, and the fall 35½ feet, which is nearly 4-10ths of an inch to a yard, *i. e.* little short of double the fall that is in the line recommended by me, and to obtain this regular fall, in order to lessen the velocity of the water in the sewer as much as possible where it enters the level sewer by Buckingham House, it will occasion a great quantity of deep cutting in Berkeley-square and Charles-street, the latter not less than 28 feet; the declination of the sewer may, however, be lessened so as to save part of this deep cutting, if so, the declination must be lessened between Bruton-street and Piccadilly, and increased from thence to Buckingham House, so that by this plan the fall from Piccadilly to its junction with the level sewer will be about half an inch in a yard. Now should it ever happen in the course of things, that a great and sudden fall of rain takes place while a great spring tide is making and near to its height, the quantity of water that will come down suddenly

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Reports by John Rennie, Esq., C. E.

from above, will, before it puts such a body of water in motion as will lie in the level part of the sewer above described, infallibly blow it up, unless some means are devised to prevent it, *i. e.* to give vent to the water from above until either that in the level sewer is put in motion, or until the tide has ebbed to a certain extent. Now this might be done by making an opening out of the sewer about Buckingham Gate at the height of spring tides, and allowing the surplus water to vent itself into the present sewer, so as to ease the sewer along the Horseferry-road, and prevent the accident I have mentioned. I am, however, of opinion, that it would be better to make a new sewer along Davies-street, Berkeley-square, Charles-street, Queen-street, Shepherd's Market, and to join the old sewer below Piccadilly, and so on by this sewer to near Buckingham House, and by a new sewer to pass along Stafford-row, Queen's Wards and Duke's-row, to a little beyond the head of Brewer-street, and from thence in a straight line to King's Scholars' Pond sewer, below the steam-engine belonging to the Chelsea Waterworks Company, and from the junction of this new proposed sewer with King's Scholars' Pond sewer to the Thames. This old sewer must, however, be scoured out, straightened and embanked so high as to be above the highest level of spring tides by at least two feet, and its sides may either be laid in a flat slope, and secured with chalk and gravel, so as to prevent the torrents from cutting it, or a brick wall may be built on each side to answer the purpose. If this work is properly done, no material inconvenience can arise from the rapidity with which the water will come from the higher ground, as it will always find a vent in the open part of the sewer until the tide subsides, but there will be a considerable deposition of mud and soil in it, which must be scoured out as required.

The low lands on each side will require to have trunks laid under the banks with valves on them to admit of their being drained as the water in the main sewer subsides, and the doors on the main sewer should be made to open like the gates of a lock, and pointing to the Thames; these will work of themselves, without occasioning the obstruction that is now experienced by the present ill-contrived valves.

Although I do not think the plan last described is so good as that recommended in my report of the 27th of May last, yet I think it only second to it; and therefore, should the objections against that plan be such as to render it ineligible, which I confess is not evident to me, I would advise this to be adopted.

I am, &c.
(signed) *John Rennie.*

Extracts from Report by Mr. Gwilt.

2. EXTRACTS from REPORT of *Joseph Gwilt*, Esq., one of the Surveyors to the Commissioners of Sewers for the District extending from *East Moulsey*, in *Surrey*, to the *Ravensbourne*, in *Kent*, dated 24 February 1843.

"My district, as you are well aware, consists of the whole of those parts of the parishes of Lambeth and Battersea, which are liable to the payment of sewer rates, and on occasions of importance, my attention has been called to the outlying districts beyond them, towards the Ember Branch of the Mole River."

"At the time I succeeded to the care of it, what was called Lambeth Marsh, being the district bounded by the parish of Christchurch, by the Westminster and Blackfriars Roads, and by the Thames, was chiefly garden ground, with here and there a few dwellings upon it. In the rainy season it was often covered with water, and in the winter several portions of it afforded the diversion of skating to thousands. The whole of what was then called St. George's Fields, was drained by the outlet of this district, and these fields were bounded on the south-east by Newington Causeway, on the west by St. George's-road, on the north and north-west by the parishes of Lambeth and Christchurch, and on the north-east by Great Suffolk-street, formerly called Dirty-lane. Excepting some parts of the public roads, the natural surface of every portion of this district was and still is under high-water mark, in some places as much as five feet."

"The ancient drainage of this tract of land was no other than an imperfect surface drainage, by means of an outlet, whose sill was considerably above low-water mark, so that the period of the time of drainage, and the depth to which it could be drained, were restricted within very narrow limits. The mode of cleansing, keeping open and repairing the banks of the sewers was at that time extremely defective; under the Act of Henry the Eighth, parties were presented to do certain works at courts which were held only eight times in the year, but if neglect of the owners and occupiers to do the works presented occurred in any part, the works done by other parties on the line became altogether useless and ineffective. While, however, the lands were used for agricultural and horticultural purposes, much was not thought of the floods and inconveniences to which they were subjected. The population, as may be collected from the above, was thin, the principal portion of it being seated on a line of street running from the foot of Blackfriars Bridge, in a direction nearly parallel with the Thames, to the foot of Westminster Bridge. Only a small relic of this street or road now remains, such being the south end of Pedlar's Acre."

* * * * * *

* * * * * *

"As soon as the 7th February 1811 it was resolved to rebuild the sluice just mentioned,† and

† The Dover Sluice drains Princes Meadow, Lambeth.

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Extracts from Report by Mr. Gwilt.

and it was thereon forthwith erected under my superintendence. The area of the old sluice was 7 feet, that of the new one thirteen feet five inches, nearly therefore double the former. The sill of it was laid down nearly to low-water mark, very much at that time to the fear and against the remonstrances of persons even acquainted with what on the Thames were considered the true principles of drainage. I think I may refer to this work with some satisfaction, inasmuch as the proof of its success is, that on land, then very frequently under water, there now stand all the new buildings comprising Upper Stamford-street, those of the Commercial-road, and of the several streets adjacent to them.

* * * * * *

* * * * * *

"On the 19th April 1816 the Commissioners came to the resolution of rebuilding Arnold, the sluice next above Dover Sluice, already mentioned. The district drained by this sluice extends southward from the Dover district, occupying a very large tract of land, which comprises what is now York-road, and the lands east, west, and south of it for a very considerable distance, the palace of the Archbishop of Canterbury being therein situated. At that time very few buildings, and those but of little importance, stood upon it. It was swampy, and not much better than the Dover level, before described. The sill of the old sluice was four feet two inches above low water, ordinary springs; its area was literally only three feet one inch superficial. The new sluice was lowered four feet two inches, that is, to low-water mark, and the area of it was increased to sixteen feet seven inches superficial, being five times and a half greater than the old one."

"New sewers, as in the Dover level, being led up from this improved outlet, that which was unwholesome marsh ground has been covered with good buildings, as the west side of the Waterloo Bridge-road, the York-road, and the numerous branch streets therefrom sufficiently testify. By it was also obtained the power of draining the Westminster Bridge-road and parts adjacent, which, from its first formation on the building of Westminster Bridge until a few years ago, had no drainage whatever, and that because the Commissioners of Sewers, as I have heretofore mentioned, had not the power to make new sewers. This sluice, by its increased dimensions, has afforded the means of receiving much more drainage than originally and naturally belonged to the level, and such has been gradually introduced upon it from year to year."

"On the 23d July 1819, another most important work was committed to my charge, namely, the more effectual drainage of the tract of country called Battersea Fields. This, as has been hereinbefore stated, was in every rainy season for weeks under water; the consequence whereof was great injury to the crops, no less than to the health of the inhabitants on its borders. The level of the old sluice was two feet above low water, ordinary springs, and its area only twelve feet four inches superficial. The general surface of the land in this district is from seven to ten feet *under* high-water mark, and it is now brought into such a state as to be capable of becoming, and it doubtless within a few years will become, building ground. Indeed, since its drainage, a church and many other buildings have been erected on it, which theretofore could not have been prudently done."

"This new drainage was effected by a pair of folding gates pointed to the river, and capable of discharging a column of water twelve times greater than that which passed through the old sluice. The sill of these gates was lowered two feet, that is, down to low-water mark."

Extracts from Report by Mr. I'Anson.

3. EXTRACTS from REPORT of *Edward I'Anson*, Esq., one of the Surveyors to the Commissioners of Sewers for the District extending from *East Moulsey*, in *Surrey*, to the *Ravensbourne*, in *Kent*, dated 23 February 1843.

"As a general fact, then, it is to be borne in mind that a very large portion of the district now under consideration lies below Trinity high-water mark, and were it not for the maintenance of the banks of the Thames at their present elevation (one of the duties of this Commission), scarcely a year would pass but, on the occasion of extraordinary high tides nearly the whole of the district would be submerged. It is doubtless in the recollection of most of the Commissioners, when, besides the floods which, at the time of high tides and heavy rains, spread over the low lands of Lambeth and Rotherhithe, the district southward of the New Kent Road was frequently under water. So important is the full consideration of this part of the subject, that, in corroboration of the above-stated general facts, the following Table is subjoined, showing the actual levels of the surface at the present time at various points, in reference to the Trinity high-water mark:

		FT.	IN.
"High-street, Borough, and Tooley-street -	above T.H.W. mark -	3	0
Obelisk, Blackfriars-road (an artificial mound) - - - - -		4	0
Great Union-street - - - - -	below T.H.W. mark -	3	1
Borough-road - - - - - -	ditto - 1 ft. 6 in. to	1	11

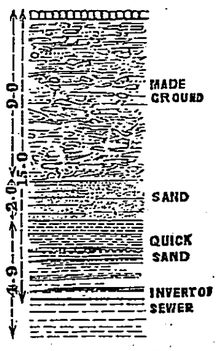
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Extracts from Report by Mr. I'Anson.

		FT.	IN.
Cross-street, near the Elephant and Castle	below T.H.W. mark	2	1
Walworth-road and Market-street	ditto	1 ft. to 1	9
Southwark Bridge-road	ditto	1	9
New Kent-road	ditto	5	0
Swan-street, Old Kent-road	ditto	6	0
Bermondsey New road	ditto	5	0

"The most elevated points of the surface are those along the old lines of road, the High-street, Borough, and Kent-street, the ancient highways into Kent and Surrey. In these the great thickness of made ground, the accumulation of ages, has given an artificial elevation to the surface, averaging about three feet above the Trinity high-water mark, or nearly on a level with the occasional highest tides. The same observation applies to the ancient parts of Southwark, but the thickness of the made ground, southward, westward, and more especially south-eastward, of the above-named localities is much less, (see the sections at the side), and the surface continues to decline until it reaches the base of the Surrey Hills."

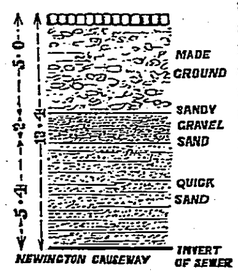


OPPOSITE UNION HALL UNION STREET.

"Such then are the general features of the district, and I now proceed to bring to your recollection the ancient nature of its sewage.

"Many of the watercourses seem to have been originally formed for tide mill-ponds. Documentary evidence exists to prove this, and it is still manifest in some of the names borne by the old sewers, such as the Pudding Mill Sewer, and Battle Bridge Mill Sewer. These mill-ponds were not unfrequently banked up above the level of the surrounding land, to such an extent that the surface drainage was carried off by culverts passing under them. In ancient times, a large portion of the Southwark district was occupied by monastic establishments, and branches were carried in all directions from these mill-ponds, for their supply of water. In later times, when manufactories requiring water were established, and numerous houses built on their banks, the ancient streams, polluted by the refuse they received, became, together with the ancient sewers laid to a somewhat lower level, the only sewage of the district.





"These facts, which were alluded to by Smeaton, in one of his reports, are adduced in order to illustrate two points peculiar to the country drained by this Commission. First, that the ancient sewers were mere surface drains; which is further confirmed by the fact that, about the year 1812, the sewage of one entire parish was still unprotected by any valve or penstock; and in the neighbourhood of Bankside, when the more careful system of preventing the influx of the tide was first systematically established, serious complaints were made that the accustomed and necessary supply of river-water was cut off from the manufacturers, through whose establishments the sewers flowed; and second, to show the reason of the very tortuous course of the old sewers, through private property, the buildings of which in many cases are still over them.

"Such was the sewage the Commissioners had to deal with, when it became a question, early in the present century, as to the best means of improving the more distant and inland parts of their district, and it was soon evident, from the sewers being mere surface drains, and much intermixed with private property, that insurmountable difficulties attended any thorough reformation of the then existing system.

"The Commissioners, therefore, at once adopted an extended and liberal view of the subject, and as soon as it was deemed expedient for the general benefit of the district within the limits of their commission, to introduce an improved system of drainage, application was made to Parliament, and extended powers procured, which led to the present improvements, forming the epoch from which the modern labours of this Commission are to be dated."

APPENDIX IX.

Appendix IX.

Special Points in Mr. Bazalgette's Plan, &c.

INFORMATION upon special Points in Mr. *Bazalgette*'s PLAN, and OBSERVATIONS upon the Expediency of uniting the Drainage of the Marsh Lands near the *Thames* with that of the Metropolis.

Statements of Committee from Towns on the banks of the River.

1. STATEMENTS of the Committee appointed to oppose SCHEMES involving Outfalls into the *Thames*, likely to be prejudicial to the Towns on the Banks of the River.

(1.)

Letter, &c. from Messrs. Smith and Southgate.

* LETTER from Messrs. *Smith* and *Southgate*, with Enclosure.

24 February 1857.

Gentlemen,

HEREWITH we beg to transmit to you, by direction of the committee appointed at a public meeting, held on the 29th December last, a statement of objections and remarks as to the mode of dealing with the metropolitan sewage, and shall be ready, on an intimation from you to that effect, to wait upon you to offer any explanations that may be thought necessary with reference thereto, and also to procure, if requisite, the attendance of persons to substantiate the facts therein alleged; and as you may prefer applying to the parties themselves direct, instead of through us, we beg to inform you, that in addition to ourselves, the following persons will, on application, be prepared to afford you information upon the several points affecting the question as connected with their respective localities, viz.:—

At Erith: Mr. Parish, agent for the Wheatley estate; Mr. Dyball, agent to Sir Culling Eardley, bart.; Mr. Charles Bendle, churchwarden; Mr. Lewis, pilot.

At Gravesend: William Fletcher, esq., the mayor of Gravesend; Mr. Ferguson, pilot; Mr. Brownfield, pilot.

We are, &c.

(signed) *Charles Augustin Smith*, of Croom's Hill, Greenwich.
Francis Southgate, of Gravesend.

The Referees on the
Metropolitan Drainage Question,
29, Great George-street.

(Enclosure in above Letter.)

METROPOLIS DRAINAGE SCHEME.

REMARKS to be submitted to the Government Referees.

1. THE new plan (B*) fixes the reservoirs and outfalls in Erith Reach, seven-eighths of a mile above Erith Church, about one mile and a half below the last rejected outfall at B., and not quite two miles and a half below the eastern boundary of the Metropolis, on the south side of the river.

2. It is proposed to discharge the sewage into the river at one hour and a half before high water at the point B*, from whence it will, at certain times in the year, be floated upwards with the tide 3 ¾ miles at springs, and 3 miles at neaps, thus passing within the Metropolitan area towards the extended Government works at the Royal Arsenal in Plumstead.

3. As the tide ebbs, this sewage matter will be deposited upon the Marsh Forelands, and sloping shores between Plumstead and Erith, and still more in the bay where Erith stands, as from the sudden indentation of the land there, the eddies of the stream form continual deposits of river filth. This deposit will extend as far as the town of Gravesend, and affect the shores of the Essex as well as the Kent side of the river.

4. In addition to the outflow of sewage for 4 ½ hours out of every 12, the continuous stream of filth from London will pour into the reservoirs, and remain stored there for nearly 8 hours out of every 12; the reservoirs being calculated to contain 1,000,000 and 3,000,000 of cubic feet of matter on the south and north sides of the river respectively.

5. The exhalations from these reservoirs and outfalls in constant agitation must be most offensive and injurious to the health of the neighbourhood, and with an easterly wind will be wafted back to the metropolis.

Appendix IX.

Special Points in Mr. Bazalgette's Plan, &c.

Statements of Committee from Towns on the banks of the River.

6. Erith Bay, particularly a point called Church Hole, just opposite the church, is a favourite anchorage for shipping; many colliers, fishing vessels, and other native and foreign shipping, and from 20 to 40 vessels per diem, for ballasting purposes, anchor there. The proposed outflow of filth under the hulls of these vessels will affect the health of the crews, and lead to quarantine restrictions in foreign ports.

7. The deposits from these outfalls will also create shoals and banks in the river, and thereby tend to impede the navigation: a reference to the reports made by the harbour master to the Navigation Committee will establish this statement.

8. Many residents at Erith, and the several towns on the banks of the river, are London merchants, and this plan will merely relieve their counting-houses in the City at the expense of their family mansions in the country, engaged for the express advantage of pure country air.

9. From the experiments made under the orders of the Metropolitan Board of Works, it appears that the rate of downward progress of substances floating backwards and forwards with the tide being from five to seven miles in 14 days, the discharge from the proposed outfalls at Erith will not only affect that locality, but all places on the banks of the Thames lower down: Greenhithe, Northfleet, and Gravesend, on the south, and the several places opposite on the north side of the river.

10. That as to the sewage discharge at the lowest point suggested in the Report of the Surveyor to the Metropolitan Board of Works, (marked D.) in Sea Reach, there is a continuous flat on the Essex shore, called Mucking Flats, and from the evidence of experienced river pilots, it appears that the ebb tide sets in from the Lower Hope into the bite at Mucking, being the point D. in Sea Reach, the effect of which will be to cause the deposit of the sewage matter on Mucking Flats before being carried away by the tide.

11. In no situation ought the sluices to be open until the tide had ebbed about two feet, whereby all floating upwards of the filth discharged would be avoided; and if the sewage were under any circumstances discharged sooner than an hour after high water, it would be carried back up the river by the flood tide.

12. That from the deposits at the suggested outfall at D. in Sea Reach, very great noxious effluvia will more or less at all times arise, and that with an easterly wind the noxious vapours will be taken directly to the town of Gravesend, containing a population, residentiary and fleeting at many times in the year, amounting to at least 30,000.

13. That from such a known fact (and the impression on the public mind generally going beyond it), the resort to Gravesend by the inhabitants of London will cease, or be greatly diminished, and the vast amount of property invested in providing for such resort will be wholly destroyed.

14. That the fish for the supply of the metropolis are brought into the Thames, and are there for some days in vessels having wells, into which the water of the Thames affected by the discharged filth will flow, and that the fish (from the pure sea-water) will be thereby destroyed in great numbers.

15. That the smaller sort of fish now caught in the Thames will by the contamination of the water be destroyed or driven away, to the vast injury of a very numerous body of fishermen.

16. That London and its connecting establishments have been for many years, and are now extending down the river on the south side to Gravesend, and that the plan of the discharge of the Metropolitan sewage should comprehend such anticipated increase.

17. That in respect of any contribution to the cost of any extended works from the property through which the main drain (if extended beyond Erith) may pass, it is manifestly unjust to transfer an admitted London nuisance to any other locality, and it is also unjust that any property should be taxed or charged for the carrying of the filth of London through any district in which such property is situate, and from which the locality will derive no corresponding benefit

18. The metropolis ought, perhaps, to be at every expense of ridding itself of its filth without injury to others, but if it should be thought right to confine such expense to the cost of the work to the extent of the Metropolitan boundary only, the additional cost of extending the outfall beyond that point, for effecting the national object of the complete purification of the River Thames, should be paid out of the national funds.

By Order of the Committee,

Charles Augustin Smith, of Greenwich, } Joint
Francis Southgate, of Gravesend, } Secretaries.

February 1857.

MINUTES

Appendix IX.

Special Points in Mr. Bazalgette's Plan, &c.

Statements of Committee from Towns on the banks of the River.

Minutes of Conference at Gravesend.

(2.)

MINUTES of CONFERENCE of the Referees with the *Gravesend* Improvement Commission.

The Referees attended a Meeting of the Committee of The Corporation of Gravesend, and of The Gravesend Improvement Commissioners on the Metropolitan Sewage Discharge, at which were present, the Mayor, Medhurst Troughton, Esq., Chairman of Improvement Commissioners; Mr. Alderman Ditchburn, Mr. Gould, Mr. Plane, Mr. Ferguson.

THE following information was communicated to them by the Committee (namely),

That the population of the Town of Gravesend was, at the taking of the last census in 1851, 16,663.

That there has been an annual increase since, and the population may be now estimated at near 20,000.

That in addition to the above-mentioned residentiary population, there is a continued resort of visitors from the Metropolis, for short periods during five or six months from April in each year, amounting to at least 1,000,000 of persons.

That the population of the adjoining parish of Northfleet has annually increased for years past, and has now a residentiary population of at least 5,000, with a daily continued resort by visitors to the extent of several thousand persons to the Rosherville Gardens, throughout what is termed the season, a period of four or five months in the year.

That the number of houses in the Town of Gravesend was, in 1851, 3166. And there having been an annual addition thereto, the present number of houses may be estimated at about 4,000.

That from the great quantity of land not only at Gravesend, but also at Northfleet and Rosherville, set apart for building purposes, there will, no doubt, be a considerable increase in the number of houses in the locality for several years to come.

The attention of the Referees was also drawn to the other facts and circumstances embraced in the remarks submitted to them by direction of the Commissioners in February last, and the Mayor and Mr. Ferguson respectively afforded information thereon, and on points immediately relating to the ebbing and flowing of the tide, and the deposits of filth on the banks, slopes and flats of the River Thames, and its prejudicial effects on the fish supplying the London market.

(3.)

LETTER from Sir *Culling Eardley*, Bart., urging Importance of Marsh Drainage.

Letter from Sir C. Eardley, Bart.

Gentlemen, Belvidere, Erith, June 8, 1857.

I TAKE the liberty of addressing you, as the Commissioners appointed by Sir Benjamin Hall to examine into the best mode of disposing of the sewage of the metropolis. In regard to that subject, I hope that the evidence, got up with considerable labour, and presented to you by the parties interested in the vicinity of the Thames, will induce you to recommend that neither Erith nor Gravesend, nor any intervening point, shall be the point of efflux for the London drainage.

I venture, however, to press upon you a collateral question. I venture to submit to you the great importance of not omitting, in your Report upon the London sewage, the great national object of the drainage of the marshes on both sides of the Thames, from London to the Nore.

If it is essential to the health of London to dispose of the sewage in the best and wisest manner, I submit that it is not less essential to the sanitary state of London (apart from the local evil to the line of country immediately affected), to cause a thorough drainage to be executed of the Thames marshes.

Your London drainage will not improbably be carried through these very marshes; and you will really not be "covering the ground" of the great question of the health of the metropolis, if you do not provide for the suburban, at the same time as the urban, object.

Of course the expense of the marsh drainage would devolve on the local owners and occupiers. All that is wanted is, that these should be forced to do the work by a public Act being passed, laying the charge on the right parties. It does seem to me that a more fitting occasion could not be taken than the publication of your Report, to insist upon such a measure being accomplished.

I will not enter into particulars, which are contained at full length in the accompanyin two documents, the substance of which I take the liberty of suggesting ought to be made public in connexion with your Report. One is the Report (with Evidence) from the Select Committee of the House of Commons on Thames Marshes, printed in July 1854; the other is a pamphlet containing letters from eminent London physicians, and from practitioners in Kent and Essex, on the same subject, procured by a committee from the two counties in 1854.

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It is enough to say, that under the effete and nearly useless Statute of Sewers (temp. Henry VIII.) no real improvement of the drainage of these marshes can be effected. No new works can thereby be legally made unless with the consent, in writing, of three-fourths of the owners and occupiers, which is a virtual bar to all improvement. This was the rough method of our ancestors for giving the public an influence upon public measures. At the same time they omitted the most effectual means, which would be to allow the administrators of a tax to be, in whole or in part, elected by the payers. Were this done (and it ought to be done), the cumbersome machinery of "consents" might be dispensed with; and thus, instead of having a body of Commissioners appointed by the Crown, who have a delicate feeling of unwillingness to tax parties with whom they are unconnected, there might be constituted a composite body, partly of Crown nominees, partly of elected Commissioners, who should administer the whole matter.

Without trespassing further on your time, I earnestly recommend the subject to your attention. I trust you will see your way to inform and guide public opinion in reference to it. It is an humiliating paradox that the valley of the Thames should in the nineteenth century be continuing to breed disease and to generate yellow fog in immediate proximity to the metropolis of England, two centuries after the remoter district of the Bedford Level has been expensively and successfully drained under the despised dynasty of the Stuarts!

I have, &c.
C. E. Eardley.

Captain Galton, R.E.
J. Simpson, Esq.
T. E. Blackwell, Esq.

(4.)

Evidence of a Deputation.

MINUTES of EVIDENCE given by a Deputation from the Committee appointed to oppose the Schemes of Metropolitan Drainage, involving Outfalls into the Thames likely to be injurious to the Towns on the Banks of the River.

Meeting of the Referees, 29, Great George-street, Tuesday, June 16.

The Deputation, consisting of:—Sir *C. Eardley*, Bart.; *William Fletcher*, Esq., Mayor of Gravesend; *G. Meeson*, Esq., of Grays, Essex; *F. Homfray*, Esq., Engineer; and *C. A. Smith*, Esq., Secretary, attended by appointment.

Sir C. Eardley handed in Messrs. Homfray (their Engineers'), Report.

MR. FLETCHER observed that he apprehended great damage to the fishing interests in the river, especially at Hole Haven, and the adjacent parts, where great numbers of the lobsters which come to the London market are temporarily deposited, if the sewage is turned out into the river, as proposed.

Mr. Meeson said that he was in favour of throwing the sewage into the river at Thames Haven, as the tide there impinges on the shore, thus preventing the return of the sewage, and also as the Thames Haven docks basins are already made.

In answer to a request from Sir C. Eardley, Mr. Simpson said that the Referees would undertake to append to the Report, though they could not pledge themselves to print, the plan prepared by Mr. Homfray.

Sir C. Eardley, in answer to Mr. Simpson, said that he agreed in thinking the Marsh drainage and that of the Metropolis should be kept entirely distinct, but thought the link of connexion between them was that defects in either had an equally prejudicial effect upon the health of people residing in the vicinity of London.

Sir C. Eardley said that all the most eminent physicians of London held that the disease to which people resident on the banks of the Thames, eastward of London, were unusually liable, viz., the ague, arose from the state of the marshes.

Sir C. Eardley was very anxious that the Referees should call attention in their Report to the above connexion between the drainage of London and that of the marshes; but did not call upon them to do more. Sir Culling thought the best plan would be for a separate commission of inquiry into the state of the marshes to be first appointed, to recommend the best mode of drainage to be adopted, the present authority of the Commissioners of Sewers being limited to the preservation of the river banks and the free course of the stream, and quite insufficient for the purposes of drainage and navigation, and suggested the appointment of a local Commission, one part of which might be elected, and the other nominated by the Crown.

With reference to the pollution of the Thames, Mr. Fletcher said that he thought the mode adopted at Gravesend, of making the chalky subsoil a medium of percolation for sewage, &c., should be insisted upon wherever the soil allowed of it.

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* *See* Appendix IX., Plate 1.

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Report by Mr. Homfray as to Tidal Experiments.

(5.)

REPORT of Mr. *Homfray* as to TIDAL EXPERIMENTS in the River *Thames.**

6, Cannon-row, Westminster,
8 June 1857.

Mr. Chairman and Gentlemen,

ACCORDING to the instructions I had the honour of receiving from you on the 30th of April and the 25th of May, to make a series of tidal observations at Erith, Kent; also some experiments to ascertain how far floating matter would be carried down by an ebb tide, and return with the flood, supposing it to be discharged into the river at the point named B*, in Mr. Bazalgette's last report to the Metropolitan Board of Works; I beg to lay before you the accompanying diagrams, the one showing the rise and fall of the tide from observations taken every ten minutes, day and night, from Tuesday May the 5th until Tuesday May 19th inclusive. The other shows, by tinted lines, the course taken by the floats during each Experiment, beginning with the one made on May the 11th (wind east); this tide was the third after the full moon, and is generally considered the highest spring tide; the float was placed in the centre of the river at high water 2·10 a.m., remaining stationary till 3·5 a.m., although the tide had fallen 13 inches at Erith Pier: upon starting, it kept the centre of the river until arriving opposite Erith Pier at 3·43 a.m., when it drew along the southern shore to Crayford-ness, thence taking the centre of the river, passing Dartford Creek at 4·26 a.m., the second measured mile staff at 5·13 a.m.; it then drew towards the southern shore, passing close to Greenhithe, rounding Broad-ness Point at 6·3 a.m., drifting towards Thurrock's Wharf, from thence down upon Northfleet, where it went ashore opposite Mr. Pitcher's Dockyard; it was lifted and placed in the centre of the river, and continued the same course, passing Gravesend Canal at 7·25 a.m., arriving within half-a-mile of Shorne Battery, where it became stationary at 8·50 a.m. It commenced returning by the flood tide at 9·3 a.m., keeping close to the southern shore, passed Gravesend Canal 10·16 a.m., driving ashore directly afterwards; between this and Rosherville Gardens, it was lifted three times and placed in the centre of the river, driving ashore each time; but upon getting west of the gardens, it made an uninterrupted course, passing the third measured mile staff at 12·15 p.m., the second at 12·40 p.m., and the first at 1·4 p.m.; it passed Erith pier at 1·40 p.m., driving ashore close to Erith Beacon; upon being lifted and placed in the current, it passed the spot at which it was put in at 2·20 p.m., and became stationary at 3·10 p.m., half a-mile further up the river than Dagenham Reach, and began to return by the ebb tide at 3·20 p.m. On the morning of May the 18th (wind S. W.), being low neap tides, the float was put in the river at the point B*, at high water, 7·40 a.m., it began to drift at 7·53 a.m., drawing towards the southern shore, and driving ashore just below the first ballast wharf at 9·40 a.m., the tide having fallen 3·35 feet at Erith Pier; it was lifted and placed in the centre of the river, drifting again towards the southern shore, it made Crayford-ness Point at 10·40 a.m., the first measured mile staff at 11·14 a.m., the second at 11·42 a.m., passing close to Stone-ness Point, it made Broad-ness Beacon at 12·42 p.m., afterwards drawing towards the northern shore, it floated thus on the Thurrock's wharf, where it drove ashore; upon being lifted and placed in the current, it continued its course as far as Tilbury-ness Point, where it became stationary at 3·24 p.m., it began to return by the flood tide at 3·35 p.m., keeping much the same course as it did on May the 11th, passing Broad-ness Point at 4·6 p.m., the second measured mile staff at 6·2 p.m., the first at 6·53 p.m., Crayford-ness at 7·25 p.m., Erith Pier at 8·34 p.m., where it remained stationary, being about a mile and a quarter below where it was put in in the morning.

On the morning of May the 26th, (wind S. W.) being spring tides, the float was placed in the river at the point B*, an hour and a half before high water, viz., 1·46 a.m., drawing towards the southern shore, it made the first magazine at 2·18 a.m., the Spa Works (or Glue Factory) at 2·28 a.m., the second magazine at 2·38 a.m., and the third at 2·42 a.m., reaching about 100 yards above the half-way house at 3·20 a.m., it remained stationary nearly ten minutes, beginning to return at 3·30 a.m., hanging the southern shore, passing the third magazine 3·57 a.m., the second 4·6 a.m., drifting ashore directly afterwards; it was lifted and placed in the centre of the river, and drew again towards the southern shore, passing the Spa Works at 4·16 a.m., the third magazine 4·25 a.m., point B* at 4.38 a.m.; then drifting over to Coldharbour Point, it passed Erith Pier at 5·2 a.m., keeping nearly a direct course to Crayford-ness; it passed the first measured mile staff at 5·27 a.m., the second 5·46 a.m., the third at 6·9 a.m., passing Greenhithe Pier 6·20 a.m., bearing up the southern shore, it drove ashore on the Black Shelf at 7·5 a.m. It being lifted and placed in the tidal current, it continued its course as far as Thurrock's wharf, passing it at 7·45 a.m., after which it drove ashore at Tilbury-ness Point at 8·10 a.m.; upon being again placed in the current, it took a direct course, passing Pitcher's dockyard at 8 25 a.m., the Gravesend Baths 8·50 a.m., Town Pier 8.58 a.m., Gravesend Canal 9·13 a.m., Denton's Mill 9·45 a.m.; here it became stationary, and began to return at 10·2 a.m.; drawing nearer the southern shore it passed Gravesend Canal at 10·23 a.m., Town Pier 10·42 a.m., the Gravesend Baths 10·51 a.m., Pitcher's dockyard 11·7 a.m., Broadness Point 11·45 a.m., drifting directly over to Stoneness Point, which it passed at 12·9 p.m., taking nearly the centre of the river it passed the third measured mile staff at 12·28 p.m., the second at 12·46 p.m., the first at 1·11 p.m., Erith Pier 1·45 p.m.; keeping close to Coldharbour Point, it made point B* at 2·5 p.m., first magazine 2.45 p.m., Spa Works 2·56 p.m., second magazine at 3.3 p.m., third

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* *See* also Report as to Experiments with Floats by the Referees, Appendix V., page 175.

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third magazine at 3·19 p.m., the Halfway House 3·46 p.m., Metropolitan boundary 3·51 p.m., and became stationary at 3·59 p.m. (about three-quarters of a mile from the halfway house), and began to return with the ebb tide immediately.

On the same day (May 26th) a float was placed in at the point B * two hours and three-quarters after high water, *i. e.* 5·35 a.m., keeping the centre of the river; it passed Erith pier at 5·54 a.m., then, drawing towards the southern shore, made Crayford-ness Point at 6·17 a.m., first measured mile staff 6·29 a.m., second 6·56 a.m., and the third 7·18 a.m.; driving towards Greenhithe, it passed close to the pier at 7·32 a.m., bearing up along the southern shore; it made Broad-ness Beacon 8·20 a.m., drifting across the river; it went ashore opposite Thurrock's wharf at 9·30 a.m. The float, upon being lifted and put into the centre of the river, drove down upon Northfleet, going ashore just below Mr. Pitcher's dockyard at 9·34 a.m.; it began to return with the flood-tide at 10 a.m., hanging the southern shore; it made Broad-ness Beacon 11·12 a.m.; Stone-ness Beacon 11·50 a.m.; third measured mile staff 11·59 a.m.; second at 12·20 p.m.; first at 12·42 p.m.; Crayford-ness 12·53 p.m.; Erith Pier 1·19 p.m.; point B * at 1·45 p.m.; hence it kept the middle of the river, passing the first magazine 2·6 p.m., Spa works 2 16 p.m., second magazine 2·26 p.m., third magazine 2·37 p.m., Halfway House 2·54 p.m., Metropolitan boundary 2·57 p.m., and became stationary at the upper end of Tripcock trees at four o'clock; it began to return at 4·5 p.m.

On the morning of June 2nd (wind east), being neap tides, the float was placed at the point B* at 8·34 a.m., being one hour and a half before high water; keeping nearly the centre of the river, it passed the first magazine 9 a.m., Spa works 9·23 a.m., second magazine 9·41 a.m., third 10·10 a.m., when it became stationary, not beginning to return until 10·18 a.m.; drawing towards the southern shore, it passed the second magazine 10·47 a.m., Spa works 11·8 a.m., third magazine 11·16 a.m., point B * 11·44 a.m., Erith pier 12·1 p.m., Crayford-ness Point 12·25 p.m.; bearing towards the northern shore, it passed the first measured mile staff 12·37 p.m., second 12·58 p.m., third 1·38 p.m., after which it drove ashore a quarter of a mile from Stone-ness; it was lifted and placed in the tidal current, passing Stone-ness Point at 2 0 p.m., then hanging Black Shelf, it drove ashore opposite Grays Thurrock at 3·42 p.m. Upon being placed in the centre of the river, it drifted opposite Botany Bay, where it became stationary at 4·10 p.m.; it began to return at 4·32 p.m., passing Broad-ness Beacon at 2·45 p. m., Stone-ness Point 5·57 p.m.; from here it kept nearly the same course as it had done on the ebb-tide, passing the third measured mile staff at 6·10 p.m., second at 7·12 p.m., the first at 7·54 p.m., Crayford-ness at 8·12 p.m., Erith Pier 9·11 p.m., point B* at 9·37 p.m., and became stationary at 10·6 p.m. opposite the Ferry-house.

On the same day (2d June) a float was placed in the centre of the river at the point B* two hours and three quarters after high water, *i. e.* 12·27 p. m., drawing towards the southern shore it passed Erith Pier at 12·53 p.m., keeping the same course, it passed Crayford-ness at 1·12 p.m., first measured mile staff 1·27 p.m., the second 1·54 p.m. the third at 2·26 p.m., passing close to Stone-ness Point at 2·48 p.m., it drove ashore nearly 500 yards below Stone-ness; upon being placed in the tidal current it drew towards the southern shore for some way, and then drifted over to the Black Shelf, where it went aground at 4·11 p.m.; upon being lifted and placed in the centre of the river it became stationary, and did not begin to return until 4·21 p.m.; between this and the buoys in Fidler's reach, used by ships whilst adjusting their compasses, it drove ashore three times, and passed Stone-ness at 5·57 p.m., third measured mile at 6·13 p.m., second 7·17 p.m., first at 7·53 p.m., continuing the same course till it reached the middle of Erith Rands, where it got ashore close to the brick-fields; upon being lifted and placed in the centre of the river it passed Erith Pier at 8·51 p.m., the point B* 9·26 p.m., and became stationary at 10·10 p.m., opposite Raynham Creek.

These experiments concluded the series I made from point B*.

Upon the following days, both at spring and neap tides, on which I had tried the drifts from Erith, I carried out the same experiments in Sea Reach, starting opposite the Hope Point Battery in each instance. The results are as follows:—

On the morning of May the 12th, it being spring tides, wind east, a float was placed in the centre of the river, opposite Hope Point Battery, at high water 2·53 a.m.; it began to drift at 3·35 a.m., passed the Blythe Buoy at 3·50 a.m., Thames Haven 4·25 a.m., Blythe Beacon 4·45 a.m., Chapman's Beacon 5·20 a.m., the River Middle Buoy 6·35 a.m., South-end Pier 7·25 a.m.; then taking a southerly direction for about a mile, it became stationary about three-quarters of a mile from the Knock Buoy at 8·37 a.m., at 8 56 a.m. the tide began to flow, driving the float on the Shoebury Sands, and to which it returned twice and remained, although lifted and placed in the current at least a mile from the shore.

On the morning of May 19th, wind east, being neap tides, the float was placed in the centre of the river, opposite the Hope Point Battery, at high water 9·25 a.m., it began to drift 9·43 a.m., passing the west Blythe Buoy at 10·20 a.m., Thames Haven 10·48 a.m., Blythe Beacon 11·16 a.m., Chapman Beacon 12·4 p.m., River Middle Buoy 2·27 p.m., and bearing southerly, it became stationary at 3 p.m.; with the flood tide it began to drift ashore on the Leigh Roads at 3·20 p.m.; it was lifted and placed in the current a mile from the shore; it returned again to the same spot, after remaining till 4·25 p.m. on the sands; it was taken out and placed at the Jenkin Buoy, and immediately drove ashore on Grain's Spit; again it was lifted and placed in the centre of the river, but it immediately drove ashore on Lobster Island.

On the morning of May the 27th, wind south-west, being spring tides, the float was placed

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placed in the centre of the river at 2·30 a. m., being an hour and a half before high water, it drifted back as far as Higham's Creek, and becoming stationary at 3·50 a. m.; at 4 a. m. it began to return with the ebb tide, going ashore close to Thames Haven Dock; at 4·50 a. m. it was lifted and placed in the centre of the river, passed Hope Point 4·54 a. m., Mucking Light 5·30 a.m., Thames Haven Railway Station 5·55 a.m., Shell Haven 6·45 a. m., Chapman Head 7·16 a. m., bearing southerly it passed Yantlet Buoy 7·47 a. m., and became stationary off Southend Pier 9·57 a. m., began to return at 10·2 a. m., Yantlet Buoy 12·4 p. m., Chapman Beacon 1·33 p. m., drifting directly afterwards on the sands; upon being lifted and placed in the tidal current it passed Scar House at 1·35 p. m., Hole Haven 2·15 p. m., where it went ashore; upon being placed again in the tidal current it went ashore at Thames Haven Dock at 3·5 p. m.; being again placed in the tidal current it only made Mucking Light at 4 p. m., when it began to return with the ebb tide 4·10 p. m.

On the same day, May 27th (wind S.W.), a float was placed in the river, opposite Hope Point Battery, at 5·56 a.m., two hours and three quarters after high water; it passed the West Blythe Buoy at 6·34 a.m., Thames Haven Dock 6·51 a.m., Shell Haven 7·7 a m., Hole Haven 7·29 a.m., Blythe Beacon 7·35 a.m., driving ashore opposite Scar House at 8·10 a.m. on the Chapman Sands; it was lifted and placed in the centre of the river, passed Chapman Beacon at 9·3 a.m., then, taking a southerly direction, became stationary opposite the village of Leigh at 9·50 a.m.; at 10·33 a.m. it began to return, passing Chapman Beacon at 11·12 a.m., drifting ashore at Deadman Point at 11·40 a.m.; upon being placed in the centre of the river it drove ashore again, opposite Scar House, at 12·5 p.m.; but being placed again in the centre of the river, it passed Blythe Beacon at 12·35 p.m., Shell Haven at 12·40 p.m., Thames Haven 1·2 p.m., West Blythe Buoy at 1·25 p.m., Hope Point Battery at 2·25 p.m., Cliffe Creek 3·50 p.m., becoming stationary at 4·10 p.m.; it began to return with the ebb tide.

On the morning of June the 3d (wind west), being neap tides, the float was placed in the centre of the river, opposite Hope Point Battery, at 8·45 a.m., being an hour and a half before high water; it passed Cliffe Creek at 9·30 a.m., and became stationary opposite Hyham Creek at 10·20 a.m.; at 10·26 a.m. it began to return, passing Cliffe Creek at 11·9 a.m., Hope Point Battery 11·47 a.m., Mucking Light 12·18 p.m., West Blythe Buoy 12·21 p.m., Thames Haven 12·42 p.m., Shell Haven 12·50 p.m., Hole Haven 10 p.m., Chapman Beacon 2·5 p.m., Lower Blythe Buoy 2·30 p.m., becoming stationary about a mile from the River Middle Buoy; at 4·28 p.m. it began to return, passing Chapman Beacon at 7·41 p.m., and drifting towards the sands at 8·25 p.m., at which time it was taken up.

On the same morning (June 3d), at two hours and three quarters after high water, a float was placed in the centre of the river, opposite Hope Point Battery, at 12·35 p.m.; it passed Mucking Light at 12·59 p.m., West Blythe Buoy at 1 p.m., Thames Haven 1·23 p.m., Shell Haven 1·49 p.m., Hole Haven 2·13 p.m., drifting opposite Scar House 2·58 p.m.; upon being placed in the centre of the river it drove again on Chapman Sands, opposite Loven's farm; at 3·30 p.m. it was again placed in the centre of the river, and traversed between here and Scar House till 6·47 p.m., when it drove ashore on the Blythe Sands; upon being placed in the centre of the river it began to return, passing Blythe Beacon at 7·25 p.m., Shell Haven 7.54 p.m., Thames Haven 8·5 p.m., West Blythe Buoy 8·32 p m., Mucking Light 8·39 p.m.; here it was taken up on account of the weather looking stormy as well as night coming on. This experiment concluded the series made from the Hope Point.

From the foregoing experiments, assuming that the discharge of sewage is to be at the side of the river, the conclusion must not be drawn that the whole of the sewage, if delivered at B* will necessarily follow any one of the courses taken by the floats, inasmuch as the sewage being discharged into the edge, whilst the floats were placed in the centre of the river. But I consider that the experiments still show, with considerable accuracy, the general line which the sewage respectively discharged from each side of the river will take.

A great portion of the sewage, if delivered as intended, will be received between the points B* and the ballast wharfs; and as between these points the water is almost stagnant, a great deposit must take place on the mud banks, which extend along the southern shore as far as Crayford-ness, and in some states of tide expose a width of nearly 300 yards just opposite to Erith. At the present time these banks yield exhalations which are very offensive to the inhabitants, and, with the addition of the sewage deposit, would become highly detrimental to their health and that of the neighbourhood. The experiments tend to show, as for a given number of days, Mr. Bazalgette will be obliged to discharge his reservoirs one hour and a half before high water, that the portion first discharged at spring tides will drift into the metropolitan district, and upon meeting the ebb tide will be dispersed and driven on the banks of either side of the river, upon which the sewage deposit will remain, and only a portion will be carried past the spot at which it had been discharged. Again, at spring tides some portion of the sewage last discharged from the reservoir will not only be found just within the metropolitan district, but actually as far as Gallion's Reach, within one and a half miles of Woolwich, and being brought back by the flood tide succeeding the ebb during which it was discharged. At neap tides a portion of sewage last discharged will in a similar way find its way up the river as far as Tripcock Trees. By taking the general course of the floats, it will be seen that the tide will drift and deposit the sewage matter for the most part upon the banks of Greenhithe, Grays, Northfleet, and Gravesend, more especially upon the banks of the latter from the quantity of slack water caused by its piers. It must be remembered that the sewage is to be discharged twice every twenty-four hours to the aggregate amount of 9,000,000 cubic feet, and that the slow progress which matter held in suspension works down the river shows clearly that the river would in a short

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short time become so filled with sewage matter between Woolwich and Gravesend, as to make it in as bad a state, if not worse, than it is at the present time between the bridges, and be far from affording the benefit so large an undertaking ought to produce.

I have, &c.,

Fredk. S. Homfray, A.I.C.E.

To the Chairman and gentlemen of the Committee appointed to oppose the schemes of Metropolitan Drainage involving outfalls into the Thames likely to be injurious to the towns on the banks of the River.

(6.)

LETTER from Mr. *Smith*, sending a Summary of the Results of Mr. *Homfray*'s Tidal Experiments.

Sir, Croom's Hill, Greenwich, S. E., 20 June 1857.

Letter from Mr. Smith.

HEREWITH I beg to transmit you the report of Mr. Homfray, the engineer, as to the recent tidal experiments made by him, by order of the committee, in the River Thames below Erith, the drawings and diagrams in connexion with which have already been handed to you.

I also forward enclosed a tabular statement of the experiments as regards the course of floating substances in the river, from which it will be seen that matters discharged into the Thames at the proposed point of outfall of the metropolis sewer at point B*, off Erith, will, under certain circumstances of tide, find their way up the river into Galleon's Reach, near the military establishments in Plumstead, such point being more than a mile above and within the eastern boundary of the metropolitan area, as defined by the Metropolis Local Management Act.

I would further remark, that the year mentioned by Mr. Bazalgette with reference to the number of days without rainfall, was remarkable for its unusual dryness and absence of rain, and that if the average were taken from the Registrar-general's reports for several years, the proportion of rainy days would be increased.

In connexion with this subject, I would beg to draw the attention of the Referees to the report† made by Dr. Letheby, the medical officer of the city of London, in the autumn of last year, as to the probable effect upon the health of the inhabitants of the metropolis of the discharge of the metropolitan sewage into the river as proposed at the point B*, near Erith Church.

I am, &c.

H. C. Saunders, Esq., (signed) *Chas. Aug. Smith.*
Secretary to the Referees on Metropolitan Drainage.

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† Extract from Report by Dr. Letheby.—"Without doubt some plan should be adopted which will effectually and for ever remove from it the sewage which now saturates the soil and pollutes the river. I do not pretend to offer an opinion on the locality which should be chosen for the outlet of so vast a quantity of decomposing organic matter, but I do say that it should be a very distant one, for whether the powers of chemistry may hereafter come to our aid in deciding on the economic use of this material, or whether it is to be let loose into the ocean, is a thing which defies our skill in usefully appropriating it; in either case it must be manifest that the locality for its outlet should be as distant as possible from the metropolis; for in the one case we must avoid the tidal flux and reflux of *a very sea of putrefying matter*, and in the other we must guard against the noxious emanations which will assuredly accompany any chemical manipulation of it. On these points, therefore, I speak emphatically, because I know that there is a tendency, from economical motives, to adopt measures of a somewhat temporising and expedient quality, measures which will be characterised hereafter as *expensive and elaborate disguises of a nuisance that is still untouched*. Eloquently, and with truth, has Mr. Simon described the pernicious effects of these sewage miasms, and has told you that 'from the *polluted bosom of the river there steams up incessantly, though unseen, the vapour of a retributive poison*; densest and most destructive, no doubt, along the sodden banks and stinking sewers of lowest level; but spreading over miles of land, sometimes rolled high by wind, sometimes blended low with mist, and baneful even to their margin, that curls over distant fields; for not alone in Rotherhithe and Newington, not alone along the Effra or the Fleet, are traced the evils of this great miasm. The deepest shadows of the cloud lie here, but its outskirts darken the distance. A fever hardly to be accounted for, an infantile sickness of undue malignity, a doctor's injunction for change of air, may at times suggest to the dweller in our healthiest suburbs that, while draining his refuse into the Thames, he receives for requital some partial workings of the *gigantic poison-bed* which he has contributed to maintain.' This and perhaps more is what we may continue to expect as long as, with perverse ingenuity, we labour to construct poison-beds for the development of disease. By nature we are excellently well situated for the maintenance of health, and the river which flows through our city should be the channel for pure water and a free current of air, the source of life to us, and not of death. We should watch jealously, therefore, over its purity, and permit no motives, economical or expedient, to futilise the favours of nature."

(7.)

SUMMARY of Mr. *Homfray*'s Report as to the Course taken by the Float placed in the Tidal Current of the Thames.
First at Point B* of Mr. *Bazalgette*'s Report.

1857.	Tide.	Wind.	Starting Point.	Time of Starting.	State of Tide.	Point of Stopping down River.	Time of Stopping with Flood.	Return on Flood.
				H. M.			H. M.	
May 11 -	Spring	East -	B* of Mr. Bazalgette's Report.	2. 10 a. m. -	High water	Half a mile above Shorne Battery.	3. 10 p. m.	
,, 18 -	Neap -	S. W.	Ditto -	7. 40 a. m. -	High water	Tilbury Ness Point -	8. 34 p. m.	
,, 26 -	Spring	East -	Ditto -	5. 35 a. m. -	2¾ h. after high water.	Below Pitcher's-yard, Northfleet.	4. 0 p. m.	
June 2 -	Neap -	East -	Ditto -	12. 27 p. m. -	Ditto -	Black Shelf - -	10. 10 p. m.	
						Point of Stopping up the River.		
May 26 -	Spring	S. W.	Ditto -	1. 46 a. m. -	1¼ h. before high water.	To 100 yards above the Halfway-house.	9. 45 a. m. -	1¾ miles above Halfway-house, and above B*.
June 2 -	Neap -	East -	Ditto -	8. 34 a. m. -	Ditto -	To 3d Magazine -	4. 10 p. m. -	Opposite Ferry-house, and opposite B*.

Secondly at Hope Point Battery.

1857.	Tide.	Wind.	Starting Point.	Time of Starting.	State of Tide.	Point of Stopping up River.	Time of Stopping with Ebb.	Return on Flood.
				H. M.			H. M.	
May 27 -	Spring	S. W.	Hope Point Battery.	2. 30 a. m. -	1¼ hour before high water.	Higham Creek - -	9. 57 a. m. -	Began to return at 10.2 a. m., and reached Mucking Light at 4 p. m., when it began to return with ebb tide.
June 3 -	Neap -	East -	Ditto -	8. 45 a. m. -	Ditto -	Higham Creek - -	4. 28 p. m. -	Went towards sands at 8. 25 p. m.
						Point of Stopping down River.		
May 12 -	Spring	East -	Ditto -	3. 35 a. m. -	High water	¾ of mile from Knock Buoy.	Although lifted twice, and placed in the current a mile from shore. 4. 25 p. m.	
,, 19 -	Neap -	East -	Ditto -	9. 43 a. m. -	Ditto -	Hope Point Battery -		
,, 27 -	Spring	S. W.	Ditto -	5. 50 a. m. -	2¾ hours after high water.	Opposite village of Leigh.	3. 50 p. m.	
June 3 -	Neap -	East -	Ditto -	12. 35 p. m. -	Ditto -	On shore at Blythe Sands.	8. 39 p. m.	

1857.	Tide.	Wind.	Starting Point.	Time of Starting.	State of Tide.	Point of Stopping down River.	Time of Stopping with Flood.	Return on Flood.
				H. M.			H. M.	
May 27 -	Spring	S. W.	Hope Point Battery.	3. 50 a. m. -	1¼ hour before high water.	Southend Pier - - - - -	10. 10 p. m.	
June 3 -	Neap -	East -	Ditto -	10. 20 a. m. -	1 mile from river, middle buoy - - - -		4. 28 p. m. -	Went towards sands at 8. 25 p. m.
						Point of Stopping with Flood.		
May 12 -	Spring	East -	Ditto -	8. 37 a. m. -	Driven on shore on Shoebury Sands - - -		Although lifted twice, and placed in the current a mile from shore. 4. 25 p. m.	
,, 19 -	Neap -	East -	Ditto -	3. 30 p. m. -	Went on shore in Leigh Roads; lifted and placed 1 mile from shore; went on shore on sands; lifted again in current at Junkins' Buoy; went on shore on Grain's Spit; lifted again in centre of river and immediately went on shore on Lobster Island.			
,, 27 -	Spring	S. W.	Ditto -	9. 50 a. m. -	Cliffe Creek - - - - - -		3. 50 p. m.	
June 3 -	Neap -	East -	Ditto -	6. 47 p. m. -	Taken up at Mucking Light - - - -		8. 39 p. m.	

Charles Aug. Smith.

Croom's Hill, Greenwich, 20 June 1857.

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Evidence of a Deputation.

2. Statements on the Subject of the *Havering* and *Dagenham* Level.

(1.)

Minutes of Evidence given by a Deputation from the Commission for the *Havering* and *Dagenham* Level.

Meeting of the Referees, 29, Great George-street, Friday, 29 May 1857.

A Deputation, consisting of *William Cotton*, Esq., Chairman; *John Davis*, Esq., Commissioner; *H. Burges*, Esq., Engineer; and *W. H. Clifton*, Esq., Clerk, attended by appointment.

Mr. Cotton stated that he acted as chairman of the Court of Sewers for the Levels of Havering, Dagenham, &c., which included about two-fifths of the parish of West Ham, in Essex, comprising the low lands adjoining the River Thames, and that he had been a Commissioner of Sewers for many years past. That the authority of the Commissioners was derived from a Commission under the Great Seal, pursuant to statute 23 Hen. 8, c. 5, and that the proceedings of the Commissioners were regulated by that and various subsequent Acts of Parliament, relating to sewers, but that the powers of the Commissioners were confined to the maintenance of the sea and river walls, and other defences for protecting the lands from inundation, and to the construction of such works as were necessary for the drainage and carrying off the superfluous fresh waters. That the powers of the Commissioners under these Acts did not extend to house drainage.

Mr. Cotton said that the lands within the Commission in West Ham parish had originally consisted of open marsh grounds, used entirely for agricultural purposes, but that of late years a large portion of these lands had been sold for building houses, manufactories, and, in Plaistow level, for the formation of the Victoria Docks; that a vast population had sprung up; in addition to which, the population of the higher parts of West Ham, which included the town of Stratford, had greatly increased. Mr. Cotton complained that some of the works under the control of the Commissioners consisted of open sewers and ditches, which formed boundaries or fences to the different marshes, and at the same time served the purpose of getting rid of the superfluous waters by means of outlet sluices into the Thames, and of supplying the cattle in the marshes with fresh water, by means of inlets from the Rivers Thames and Lea, and its branches.

That, in consequence of no system of house drainage existing in the parish of West Ham, the filth and refuse from many of the dwelling-houses and manufactories is carried into some of these open watercourses, causing an intolerable nuisance, whilst the effect of this filthy evaporating surface is highly injurious to the health of the inhabitants of the district.

Mr. Cotton said, that on this state of things being brought under the notice of the Commissioners, they had expressed their earnest desire to co-operate with the parishioners of West Ham, in providing a remedy for the evils in question; and the Commissioners, at the instance and desire of a large majority of the parishioners in vestry assembled, in the year 1853, applied to Parliament for an Act to extend their powers, by enabling them to construct a system of deep covered sewers, which had been suggested by Messrs. Walker & Burges, the Commissioners' Engineers. The Commissioners obtained this Act in the Session 1854, and would ere this have proceeded to carry out the works contemplated by the Act, but for the opposition offered to the scheme by some of the parishioners of West Ham, who memorialised the Commissioners to abstain from exercising the powers conferred upon them by the Act, and to allow the house drainage of the parish to be carried out under the provisions of the Public Health Act. The Commissioners had also had great trouble with, and opposition from, the Victoria Dock Company, and had been and were engaged in litigation with them, owing to the refusal of the Dock Company to complete a cut and outfall which the Company had been required by the Commissioners, and had agreed, to make in conformity with a clause in the Company's Act, and in consequence of their interference with the former drainage of the district by the formation of the Docks, and that the Commissioners had succeeded in obtaining a writ of mandamus against the Dock Company, by which they were commanded to proceed with these works, which the Company had not yet done, although, by an agreement to which the Commissioners had assented, for compromising the legal proceedings, the Company had undertaken to complete the cut and outfall by the commencement of the present year.

Mr. Cotton was of opinion that the existing powers of the Commissioners were sufficient for all the purposes contemplated by the Sewers Acts, and he believed that the outfalls generally in this Commission were sufficient to keep at a low and proper level all the watercourses and ditches in the marshes, and that, when the Dock Company had completed the works to which he had referred, the surface drainage in that particular level would be amply provided for; and Mr. Cotton said that the Commissioners exercised a control over these watercourses,

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watercourses, by regulating the height of water in them, and by requiring the owners and occupiers to scour and cleanse them from time to time, on presentments from the marsh bailiffs and assistants.

Mr. Cotton alluded to the insufficient drainage in the marshes in the valley of the River Roden, in Essex, which he thought it desirable should be placed under commission. Mr. Cotton had heard that complaints existed of insufficient outfalls in some of the levels on the Kentish side of the River Thames, and that objections had been raised by the proprietors and occupiers to any interference by the Commissioners of Sewers in those districts; and he considered that in such cases it might be desirable that the Commissioners of Sewers should have power to construct proper outfalls and other necessary works for securing effectual drainage, without the previous consent of three-fourths of the owners and occupiers of the lands to be charged, as at present required under the Sewers Acts.

Mr. Cotton handed in a plan, showing the line of covered sewers proposed to be laid down by the Commissioners in West Ham, and which he believed would have been most efficient, as constituting an arterial system of drainage. Mr. Cotton stated that the main sewer was to have been 6 feet in diameter, and that this sewer was to have been 22 feet below the surface at the crossing of the Stratford-road, varying from 22 feet to 11 feet, and less, in the Marsh. There were also seven other lines of branch sewers, all of which are shown by red lines on the plan.

Mr. Cotton stated that a Local Board of Health had now been established in West Ham, and that, on the suggestion of the general Board of Health, the Commissioners had consented to suspend the powers under their Act of 1854 for two years, from August last, to give the parishioners of West Ham the opportunity of carrying out a plan of their own, for draining the houses, &c. in the district, under the provisions of the Public Health Act; and if this plan was satisfactory to the Commissioners, the latter body intended to forego altogether the powers conferred upon them by their Act of 1854.

Mr. Cotton understood that the Local Board of Health for West Ham, were, or would be very shortly, prepared with plans for draining the parish, from their engineer.

Mr. Cotton stated that he was of opinion that the original jurisdiction of the Commissioners was most useful and important, and should be preserved; but thought it desirable that the house drainage in such populous districts as West Ham should be placed under the management of bodies possessing different powers and functions to the Commissioners.

Mr. Cotton said that the Commissioners had great cause to complain of the sewage matter from West Ham being carried into the streams and watercourses under their control, and that the Commissioners had passed a resolution, that after the two years had elapsed they would oppose the pollution of these watercourses, in the manner he had before described.

Mr. Cotton thought that the drainage of London ought to be carried out on a large scale, capable of extension, and that the future state of the Metropolis, and the probability that outlying districts will pour their sewage into the contemplated sewers, would require provision to be made for a cent. per cent. increase in the power of drainage.

Mr. Cotton, being of opinion that the Metropolitan drainage scheme might be made available for the efficient drainage of West Ham, where it was proposed to place one of the pumping stations, had, with Mr. Davis (also a Commissioner), applied to the President of the General Board of Health on the subject; but the answer had been, that this must be a matter of arrangement with the Metropolitan Board of Works.

Mr. Cotton expressed himself most willing to co-operate in such an arrangement.

Mr. John Davis, of Cranbrook Park, Ilford, one of the Commissioners, confirmed the observations of Mr. Cotton in all respects, and particularly referred to the anxiety which had been felt by the Commissioners to carry out an efficient system of sewage in the populous district of West Ham, including Stratford, Plaistow, and the locality of the Victoria Docks, for which purpose the Commissioners had obtained powers from Parliament, under their Act of 1854, which would have been exercised by the Commissioners but for the opposition offered by certain parties in West Ham, who were desirous of having the provisions of the Public Health Act applied to the district, which had since been done.

Mr. Davis was satisfied that the district could not be possibly drained by means of pipes, which he had heard suggested.

Mr. Clifton, of Romford, Clerk to the Commissioners, wished to draw the attention of the Referees distinctly to the fact that the powers and duties of the Commissioners of Sewers were confined by the Acts 23 Henry 8, c. 5; the 3 & 4 Will. 4, c. 22; 4 & 5 Vict. c. 45; and 12 & 13 Vict. c. 50, to protecting the lands in their jurisdiction against irruptions of the sea and tidal rivers, and to the supervision and maintenance of works for securing the surface drainage of those lands within the Commission.

Mr. Clifton stated that many of the watercourses under the control of the commissioners in the West Ham Levels were improperly made receptacles for the filth and refuse matter from houses in the district having no cesspools or other means of drainage, and causing complaints which could only be remedied by an efficient system of covered sewers, which he

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he understood the Local Board of Health were now about to provide for draining the whole parish of West Ham.

Mr. Clifton stated that the commission comprised the levels of Havering, Dagenham, Barking, East Ham, West Ham, Ripple, Leyton, Walthamstow, Bromley and East Marsh, in the counties of Essex and Middlesex, and the small portion of Kent, on the Essex side of the Thames, and extended over about 8,000 acres of land.

Mr. Clifton handed in a plan of the whole of the lands within the commission, and also a plan of the district of the Victoria Docks, showing the line of the cut which the Commissioners had required the Dock Company to construct under the 59th section of the Victoria London Dock Act, 1853, and with respect to which the Commissioners had been engaged with the company in litigation, the company contending that they were only bound to proceed with the cut as their own works progressed, whereas the Commissioners insisted that the company were bound to complete the cut and outfall forthwith, and the Commissioners had succeeded in establishing the correctness of this view by a verdict obtained in their favour on the trial of an issue under the writ of mandamus issued by the Court of Queen's Bench against the company, at the instance of the Commissioners. Mr. Clifton stated, that the Dock Company had appealed to the Court of Exchequer Chamber, but that terms of compromise had been agreed upon in August 1856, by which the Dock Company were to have completed the cut and outfall within six months from that date, but notwithstanding this agreement the Dock Company had not proceeded with the works, though they had made repeated promises to do so, and he feared the Commissioners would be obliged to renew the litigation against the Dock Company to compel the performance of their agreement. Mr. Clifton considered that the construction of this cut and outfall would be of immense advantage to the surface drainage of the West Ham levels.

Mr. Clifton alluded to the difficulties which had been thrown in the way of the Commissioners carrying out their Act of 1854, by certain parties in West Ham, as well as the Victoria Dock Company, but considered that it was expedient that the Commissioners should confine their attention to the discharge of those duties contemplated by the commission and the several Acts of Parliament relating to the sewers, which he believed the Commissioners had hitherto done to the satisfaction of the landowners in their district.

Mr. Burges, of the firm of Walker, Burges and Cooper, the Commissioners' engineers, submitted several maps, one of them showing the long cut which the Victoria Dock Company were bound to carry out parallel with the docks, the length of which from the inlet at Lea mouth to the outfall at Gallion's, would be 2¾ miles.

The cut would be 30 feet wide, and from six to nine feet deep, and when completed would effectually get rid of the surface drainage of the district, and probably, to some extent, of the leakage from the docks, of which complaints had been made.

Mr. Burges said the outfalls within this commission were quite sufficient, if necessary to drain all the water from the ditches in these marshes.

Mr. Burges, however, stated that it was important to retain a certain quantity of fresh water in these ditches for the use of the cattle, and that no injury would result, so long as these ditches were kept cleansed, and the water in them at a proper level, which was regulated by the officers of the commission.

Mr. Burges alluded to the foul state of many of the marsh ditches in the West Ham level, for which the Commissioners Act of 1854 would have provided a remedy.

(2.)

Evidence of Mr. Rawlinson, C.E.

MINUTES of EVIDENCE given by *Robert Rawlinson*, Esq., C.E.

Meeting of the Referees, 29, Great George-street, Thursday, 18 June.

Mr. *Rawlinson* attended by appointment, to give particulars with regard to the Sketch Plan for the Drainage of *West Ham*.

IN answer to Captain Galton, Mr. Rawlinson said, that none of the works were yet begun, or even authorised, but it was proposed to carry away the sewage in a covered sewer, parallel with the open cut of the Victoria Docks, discharging into the Thames at Gallion's Reach.

In answer to a question Mr. Rawlinson said that this point of outfall was within the Metropolitan limits.

Some members of the Local Board wish to discharge the sewage into the River Lea, in Bow Creek.

Mr. Rawlinson showed the section of his sewer which would discharge at point marked B, with the lower lip at a point determined on by the observation of low water on the 14th

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14th April 1857. Mr. Rawlinson said, that the size of his sewer at the outlet would be six feet (circular); he proposed to lift the sewage by a series of scoop-wheels. In answer to Mr. Blackwell, Mr. Rawlinson said, that he lifted sewage at Worthing a height of 25 feet by means of three 15-inch pumps, but found they were very liable to get choked up, and required cleaning each day. On the whole he thought this mode of pumping for large areas would be unsatisfactory.

Mr. Rawlinson said, that by far the greater part of the West Ham District was undrained, and that none but a few old drains in some parts at present existed. The greater portion of the district is under high water mark.

The fall of the proposed sewer would be one foot per mile, and would require occasional, though not very frequent, flushing. The level of the outfall would be six feet below Ordnance datum.

Mr. Rawlinson related the circumstances under which the proposed plan had been prepared, referring to the Act obtained by the Commissioners, giving them powers to carry out a system of drainage which is held in abeyance, unless one was initiated by the inhabitants themselves through the Local Board of Health recently formed before a certain time.

Mr. Rawlinson said, that the proposed system of drainage would be in abeyance till it was known what was to be done in intercepting the drainage of the Metropolis. The proposed point of outfall would be within the metropolitan area.

With reference to drainage generally, Mr. Rawlinson did not know if deodorising works could pecuniarily be made to answer, but held that every town ought to be bound to deodorise its sewage at its own expense, if even the process was not remunerative.

Mr. Rawlinson related his experience in drainage at Berwick-on-Tweed, Chorley, Carlisle, Morpeth, Alnwick, &c.

Did not believe sewage when thrown into a sufficiently large stream was a nuisance house sewage, or sewage proper, did no harm to fish, though chemical substances discharged into rivers had a very injurious effect.

In answer to Captain Galton, Mr. Rawlinson said, that he believed the population of the district (West Ham), to be drained was now about 80,000, but had no reliable data to found his calculation upon.

Of the portion to be drained, 260 acres was fully covered with houses, and streets laid out for building; this was the part of the district he was mainly proposing to drain. The total area of the district was 5,980 acres.

Mr. Rawlinson said, that he intended to pump the sewage at all times of the tide.

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3. OBJECTIONS to the Construction of Mr. *Bazalgette*'s proposed Low Level Sewer on the North of the Thames, in the Vicinity of the Houses of Parliament, and St. Paul's Cathedral.

Objections to proposed Low Level Sewer on the north.

(1.)—OBJECTIONS urged by Sir *C. Barry* as to the Houses of Parliament.

As to Houses of Parliament—Sir C. Barry.

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1. MINUTES of EVIDENCE given by Sir *Charles Barry* before the Referees.

Meeting of Referees, 29, Great George-street, Friday, 1 May 1857.

Sir *Charles Barry*, Architect of the New Palace of Westminster, attended by appointment.

IN answer to a question put by the Referees, Sir Charles Barry said that the flagging on which the tower of the New Houses of Parliament rested was 9 feet 6 inches below Trinity datum, and that under this flagging there was a bed of concrete 10 feet 7 inches thick. The bottom of the excavation for the proposed sewer would be 15 feet 6 inches below Trinity datum.

The depth of the sand, silt, and gravel below the footings in the centre of the Victoria Tower to the stratum of clay is 17 feet 9 inches; the gravel bed above the clay is 11 feet 6 inches. Both the silt above the sand, and the sand, as well as the gravel, were largely charged with water.

Sir Charles stated that the pressure of the tower per foot superficial upon the landings under the footings is 7½ tons for the building alone.

Sir Charles said that he anticipated danger from running the sewer at the level proposed by the Metropolitan Board of Works, though it was not to be constructed so deep as he at first supposed.

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Sir Charles suggested that it would be better to drive the sewer further west, starting from the bank of the river behind the Millbank Penitentiary and taking the line of the park.

Sir Charles said that the river wall in front of the New Houses by no means prevented the action of the tide while working at the foundations, the water being found to rise and sink with the flow and ebb of the tide in the river.

The great objection to the proposed large sewer works was the withdrawal of water from the sand, which would be very likely to weaken the foundations of the Houses, as well as of other buildings in the neighbourhood.

In fine, Sir Charles Barry said that he must object, unhesitatingly, to the driving a sewer like the proposed one, at the depth required by the levels, and so near the foundations of the Victoria Tower.

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2. Letter from Sir *Charles Barry*.

To the Referees on the Main Drainage of London.

Old Palace Yard, 2 June 1857.

Gentlemen,

I return to you the plans which you have forwarded to me, showing a deviation in the course of Mr. Bazalgette's proposed main sewer through Westminster, so that it may be more distant from the Victoria Tower than in the plan exhibited to me at my interview with you about one month since. Having, in compliance with your request, considered the effect of the formation of such a sewer as regards the New Palace at Westminster, I am still induced to entertain some apprehension that it may endanger the safety of that building, whose foundations, generally, rest upon a bed of gravel and sand, fully charged with water. Although the bottom of the proposed sewer is not intended to be lower than those foundations, I am inclined to think that the effect of the digging and pumping which will be necessary to lay in the bed of the sewer, will have the effect of destroying the equilibrium of the water of the district, and cause a disturbance and possibly an abstraction of a portion of it from beneath the foundations of the New Palace, by which the superstructure may be endangered.

I should also be fearful that the same risk would ensue with respect to the safety of the Abbey; for in a sewer which I had occasion to construct, in the year 1838, from College-street, through Old Palace Yard and St. Margaret's-street to Bridge-street, when I made a careful examination of the foundations of Henry the Seventh's Chapel, I deemed it necessary to make that sewer fall north and south from that spot, in order that the excavation might be as shallow as possible.

I have, &c.
(signed) *Charles Barry.*

As to St. Paul's Cathedral—Mr. F. C. Penrose.

2.—Information as to Objections, similar to the present, raised on the proposal to Construct a Sewer near St. Paul's Cathedral, in 1831.

Correspondence, &c., on the subject, laid before the Referees by *F. C. Penrose*, Esq., Surveyor to the Fabric of St. Paul's.

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19 August 1831.

Sir,

Until Mr. Acton's return I recommend you to suspend the works of the sewer on the south side of St. Paul's Cathedral, and unless you do so immediately, I shall feel it my duty to apply to the Lord Mayor to that effect.

I am, &c.
(signed) *C. R. Cockerell.*

Mr. Richard Kelsey.

32, Wilson-street, Finsbury-square,
19 August 1831.

Sir,

Mr. Acton left town yesterday morning for a few days; but I will take care to transmit your letter as early as possible.

Had Mr. Acton remotely thought that the stability of St. Paul's Cathedral could be in the least affected by the sewer he is now constructing, good feeling would have instantly prevented his attempting it; but upon reconsideration I trust you will see that there is no ground for alarm upon the subject, and you may be satisfied that every requisite precaution will be taken by the commissioners to complete their works without injury to any one.

I know that Mr. Acton was not at all aware who was the surveyor to the Dean and Chapter; but it is certainly singular that, until so late as yesterday morning, you should have remained uninformed of a work which has been in progress for many weeks, especially as a Mr. Lingard, who described himself to be sub-surveyor to St. Paul's Cathedral, must have

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have not only known it as matter of public notoriety in the neighbourhood, but was applied to by Mr. Acton, as the only ostensible person he knew in the business, that the bar on the north side of the Cathedral might be opened, while the south side of the churchyard was necessarily closed.

After going through several official forms, Mr. Acton succeeded in obtaining permission from the Bishop of Llandaff and the Lord Mayor for the passage of carriages going westward, and it will be matter of regret to him, that after taking so much pains and seeing so many persons, he should not have been made acquainted of the existence of a gentleman whose office and professional rank would, as a matter of course, entitle him to information on the subject.

I shall, in Mr. Acton's absence, feel happy to attend any appointment you may make; but you may rest quite assured that the work is in the hands of persons who will do everything which they feel necessary to execute their task in a satisfactory manner.

I am, &c.
(signed) *Richard Kelsey,*
Surveyor's Clerk to the Commissioners of Sewers.

C. R. Cockerell, Esq.

At a public Meeting of the Commissioners of Sewers of the City of London and Liberties thereof, held this day, 24th August 1831, in Guildhall:

Resolved, Upon consideration of the surveyor's report, that although this Commission entertain no apprehension that the safety of the Cathedral Church of St. Paul can be endangered by the sewer they are now constructing in St. Paul's Churchyard, yet, to meet the wishes of the Dean of St. Paul's, and to satisfy the public mind, they appoint and authorise Mr. Telford and Mr. Brunel, together with Mr. Acton, on their part, to meet and confer with Mr. Rennie and Mr. Smirke, together with Mr. Cockerell, on the part of the Dean and Chapter, and to report their opinion on the construction of the work, and the effect, if any, which it may have upon the foundation of the Cathedral, and that this Commission will be ready to receive and consider any suggestions which the said gentleman may have to offer for the further security of the work. And for the necessary information of the gentleman to whose judgment the matter is referred, it appears to the commissioners to be absolutely requisite that the surveyor to the Dean and Chapter should, by examination, ascertain the precise depth and extent of the foundations of the Cathedral, and the nature of the soil or strata upon which they rest, and more especially as to that part of the fabric opposite to the sewer now in progress, and whether any other sewers or openings exist under any part of the Cathedral, and at what depth.

Resolved further, that the works in St. Paul's Churchyard be suspended until the said report be received.

(signed) *F. J. Donne,*
Principal Clerk.

Sewers' Office, Guildhall,
25 August 1831.

Sir,

I am directed to acquaint you Mr. Sibley has been appointed (instead of Mr. Telford, who was previously engaged,) to confer respecting the construction of the public sewer on the south side of St. Paul's Churchyard; and as the work is now suspended the Commissioners hope to be favoured with an early reply.

I am, &c.
(signed) *F. J. Donne,*
Principal Clerk.

C. R. Cockerell, Esq.

Memorandum by Mr. *Cockerell.*

St. Paul's Churchyard, 1 September 1831.

Met Mr. Walker on the part of Mr. Rennie; measured the depth of the well sunk at the east side of south transept, and found it 33 ft. 6 in.

The depth from top of well to level of street was 3 ft., leaving the depth of the well from the street pavement 30 ft. 6 in.

The workmen came to this depth at 4 o'clock, P.M., on Wednesday, 31st August, when finding the water come in fast upon them, they dug no lower; the water rose until 7 o'clock, 1st September, when the sewer pump beginning to ply, the water was cleared off in a great measure, but the bottom is now filled with water and sand, and the workmen state the sand (or bottom of the well) to have filled in about one-fourth.

A specimen of the sand and water is deposited in the vestry.

Well sunk on the south of transept in the street.

Appendix IX.

Special Points in Mr. Bazalgette's Plan, &c.

Objections to proposed Low Level Sewer on the north

Measured and found this well 31 feet below the street level.

The workmen arrived at this depth at 12 o'clock on 31st August, when finding the water and sand come in upon them, they desisted.

Since then the sand and water have filled in 6 inches to a foot; the sand falling in from the sides and undermining the sides (all round a 4-feet well about 6 inches); it is observed that on the north side of well towards cathedral, the sand has come in in greater quantity, making the side of the circle northward, irregular and flat.

In both wells, underneath the pot earth (the thickness of which varies from 3 feet to 4 feet), sand and gravel in layers have been found to the depths above mentioned.

Called on Mr. Allsop (late Pellat & Green), and found his well 23 feet below level of street, and the water has hitherto been 6 feet to 8 feet high, making the top of water 13 feet to 17 feet from the level of the street pavement.

Saville-row, 1 September 1831.

Sir,

I BEG to inform you that in conformity with the suggestion of the Commissioners of Sewers, I have caused holes to be dug in three places in order to ascertain the facts of the depth of the foundations of the Cathedral, and the nature of the strata upon which they are placed. These holes are on the west and east sides of the south transept, close to the sides of the fabric, and in the street at the south front of the south transept, the two latter (on the east and south) are as deep as the workmen have been able to dig with security, the sand and water coming in upon them, and a greater depth requiring pumping and steyning. These experiments leave no doubt of the accuracy of the historical account of the fabric.

These openings having been completed this morning, I take the earliest opportunity of communicating the result; and I have directed the deputy-surveyor, Mr. Lingard, who is in attendance in the Cathedral, to afford you every means of examining them with reference to the subject in hand.

I remain, &c.
(signed) *C. R. Cockerell,*
Surveyor to the Fabric of St. Paul's.

J. Acton, Esq.

Red Lion Place, Giltspur-street,
1 September 1831.

Sir,

AGREEABLY with your orders, I have measured the distance between the pavements near, and the sand in the shafts on the east and south sides of the south transept of St. Paul's Cathedral, at different times, at one o'clock, at three, and at four, and find the distance in each shaft to be uniformly the same; that is, 33 feet 3 inches in the east shaft, and 30 feet 6 inches in the south. There is rather less water in the shafts than when you were there, owing to the sewers' pumps having been in constant work.

I am, &c.
(signed) *Henry Munn.*

C. R. Cockerell, Esq.

MEMORANDUM by Mr. *Cockerell*, 2 September 1831.

	Ft.	*in.*
Mr. Munn found the opening east of south transept - - - - -	32	4
So that since yesterday the sand has risen - - - - - -	–	11
TOTAL - - - *Ft.*	33	3

EXTRACT of LETTER.

Wintershall, 2d September 1831.

YOUR letter is so far satisfactory as to show that the sand is a quicksand and, therefore, dangerous to the church. The great error has been to attempt making the sewer without due notice to you, and the question now is whether the continuation of the sewer is dangerous to the edifice. Reasoning abstractedly; if the sides of the excavation could be kept from running in, and no displacement of the sand takes place, no danger can be apprehended, but if the sand is found to run, and cannot be kept back, the excavation is dangerous The next question is what is to be done? My answer is, that I shall be in town on Monday morning at 10, and decide accordingly, and visit St. Paul's immediately.

(signed) *George Rennie.*

C. R. Cockerell, Esq.
&c. &c. &c.

Appendix IX.

Special Points in Mr. Bazalgette's Plan, &c.

Objections to proposed Low Level Sewer on the north.

6 September 1831.

Sir,

I AM requested by Mr. Smirke and Mr. Rennie, appointed in conjunction with myself by the Dean and Chapter, to advise respecting the new sewer in St. Paul's Church-yard, to say that, feeling the importance of the operation to the Commissioners of Sewers, to the public, and to the fabric, of as early a communication of their opinion on the subject as possible, they think no time should be lost, and finding a meeting of all the persons appointed is extremely difficult to arrange, and, from a meeting of five of the six persons to day, that Mr. Brunel coincides in a great measure with them respecting the operation; they beg leave to recommend to the Commissioners of Sewers to adopt a line of sewage further removed from the fabric, their opinion being that great risk is incurred to St. Paul's Cathedral by the present line.

That in the hope the Commissioners will find the means of adopting another line, they forbear to make any observations on the present, or any other mode of execution of the work in the present line, their conviction being that the present line cannot be carried into effect with due regard to the security of the Cathedral.

(signed) *C. R. Cockerell.*

Mr. Acton,
Surveyor to the Commissioners of Sewers.

Stratford Place, 6 September.

My dear Cockerell,

I DID not receive your note till yesterday evening, and having made several engagements for this morning, I could not attend the discussion referred to in your note, nor indeed did you say where it was to take place.

When you communicate the observations you have made upon the water and sand in the wells, I think there will be no question about the "prudence" of altering the line of the sewer.

Yours, &c.
(signed) *Robt. Smirke.*

C. R. Cockerell, Esq.

MEMORANDUM by Mr. *Cockerell.*

WE are informed by the "Parentalia," p. 260, which is the only authentic account I am acquainted with, that the fabric of St. Paul's Cathedral is founded on a bed of potearth, six feet thick to the north, and four feet thick on the south; that under this bed, down to the level of low water-mark, is a sand so loose as to run through the fingers, to the thickness of about 40 feet, to the original London blue clay; the bed of potearth is found from 12 to about 20 feet below the present surface, by various experiments, both within the crypt and in the street; the present sewer is 35 feet below the surface of the street, at the south gate, consequently 15 feet below the bed of potearth; the apprehension is the removal of a vein of running sand, connected with the bed described, may endanger the stability of the bed of potearth superincumbent, with the Cathedral placed upon it. Not only the present operation affords abundant grounds for such an apprehension, but if in so large a drain, 6 × 7 feet, at least 20 feet circumference, by 4 or 500 feet long, at any time the smallest accident in the drain might admit the running sand with the stream of water, and thus carrying the sand through the sewer, gradually undermine the Cathedral itself.

That the account of "Parentalia" is correct, is proved by the fact that the opening in the bed of sand in Paul's-chain has given vent to the water in the sand, so as to oblige the erection of a steam engine to keep the sewer already building dry, and secure the workmen; and all the wells round the churchyard north and south have been dried as far as the Newgate Market wells. The excavation to the south of the cathedral is inundated with a running sand and water, so as to put the workmen and works in great danger, only warded by planking and caulking with the utmost attention by 3 and 4 feet at a time; such planking is left behind the walls of the sewers, but it is impossible to retain the sand; consequently it may be feared that much more than the contents of the sewer, 6 × 7, is removed, and already damage may have been occasioned; the continuing of it seems obviously fraught with the utmost peril to the cathedral.

COPY of REPORT.

WE, the undersigned, having by the direction of the Dean and Chapter of St. Paul's Cathedral examined and considered the situation in which the Commissioners of Sewers have begun to construct a sewer on the south side of the cathedral, and considering that the footings of the walls rest chiefly upon a thin bed of potearth, beneath which is a very deep stratum of sand and gravel containing a considerable quantity of water, and that the walls of the south transept have sunk, and are fractured, apparently, by reason of some partial weakness in this part of the foundation; are of opinion that the security of the fabric will be endangered if the sewer is constructed in the churchyard.

We

Appendix IX.

Special Points in Mr. Bazalgette's Plan, &c.

Objections to proposed Low Level Sewer on the north.

We are likewise of opinion, that however carefully the work may be constructed, it will be scarcely possible to prevent some degree of motion from taking place in the said stratum of sand and gravel, either during the construction of the sewer, or at a future period, in consequence of it. And we therefore earnestly recommend that the Commissioners should be requested to abandon this line for their sewage, and remove it to such a distance as will prevent all risk of injury to the perfect security of the cathedral.

(signed) *Robert Smirke.*
George Rennie.
C. R. Cockerell.

Saville-row, 10 September 1831.

COPY of LETTER obtained from City Commissioners of Sewers.

Sewers Office, Guildhall,
21 September 1831.

Sir,

THE Commissioners of Sewers of the City of London and liberties thereof have had under their consideration the report of the surveyors appointed in relation to the public sewer intended to be constructed through part of St. Paul's Churchyard, and I am directed to acquaint you, the Commissioners have ordered the shaft near the south transept of the cathedral to be filled up forthwith, and to be made secure under the direction of their surveyor; and I am further to acquaint you, they have determined that a portion of the course of the sewer shall be diverted from the intended line; and that, instead of continuing it westward on the south side of St. Paul's Churchyard, it shall be constructed from Watling-street, through part of the Old Change and Little Carter-lane, to communicate to the sewer recently built in Paul's chain.

I am, &c.
(signed) *F. J. Dunne,*
Principal Clerk.

P.S.—I have been directed to make known the determination of the Commissioners to the Lord Bishop of Llandaff.

C. R. Cockerell, Esq.,
&c. &c. &c.

LIST OF PLATES TO APPENDIX IX.

Plate I. Plan illustrating the Experiments made with Floats in the River Thames by Mr. Homfray, May and June 1857.

APPENDIX, IX. *(Plate 1.)*

RIVE

Exp

Var.n 21° 35' W

Dagenham Marsh

RAINHAM

Church

London, Tilbury & Southend Railway

PART OF KENT

Barking Creek

Magazine

Barking Pt.

GALLIONS REACH

BARKING REACH

HALFWAY REACH

Gress Ness

Halfway House

Dagenham Creek (Branch)

Beacon

Margaret Ness

Tripcock Ness

Beacon

Magazine

Rainham Creek

Rainham Marsh

Ferry Ho.

Sewage Works Magazine

Terminus

Gallion Pt.

Marshes

Erith Marsh

Wennington Marsh

Magazine

Pier

Pier

Magazine

Abbey Manor Weir

Aveley Marsh

WOOLWICH

NORTH KENT RAILWAY

Station

Station

Abbey Mead

Harrow Inn

Cold Harbour Pt.

Hamsted Obt.

ERITH RANDS

PURFLEET

Belvidere Ho.

Church

Church

Station

Station

Crawford Ness

Ferry

ERITH

Brick Field

Darnford Creek

Long Reach Fort

Northumberland Heath

NORTH

Thurrock Marsh

Little Thurrock

Church

PLAN

OF THE

RIVER THAMES

Showing the Drift of

Experimental Floats,

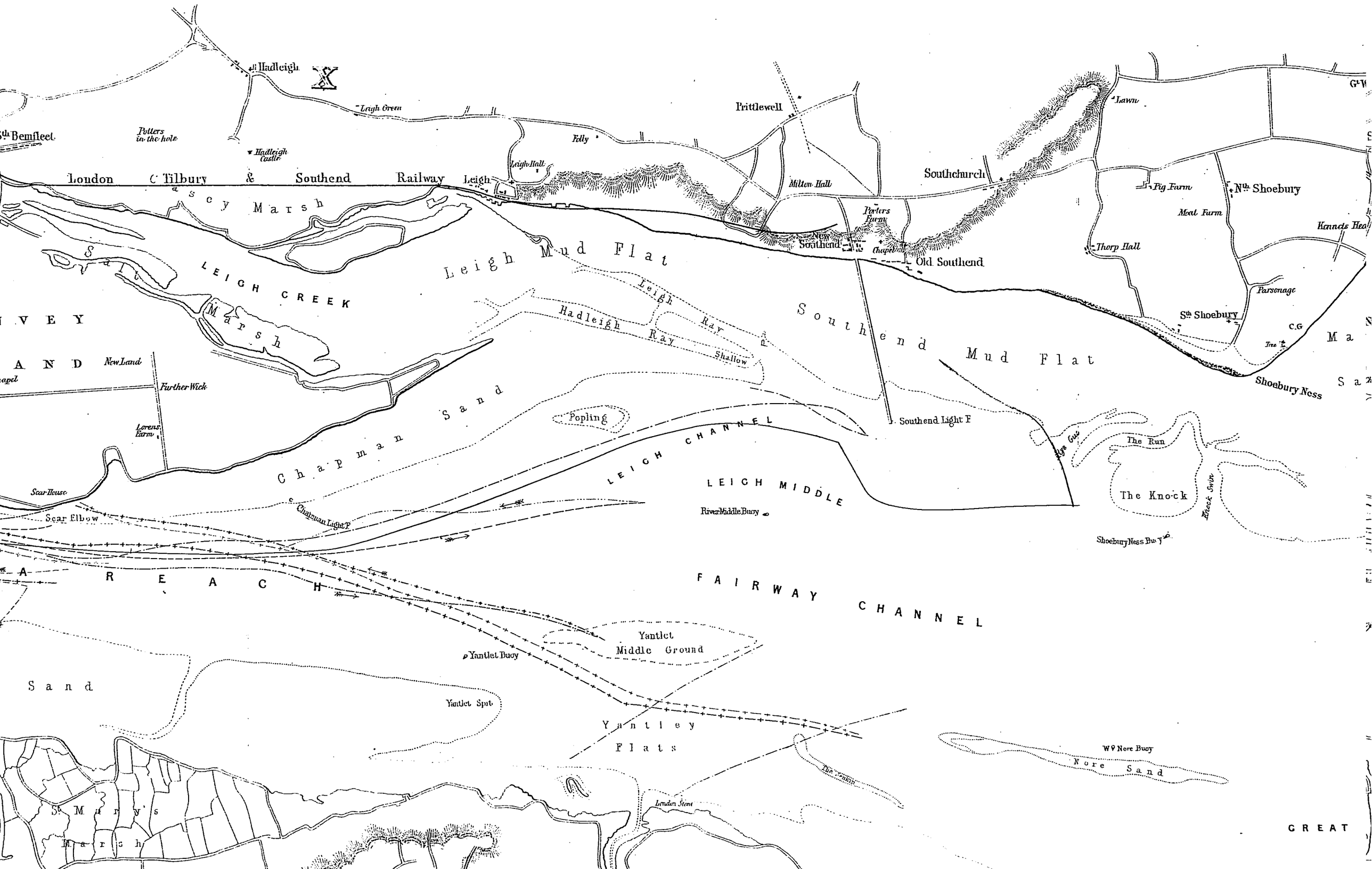
1857.

Fred.k G. Homfray.



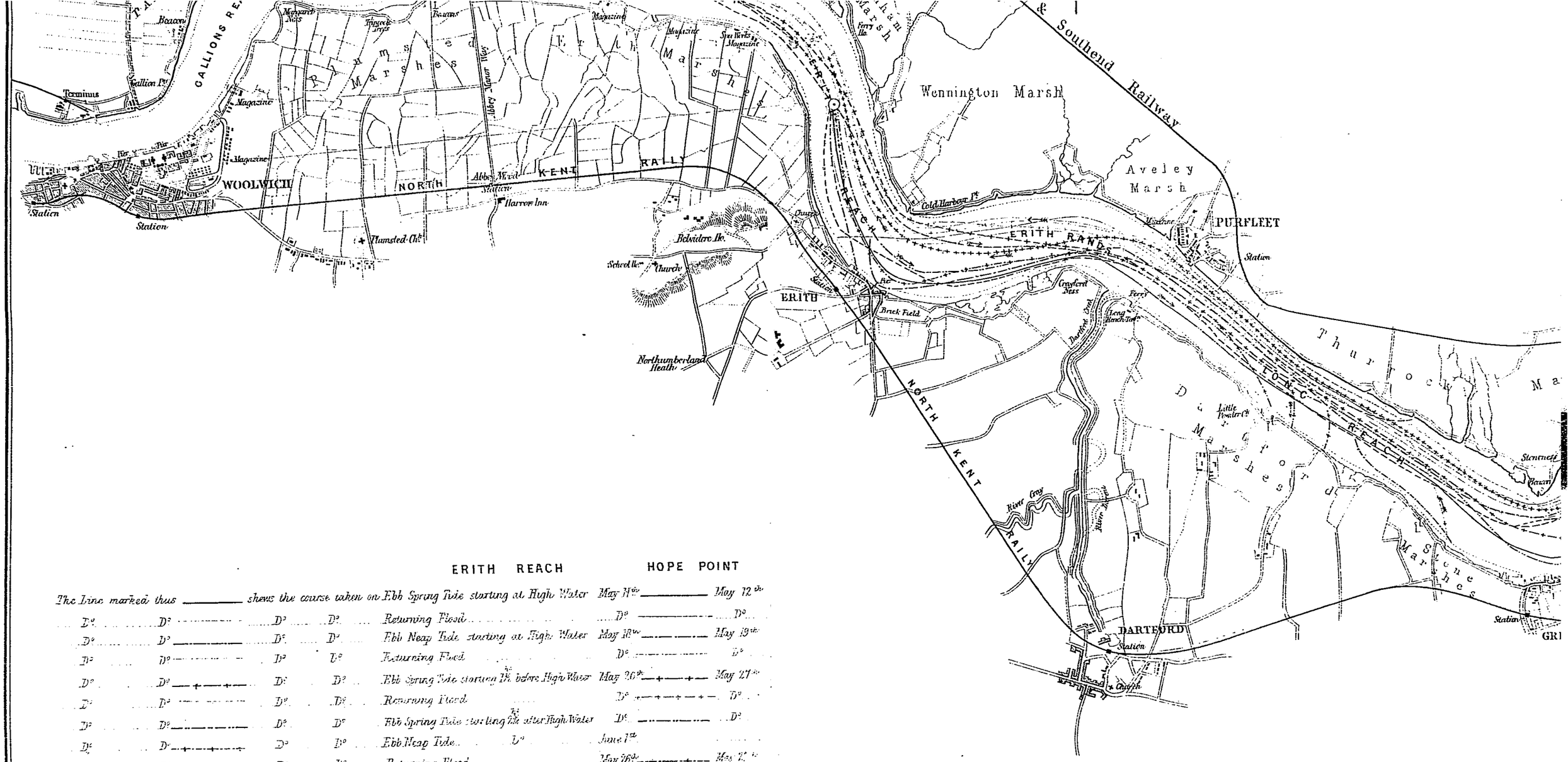
Pitsey Marsh
Vange Marsh
Bowers Marsh
Fobbing Marsh
Corringham Marsh
Canvey Island
Cliffe Marsh
Cowlins Marsh
St Mary's Marsh
Blyth Sand
Hadleigh
Leigh Creek
Chapman
Sea Reach
Lower Hope Reach
Mucking Flat
Blyth Spit
Thames Haven Branch Railway
London Tilbury & Southend Railway
London Tilbury & Southend R
Bowers Church
Yang
Pollice Farm
White Hall
Great House
Fobbing
Corringham
Muscles Farm
Johnans Hall
Sth Benfleet
Potters in the hole
Leigh Green
Hadleigh Castle
Sth Staines
Waterside Farm
Et Haven House
Monks Wick
New Land
Chapel
Church Hill
Further Wick
Lorens Farm
Sluice House
Scar House
Scar Elbow
Chapman Light F.
Sheel Haven
Thames Haven Pier
Mucking Ct
Mucking Light
E. Blyth
W. Blyth
East Tilbury
Lower Hope Pt
Old Battery

APPENDIX, IX. (Plate 1



APPENDIX, IX. *(Plate 1.)*

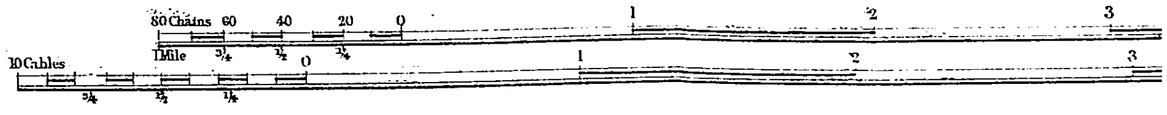




ERITH REACH					HOPE POINT	
The Line marked thus _____ *shews the course taken on Ebb Spring Tide starting at High Water*					*May 11th* _____	*May 12th*
D²	D²	D²	D²	*Returning Flood*	D² _____	D²
D²	D² _____	D²	D²	*Ebb Neap Tide starting at High Water*	*May 18th* _____	*May 19th*
D²	D²	D²	D²	*Returning Flood*	D² _____	D²
D²	D²	D²	D²	*Ebb Spring Tide starting 1¾ before High Water*	*May 26th*	*May 27th*
D²	D²	D²	D²	*Returning Flood*	D²	D²
D²	D²	D²	D²	*Ebb Spring Tide starting 2¾ after High Water*	D² _____	D²
D²	D²	D²	D²	*Ebb Neap Tide*	D²	*June 1st*
D²	D²	D²	D²	*Returning Flood*		*May 26th* _____ *May 27th*
D²	D²	D²	D²	D²		*June 1st*
D²	D² _____	D²	D²	*Ebb Neap Tide starting 2¾ after High Water*	*June 2nd* _____	*June 3rd*
D²	D²	D²	D²	*Returning Flood*	D² _____	D²
D²	D² _____	D²	D²	*Ebb Neap Tide starting 1¾ before High Water*	D² _____	D²
D²	D²	D²	D²	*Returning Flood*	D²	D²

N.B. Where the lines are broken the Floats were lifted and placed in the Currents.

SCALES.



S

Railway

Aveley Marsh

PURFLEET

Station

Ferry

Long Beach Toft

Thurrock Marshes

Church

Black Shelf

Grays Thurrock

Station

Church

London Tilbury & Southend Rail.

London Tilbury &

Madeira Cft

Dagenham Marshes

Little Ponton Ch

Mayesbrook Marshes

TONC

REACH

Stonewall

Tower

CLEMENTS REACH

Broadness

NORTHFLEET HOPE

Butterry Buoy

Wharf

East Tilbury

Church

Tilbury Marsh

Tilbury Ness

Tilbury Fort

Pier

Ruttery

Coldhouse Pt

Wharf

Queens Buoy

Cliffe Creek

Higham

H.W.O.S. & H.W.F.C.

Stone Marshes

Swanscombe Marsh

Ingress Abbey

Gallery Hill

Station

GREENHITHE

DARTFORD

Station

Telegraph

Station

Pharaoh College

Stuff

Tilbury Dock

Rosherville

Church

NORTHFLEET

Station

GRAVESEND

Terrace Pier

Pier

GRAVESEND REACH

Derton Wharf

Lobster Inn

Fk Madmy Canal

Gravesend Marshes

Shornemead Battery

Milton

Octagon

Windmill Hill

Chalk

NORTH

K

N

E

SCALES.

1 2 3 4 5 6 Statute Miles

1 2 3 4 5 6 Sea Miles

London Tilbury &

Mucking Ck

Mucking Flat

Pier

Mucking Light

S E A R E A C H

E. Blyth
Man Buoy

W. Blyth

Blyth Spit

B l y t h S a n d

LOWER HOPE REACH

Lower Hope Pt
Old Battery

C l i f f e M a r s h

C o w l i n g M a r s h

S t. M a r y ' s M a r s h

East Tilbury

Church

Battery

Coalhouse Pt

Wharf

Queens Buoy

Cliffe Creek

Chalk Mo.

Fleet

Highway 6.40 A.M

Church

Cliffe

Decoy Farm

St. Mary's Church

Northward Hill

Clinch Farm

Cowling Church

Cowling Street

Cuckolds Farm

Oste

High Halstow Church

Stoke

H i g h a m M a r s h

Shornemead Battery

Derdon Wharf

Lobster Inn

Gravesend Marshes

Higham

Upper Stoke Marsh

NORTH KENT RAILY

Chalk

Hoo

Hoo Church

Hoo Marshes

Okchan Marsh

Slede Ooze

Scar Elbow

Shoebury Ness Buoy

E A R E A C H

F A I R W A Y C H A N N E L

Yantlet Middle Ground

Yantlet Buoy

t h S a n d

Yantlet Spit

Y a n t l e y F l a t s

W⁹ Nore Buoy

N o r e S a n d

The Ridge

London Stone

CREA

S. M a r y ' s M a r s h

Allhallows

Decoy Farm

St. Mary's Church

Northward Hill

Cliffe Farm

Cuckolds Farm

Osterland

Church

Stoke

Grain Bridge

I S L E

St James's Church

The Cock

O F

Martello Tower

Home Farm

Outer Black Beacon

Inner Black Beacon

Southern Tree

White Beacon

G R A I N

Graan Spit

Little Nore

Garrison Pt

SHEERNESS HARBOUR

Dock Yard

Church

Blue Town

Beach Mill

New Church

Cheney House

Mile Town

Old Fleet

ISLE OF SHEPPI

S t o k e M a r s h

Upper Stoke Marsh

Stoke Ooze

C.G.

Elphinstone Pt

Colemouth Spit

R I V E R M E D W A Y

Saltpan Reach

Stoke Ness

Yantlet Creek

Hoo Ness

Hoo Marshes

Okcham Marsh

Sled e Ooze

Hoo

Hoo Church

Kitchale Reach

Burntwick Marsh

Swingate Creek

Smile Ness

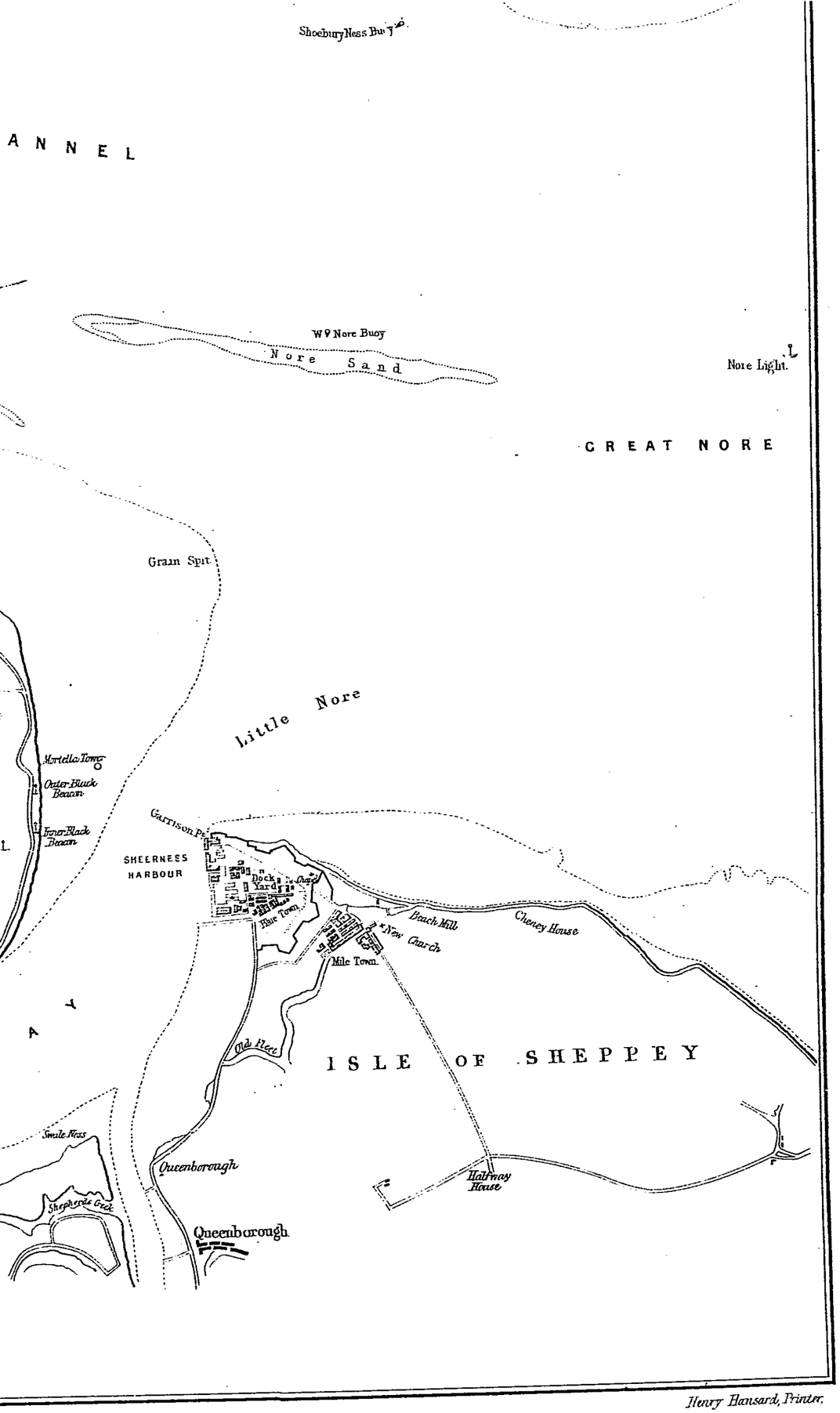
Shepherds Creek

Queenborough

Queenborough

Halfway House

Nº 233. Ordered, by The House of Commons, to be Printed, 3rd Aug



Henry Hansard, Printer.

№ 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.

APPENDIX X.

SCHEMES for the MAIN DRAINAGE of the METROPOLIS submitted to the REFEREES.

Appendix X.

1.—TABULAR STATEMENT of the various Schemes received. - - -

TABLE, No. 1.—The Sewage of each House to be

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Goddard, Henry -	Proposes to run the sewage from the water-closets of each house into an iron tank, which is to be hermetically sealed, and removed by drays, weekly, to a railway, and carried 30 miles into the country. Each house is to provide three of these tanks.	- - House sewage only to be removed.	- - - -
Hawkesley, Thomas, M. D.	Proposes to eject the sewage from the water-closets into an iron pipe, leading into an iron air-tight box, and deodorise by charcoal and ashes; the liquid to pass into the sewers, and the solid to be removed periodically by scavengers.	- - Proposes to allow everything except the matter from water-closets to flow into the sewers, and thence to the river.	- - - -
Williams, John - -	Proposes that Manure Companies should be formed for the daily removal of the sewage from each house, which is to be preserved for the companies under penalties.	- - The rainfall to pass off into existing sewers.	- - - -

TABLE, No. 2.—Plans in which the Metropolis is divided into Districts, to each of which a Reservoir

Banister, Thomas -	Proposes to form sewage districts - - - - - - - -	- - Separates sewage from rain water.	- - - -
Beadon, W. - -	Proposes tunnels under London to admit men and vehicles and to contain gas and water pipes, &c. Other tunnels at the sides, below the first tunnels, to be made for conveying the sewage, receptacles and machinery being placed at convenient distances for the purposes of deodorisation, steam power being used to create an artificial down draught to draw in smoke from flues.	- - - - -	- - - -
Burness, W. - -	Proposes to divide the metropolis into manurial districts, according to their levels, allotting land to each district to which the sewage is to be pumped, and filters to be erected so as to enable it to be applied continuously during the year. Companies to be formed to work the scheme commercially. Until this can be carried into effect, proposes to remove the sewage to the German Ocean, by means of trunk drains.	- - Separates the rainfall from house sewage.	- - - -
Footman, William -	Encloses observations on the sewage plan of the Metropolitan Board of Works. Proposes to divide the north and south side of the metropolis into two districts, upper and lower, and to form the south side into one district, and lead the sewage from the heart of London towards each, the upper or western one to have its sewage works at Sandy End or the outlet of the Counter's Creek, however, and the lower, or east at Old Ford, on the River Lea, the south side works being at Greenwich Marsh. Proposes to filter this sewage, and to run the purified water into the river. The foul material for the filter to be dried by furnaces arranged so as at the same time to ventilate the sewer; each terminus to be provided with reservoirs.	- - - -	- - - -
Gibbs, Joseph* (page 366.)	Proposes to collect the sewage by intercepting sewers in or near the outlets; to divide the metropolis into districts, each having its intercepting sewer, and its deodorising and pumping establishment. The concentrated material or precipitate of the sewage (one-thirtieth part) to be pumped through a main pipe, and either laid over the Bagshot district or the marshes of Kent and Essex, and the deodorised part of the sewage to be discharged into the Thames. That a land company should be invited to co-operate with Government in the agricultural distribution of the sewage.	- - - -	- - - -
Gotto & Stothert - (Pages 369 and 444.)	Proposes to divide the metropolis into four separate areas, each having a depôt or point of outfall. Proposes that these depôts should be at the mouth of the Kensington Canal, the Bank of the River Lea, the Deptford Creek at Greenwich, and at Battersea Creek; that intercepting sewers be made to convey the sewage to these depôts, where it is to be deodorised, the solid portion to be retained for manure, and the water used for the purposes of irrigation and flushing the sewers.	- - - -	- - - -
Henman, Charles -	Proposes a diverging instead of a continuous system of sewers, and conveys the foul sewage to two depôts, one on the east and the other on the west of the metropolis, on the north side of the Thames; the eastern division of the southern sewage being brought across the river at the Thames Tunnel, the western division being conveyed across in iron pipes. The sewage at the depôt to be filtered and deodorised, and the liquid, if pure, to be run into the river; if not pure, to be removed by a pipe to a final outfall in the river, east of London.	- - Proposes to place pipes on or below the invert of the present sewers, for removing the offensive sewage in a more concentrated form, the upper sewer remaining to remove surface water, which is to run into the Thames.	- - - -

* The References under certain names denote that the text of their

Appendix X.

- - - 1.—TABULAR STATEMENT of the various Schemes received.

collected into Cesspools or Moveable Receptacles.

Whether any, and if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE.		REMARKS.
		Without Deodorisation.	With Deodorisation.	
- - - -	- - - -	- - Proposes that the sewage in the before-mentioned tanks shall be sold for manure, and assumes that it will be very valuable.	—	—
- - - -	- - - -	- - - - - - - -	Deodorises in the cesspool.	—
- - - -	- - - -	- - The company to manufacture manure by boiling the fœces and urine with sawdust or clay.	—	—

is to be supplied, into which the Sewage is to be run, and there Deodorised or otherwise prepared for removal.

- - - -	- - - -	- - - - - - - -	- - The sewage to be disinfected and sold.	—
- - - -	- - - -	- - - - - - - -	- - For purposes of deodorisation London is to be divided into sewage districts.	—
Proposes to pump.	—	—	—	—
- - - -	- - - -	- - - - - - - -	- - Apparently proposes to apply the dried material as manure.	—
- - - -	- - - -	- - - - - - - -	- - With deodorisation.	—
- - - -	- - - -	- - - - - - - -	- - Proposes to deodorise the sewage by means of lime, charcoal, and sulphate of alumina, which is mixed with the sewage by means of a powerful mixing machine.	—
- - - -	- - - -	- - - - - - - -	- - Proposes the economical collection and distribution of the sewage for the purpose of manuring the land.	—

Plans or the Minutes of their Evidence are to be found on the page indicated.

(continued)

Appendix X—*continued.*

TABLE, No. 2, *continued.*—Plans in which the Metropolis is divided into Districts, to each of which

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Martyn, George -	Proposes two plans; 1st. To divide London into four districts, by a line passing north and south through Blackfriars'-bridge, and convey the sewage from the two easterly districts into the Thames; viz., one to Erith, and the other to Rainham; from the two westerly districts, to be deodorised, viz., one at Wandsworth, and the other at Putney. 2d. To convey the sewage to the Sussex coast, near Newhaven, and run it into the sea.	- - - - -	- - - - -
Slade, Thomas - -	Proposes to run the sewage into tanks, of which one is provided for 70 hours; the sewage to be pumped out every morning into carts and removed into the country. Deodorising powder or liquid is to be put into the tanks daily to prevent any smell.	- - Proposes to allow the rain-water to pass along the existing sewers, and the sewage to be run into tanks, as described.	- - - - -

TABLE, No. 3.—Plans in which the Sewage is to be allowed to flow down to the present supernatant Water being

Alderson, J. - -	Proposes to form a main low level intercepting sewer, which is to be connected with wharves in the river by means of other sewers or tunnels, in which the sewage is to be collected by manual labour, and packed in iron tanks or casks, so as to be forwarded along the coast in barges, or sent to railway stations. A tramway of granite to be formed along the bottom of the sewer. Places at the entrances of the sewers, floodgates of glass, with rebates of India rubber. Ventilators to be carried up party walls of houses on the principle of those at Middlesex Hospital.	- - - -	- - Allows storm water to escape into the Thames.
Bell, Sydney J. - -	Proposes that the sewage should be collected from the houses and streets into large portable cisterns floating in the river, and that at stated times steam-tugs should call at each station and tow them (the cisterns) far out to sea for the deposition of their contents.	—	—
Bentley, S. W. - -	Proposes to moor vessels at the mouths of each of the existing sewers, and to connect them with the sewers by means of iron or flexible pipes, floodgates being erected at the mouths of the sewers to insure a sufficient depth. The water to pass off by filtration, and the more valuable matter to be passed into the vessel.	—	—
Brickwell, W. - -	Proposes to deodorise the sewage at the mouth of each sewer, and allow the pure water to flow into the river and collect the sewage from several outfalls, and then deodorise it.	- - - -	- - - -
Dover, Richard - - (Pages 363 and 443.)	Proposes to construct deodorising works, the sewage-water before its discharge into the Thames being thoroughly disinfected; that the operation required to deodorise the sewage and separate the residuum to be so conducted that no nuisance shall arise in the neighbourhood, and the residuum converted into an available and profitable agricultural and commercial commodity.	- - - -	- - - -
Duff, Admiral - -	Proposes to run the sewage at existing outfalls into barges, one of which is to be continually off the mouth of each sewer, the sewage to be run through a gutta percha tube. The barges, when full, to proceed to some port at which the manure can be sold.	- - - -	- - - -
Edwards, William -	Proposes that the sewage should be filtered through a filter of his invention near Barking or North Woolwich, the liquid discharged in a pure state into the river, and the solid matter sold.	- - - -	- - - -
Higgins, Joseph, C.E.	Proposes to construct at the mouth of each existing sewer tanks provided with filters, into which the sewage would flow, and be filtered through ashes, sand, &c.; the pure water passing into the river, the ashes when saturated to be removed in barges.	- - - -	- - - -
Johnson, Howard F. -	Proposes to receive sewage at existing outfalls in barges, and then pump it into vessels, which are to convey it for the use of the land on each side of the river, or to be discharged into the sea.	- - - -	- - - -
Pettitt, Edwin - -	Would remove the deposits of sewage mud by barges to Essex and Kent, and then sell it for the price commanded by its agricultural value.	- - - -	- - - -
Senex - - -	Would take the sewage and convey it by means of iron vessels, and drop it into the sea.	- - - -	- - - -

Appendix X—*continued.*

a Reservoir is to be supplied, into which the Sewage is to be run and then Deodorised—*continued.*

Whether any, and if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE.		REMARKS.
		Without Deodorisation.	With Deodorisation.	
- - - -	- - - -	- - - - - - - -	- - Would deodorise the sewage from the two proposed western districts, and sell it.	—
- - - -	- - - -	- - - - - - - -	- - Proposes that the sewage should be used by market-gardeners, farmers, &c.	—

Points of Outfall in the River, and be there either run into Barges, or converted into Manure, the discharged into the River.

- - - -	- - - -	- - Proposes that the sewage should be sent into the country for agricultural purposes.	- - Suggests that deodorising might be employed.	—
—	—	—	—	—
- - - -	- - - -	- - The solid matter thus obtained to be transferred to barges, and removed to where it might be required.	—	—
- - - -	- - - -	- - - - - - - -	- - Does not describe the mode of deodorisation to be adopted.	—
- - - -	- - - -	- - - - - - - -	- - Proposes residuum of sewage should be used for agricultural purposes.	—
- - - -	- - - -	- - Would sell the sewage, to be applied to farms.	—	—
- - - -	- - - -	- - - - - - - -	- - Proposes to retain the solid matter when filtered and deodorised, for agricultural purposes. Estimates the value at 8,000,000 *l.* per annum.	—
- - - -	- - - -	- - Proposes to sell the ashes mixed with sewage derived from the filtering tanks, and considers that the system would be self-paying.	—	—
- - - -	- - - -	- - The sewage to be applied to the land in a liquid state.	—	—
—	—	—	—	—
—	—	—	—	—

(*continued.*)

Appendix X—*continued.*

TABLE, No. 3, *continued.*—Plans in which the Sewage is to be allowed to flow down to the present Points

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Steill, W. B.	Would form caverns from Blackfriars Bridge to the House of Correction, on the level of the bottom of the Fleet Sewer, for receiving and deodorising the sewage, and remove it by water when deodorised.	-	-
Smith, Charles Augustus. (Pages 423, 319, &c.)	Proposes that the surface drainage of London should continue to flow into the Thames, but that the sewer outfalls should terminate in two capacious tunnels, constructed one on each side, formed by embankments in the bed of the river between Battersea and Limehouse; that at certain intervals works should be erected on the banks of the river, provided with shafts down into the tunnels, and large furnaces at the top of each, which would draw up and consume the offensive gases; that the solid results should from time to time be removed in barges, to raise the level of the marsh lands near the river.	Yes	-
Strutt, James	Proposes that shafts should be dug down at the mouth of every sewer, as reservoirs for the settlement of the sewage, with an outlet in each at about half-tide, which would allow the water to pass off into the river, leaving the solid refuse to be carted away, and proposes to construct a high zinc chimney, which would convey off all smells. Thinks that the pollution of the river caused by the fluid part of the sewage would not be great.	-	-

TABLE, No. 4.—PLANS which propose that the Sewage should, after being collected in Central

Booth, G. R.	Proposes to divide the metropolis into 50 or 100 districts, in each of which the sewers are to be classified into high-level, low-level, and storm-water sewers; each district having its own reservoir or pool, not to be covered, as the sewage water would be deodorised before entering the pool; the purpose of which is, to supply the agriculturist with liquid and solid manures; the sewage to flow along canals from which it would be taken by agriculturists.	-	-Proposes that storm-water shall flow into the Thames.
Chard, Alfred	Proposes to concentrate the southern sewage at Deptford, and to pump it into a reservoir, from whence it is to be conveyed to another reservoir on Hayes Common, whence it is to be distributed into Kent and Surrey for irrigation; the northern sewage to be concentrated at Blackwall, and to be conducted up the River Lea for use, the sewage to be distributed in four directions in the country.	-	--Objects to separating storm-water from sewage, because it serves to flood the sewers.
Fowler, Charles C. E.	Proposes a plan for disposing of the sewage of the metropolis so as to render it available for fertilising the country. That the whole metropolis be divided into districts; that the sewage should be collected from each district into wells, from whence it should be propelled by pumps through main pipes, which pipes should run straight out into the country, embracing an area of about 24 miles radius, according to the spot which may be most suitable for the outfall and distribution of the liquid manure. Considers this scheme would not be more injurious, in a sanitary point of view, than land heavily manured.	-	-
Hilles, Thomas W.	Proposes to form 10 catch-water basins to the north of the Thames, and two to the south, each five acres in extent and 10 feet deep, to retain the rain-water and apply it to useful purposes, and thus to reduce in size and cost the tunnels necessary for the drainage of London. Would apply the rain-water to fountains, to watering the streets, and to flowing through the sewers.	--Proposes the separation of house sewage from rainfall.	---Storm-water to flow from catchwater basins into Thames.
Jeyes, John, and William Hull. (Page 447.)	Would intercept the sewage, either at the level of the Thames or in other parts, and pump it up to sufficient height to allow it to gravitate along pipes radiating in different directions into the country.	-	---Allow surplus water to flow into the Thames.
Marshall, Thomas	Would conduct the sewage into reservoirs on certain farms, one selected for each section of the metropolis at such a level as would drain it.	-	-
Martin, the late John (as sent in by Mrs. Isabella Martin.)	Proposes to divide the metropolis into districts, and to divert the sewage from the river by intercepting sewers, and carry it into the country for agricultural purposes.	—	—

Appendix X—*continued.*

of Outfall in the River, and be there either run into Barges, or converted into Manure, &c.—*continued.*

Whether any, and, if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE. Without Deodorisation.	UTILISATION OF SEWAGE. With Deodorisation.	REMARKS.
-	-	-	--Suggests deodorisation.	—
-	-	-	--Proposes machinery for disinfecting the sewage refuse.	—
-	-	--Proposes solid portions of sewage should be used as manure.	—	—

Positions, be pumped along Lines of Pipes into the Country, for the Purposes of Irrigation.

--Would use the tidal power of the Thames for lifting the sewage.	-	-	--Proposes to deodorise the sewage as soon as it begins to flow in the sewers, and to apply it in a liquid form to agricultural purposes.	—
--Proposes to pump all the sewage by means of a self-acting wind engine, which will require no attendance, but will regulate itself with every change of wind, being the cheapest motive power in existence.	-	--Would apply the sewage to land by irrigation.	—	—
-	-	--Irrigates the land. Assumes that land now worth 20 *s.* per acre would, with the sewage, be worth 6 *l.* per acre, and that 20,000 acres so irrigated would produce a profit of 100,000 *l.* per annum.	--Deodorisation to depend upon the will of those to whom it is distributed, but not to be a Government work.	—
-	-	--Contemplates the utilisation of the sewage, as its value would be increased by reducing the quantity of water mixed with it.	—	—
-	-	--The Board of Works to take barren land, and to run the sewage on to it until it is fertilised, and then to sublet the land.	—	—
-	-	--Proposes to drain off the water, and use the solid refuse for agriculture.	--Or proposes to deodorise the sewage by means of lime, according to the Leicester plan, and sell the manure.	—
—	—	—	—	—

(*continued*)

Appendix X—*continued.*

TABLE, No. 4, *continued.*—Plans which propose that the Sewage should, after being collected in Central

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Pratt, George	Proposes to divide the river front into 12 sections, corresponding with the sewer outlets, and at each principal one, to make a reservoir to contain 24 hours' sewage, which is to be pumped up, so as to flow by gravitation to land within 20 miles of London.	-	-- Allows storm-water to run into the Thames.
Rogers, William	Proposes to remove the sewage in four directions down sewers laid alongside the railways.	-	-
Smith, Thomas	Proposes that the sewage should be delivered at such a height as would enable it to be applied to the ground by irrigation.	-	-
Sowerby, William, C. E.	Proposes to divert the sewers at their lowest levels, viz. their outlets at the river, and form a series of intercepting sewers, each having a forcing engine with hydraulic power, for raising the sewage and pumping it away into the country. The perfect ventilation of the sewers would be effected by the engine fires, and by the head of each sewer being protected by the patent slate valves.	—	—
Stones, W.	Would conduct the sewage in a southerly direction to waste lands in Surrey or Sussex, and form reservoirs there, when the sewage is to be allowed to settle, and the supernatant waters run off.	-	-

TABLE, No. 5.—Plans which propose that the Mouths of existing Sewers should be connected either with Sewage would be conveyed to some Point down the Thames where

Austin, William	Proposes to construct a conduit tunnel under each fore-shore of the river from Fulham to Dagenham Marshes, and if necessary, to the mouth of the Thames. The north conduit to be 12 feet in diameter, and the south conduit 8 feet: the combined capacity of discharge being 300,000,000 gallons in 24 hours. The crown of the tunnels to be below low water mark. The tunnels to be constructed of patent concreted blocks. Cost of tunnels, &c. to Dagenham is estimated at 2,500,000*l.*; if extended to mouth of Thames, at 4,000,000*l.* If the sewers terminate at Dagenham, the sewage is to be run into two large reservoirs on each shore; those on the north side, capable of holding 24,000,000 cubic feet, those on the south side 13,000,000 cubic feet. If the sewers are continued to the mouth of the river, smaller reservoirs, or possibly none at all will be required.	-	-- Would allow storm-water to escape into the river; but if objected to, would propose that a special tunnel should be constructed to remove it, and that storm-water reservoirs should be formed in connexion with an embankment to be available when storms occur at high water.
Bell, Richard	Proposes to form a large reservoir in Dagenham Marsh, divided in two parts by a filtering medium. The reservoir to be 10 feet deep, and the top surface of water in it to stand at 5 inches above low water, and to be filled every tide with water from the river. Two main sewers to lead into this reservoir, one from Kensington Gardens, and the other from Hampstead. Assumes that 2 cubic feet of sewage per head per diem is the whole flow of sewage in the metropolis; and takes the rainfall at the amount mentioned by Mr. Bazalgette. The pure water after being filtered to run into the river.	-	-
Burch, W.	Proposes to construct a sewer by means of a portable vertebrated dam along the bed of the river, 24 feet in diameter, to discharge at Sea Reach. Considers that if a large reservoir were formed at Sea Reach, and if the capacity of the sewer were such as not to require more than 8 and 10 feet fall, the discharge might be effected by tidal action.	—	—
Burley, John	Proposes to construct intercepting drains at the level of the river, and to form cesspools or reservoirs at some point down the river where the sewage is to be filtered, and the clear water run into the Thames.	-	-
Chowles, A.	Intercepts the sewage from the river by two tidal sewers, (one on each side of the river from Battersea Bridge to Gravesend,) sufficiently large to receive the sewage. The crown to be 4 feet above high water. The depth to be 15 feet at the upper end, and 20 feet at the lower end. A large reservoir to be constructed at the upper part of the sewer to be filled at high water; the water to be run out at half ebb to assist in scouring the sewer.	-	-

Appendix X—*continued.*

Positions, be pumped along Lines of Pipes into the Country for the purposes of Irrigation—*continued.*

Whether any, and if so, what Method of Pumping or Moving Sewage by Mechanical Means is procured.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE. Without Deodorisation.	UTILISATION OF SEWAGE. With Deodorisation.	REMARKS.
-- Pumps the whole sewage by means of an apparatus having wheels 60 feet in diameter each, with 36 buckets attached, each bucket containing 72 cubic feet of sewage.	-	-- Proposes that sewage should be applied to land in a liquid form, and considers that it would produce an annual revenue of 1,120,416*l.*	—	—
-- Proposes to use wind or steam power for pumping.	-	-- Liquid sewage to be applied to irrigation.	-- Solid sewage to be deodorised and sold for manure.	—
-	-	-- Proposes that the sewage should be used for irrigation.	—	—
—	—	—	—	—
-	-	-- The solid refuse formed to be dried, and compressed by hydraulic pressure, and sold for manure.	—	—

a Main Drain on each side of the River, or with one Central Drain in the Bed of the River, by which the it would be Deodorised, or discharged without Deodorisation.

-- The whole sewage must be lifted, and proposes to make use of the river stream, and steam power, as an auxiliary.	-- Proposes that the crown of the arch of each sewer should form a foundation for river walls to be erected along the banks of the Thames.	-- Proposes that the sewage should be applied in a liquid form to agricultural land, if the outfall is at the mouth of the Thames.	-- If the outfall is at Dagenham, the sewage is to be deodorised by means of Collins' patent chemicals.	—
-	-	-- Proposes to retain the fertilizing material of the sewage after filtration.	—	—
—	—	—	—	—
-	-	-- Proposes to allow the sewage to settle and then to filter it, and to saturate tan with the liquid. The refuse and the tan to be sold for manure. The liquid to be used, if people will buy it, if not, to be run into the river.	—	—
-	-- Proposes that the excavations for the sewers should be used to form an embankment to the river.	-	Would deodorise the sewage.	—

(continued)

Appendix X—*continued.*

TABLE, No. 5, *continued.*—Plans which propose that the Mouths of existing Sewers should be connected either with a Main Drain on each side of the River, or with one Central Drain, &c.—*continued.*

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.	Whether any, and, if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE. Without Deodorisation.	UTILISATION OF SEWAGE. With Deodorisation.	REMARKS.
Cochrane, A.	Proposes to carry off the sewage of London through a main sewer stretching from the lowest level in Chelsea to the mouth of the Thames; will not require pumping by steam power, excepting at the mouth of the river, in order to force it out to sea or to distribute it for agricultural purposes; would undertake this plan for 2,000,000 of money.	-	-	-	-	No deodorisation	-	Proposes, if his plan is adopted, to pay off the National Debt in 20 years.
Couchman, J. W. (Page 440.)	Proposes to divide the metropolis into sections, and convey the sewage, by four reception sewers on the north side of the Thames, and two on the south side.	—	—	—	—	—	—	—
Cox, Charles	Intercepts the sewage at a low level by two tunnels, one on each side of the river; the liquid to flow into the Thames beyond Woolwich.	-	-	-	-	The sewage to flow through pipes into from 1,000 to 2,000 galvanized iron tanks, capable of holding five tons of solid manure; each tank to be provided with a moveable filter, which allows purified liquid to pass into the Thames; the solid manure remaining to be lifted into railway trucks.	—	—
Deakin, John	Proposes to convey the sewage from the outfall of the existing sewers by a tunnel on each side of the river. The northern tunnel commencing at Chelsea, and following the course of the river to Millwall, thence straight to Blackwall, and by the North Woolwich Marshes to the sea. The southern tunnel to commence at Vauxhall Bridge, and to be continued by the river side to Greenwich, and thence in a straight line to Woolwich, Erith, Greenhithe, and Gravesend, to the sea.	-	-	Contemplates pumping the sewage.	The scheme may be connected with the Thames embankment.	Without making the use of sewage manure a part of the plan, he considers that this scheme would afford every requisite facility for the application of sewage to land in a liquid form.	—	—
Dike, Edwin	Proposes to carry the sewage away by a large tunnel in the London clay, on the south side of the Thames, the northern sewers being connected by a tunnel under the river; the tunnel to be constructed by being excavated, and the interior baked, or else lined with bricks.	-	-	Sewage to be all pumped.	-	Proposes to filter the sewage, and subject the solid deposit to heat, in order to decompose it and render it valuable for manure.	—	—
Dixon, Benjamin (Page 442.)	Proposes that there should be constructed four brick reservoir tunnels, each 15 feet in diameter, 1,200 feet long, and capable of containing 2,000,000 cubic feet of sewage. When this is full the sewage is to be allowed to remain at rest for eight or ten hours to settle, and the supernatant water is to be run into the Thames, the silt to be received in covered tanks alongside.	-	Provides an outlet for storm-water, by means of tunnels, under the reservoir tunnels.	Provides two steam-engines for pumping the sewage.	-	The silt is to be used for manure.	—	—
Gisborne Lionel, C.E. (Pages 369 & 443.)	Proposes the embankment of the Thames between Lambeth and London Bridge, and suggests that it affords the opportunity of constructing a low-level sewer.	-	-	-	Proposes embankment of Thames.	—	—	—
Goodwin, Charles	Proposes a low level tunnel, to commence at Woolwich, and to pass from thence to Greenwich, Deptford, Lambeth, and under the Thames near the Penitentiary, and then through St. James's Park, Cockspur-street, St. Martin's-lane, Holborn, Hatton-wall, St. John's-square, Tabernacle-row, and then on to Stepney-green, under the Regent's Canal, and under Bow Creek, to pass into West Ham Marshes, through the Plaistow, East Ham, and Barking Marshes, under Barking Creek to the north of the town, and to West Thurrock, and thence into a reservoir, where the sewage is to be allowed to settle, and the clear water to pass into the Thames.	-	-	-	-	Proposes that the sewage should be allowed to settle in a reservoir, and the silt be used for manure.	—	—
Gove, Alexander (Page 385.)	Proposes to construct a canal to a point 32 miles down the river, below the low-water mark, subject to tidal influence. Sewage left at bottom of canal to be removed by barges.	-	-	Proposes to use pumping machinery, if necessary.	—	—	—	—
Grimes, Jeremiah	Would construct a main sewer on each side of the Thames, to convey the sewage to reservoirs between Greenwich and Woolwich, and opposite; each sewer to consist of four drains of cast iron, to admit of frequent cleaning and repairs. Arrangements are provided for ventilation. The sewage to be passed from the reservoirs into filtering beds, and the clear water to pass into the Thames.	-	-	Sewage to be pumped from reservoirs into filtering beds.	-	The sewage to be filtered, and the filtered matter to be dried and sold as manure.	—	—
Hanson, George	Proposing two intercepting sewers or tunnels, one on each side of the river, the top to be four feet below the bed of the river; the tunnels to be lined with cast-iron segments, bolted together; and to be excavated by means of a submarine plough, described in the communication.	—	—	—	—	—	—	—
Harris, Henry	Would intercept the sewage by a circular sewer at the depth of Thames Tunnel, which is to form part of the sewer.	—	—	—	—	—	—	—
James, W. H.	Proposes that the whole of the fresh water of the Thames shall be diverted from the river at Teddington, to afford a water supply for London, and then to be passed through sewers, which will remove the general sewage, and by means of a tunnel be emptied into the sea at Rayleigh, or Rochford, in Essex. The southern sewage is to be conveyed across the river to the north side at the Thames Tunnel. The main feature of this scheme is to provide that salt water shall flow up to London, so as to secure to the metropolis the advantage of being on a tidal estuary. He would also construct a new series of sewers for matter from water-closets and privies.	-	-	-	The sewer to afford a foundation for embanking the Thames from Chelsea to the Tower, and affording a promenade and railway.	-	The sewage from water-closets, privies, &c., to be deodorised and converted into gas for lighting London.	—

(continued)

Appendix X—*continued.*

TABLE, No. 5, *continued.*—Plans which propose that the Mouths of existing Sewers should be connected

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Jeans, J. H., M.D.	Proposes to construct a leviathan drain of great size and strength on each side of the Thames, to commence some miles above London, and to be carried 20 or 30 miles below London, terminating, if possible, in a limestone stratum, away from a thickly populated district; the drains to be outside of stone, and inside of brick, with floodgates at intervals, to be opened and shut for repairs. Pipes to be laid from the Thames to the excreta sewers, and water to be continually pumped through these pipes to wash them out. The waste water to be carried by a waste drain down to the sea.	- - - -	- - - -
Judd, W. H.	Apparently, would construct a low level intercepting sewer on each side of the river, the southern sewer to be carried across to the north at the Thames Tunnel in boiler plate conduits. The united sewage to be here pumped into a canal, and run down into one of the creeks of the Broomhill River, or the Crouch, Colne, or Blackwater.	—	—
Kitson, John	Proposes to construct a sewer on the south side of the Thames from Putney to Gravesend, and a sewer on the north side from Putney to Barking, with connexions across the river at several points.	—	—
Leslie, John (Pages 399 & 448.)	Proposes a tunnel at a low level from Putney to Sea Reach, along the south side of the river; the northern sewage being brought across the river at three points.	- - Would separate the house sewage from the rainfall, the latter being permitted to flow into the river direct.	- - - -
Lloyd, E.	Would construct a low level sewer on each side of the Thames, with an outfall on the north side of the River Roding, and on the south side of the River Darent.	- - - -	- - - -
M'Call, Robert	Proposes that sufficient space should be taken in when laying the main drains from London to the sea, so as to admit of all the curves in the river being made straight, which would regulate the ebb and flow of the tide, and improve the navigation. Calls attention to the draining of Windsor and Reading as they both drain into the Thames; and to his new plan for purifying sewage by infiltration, and rendering it fit for infusing tea, and all domestic purposes. Would undertake to complete the drainage of London and the reclaiming of Goodwin Sands, by conducting the sewage there, within two years.	- - - -	- - - -
Malins, William	Proposes that the sewage shall be removed from the low levels by iron pipes from the mouth of the sewer as far as Dowgate, and then by a sewer similar to Mr. Bazalgette's proposed low-level sewer; the low-level drainage of the south side being brought across the river. Mr. Malins states that he does not contemplate the consideration of the high-level intercepting sewers, or state anything concerning the position or number of the outfalls.	- - - -	- - Storm water to flow into the Thames.
Moore, Charles F.	Proposes to discharge the sewage into the German Ocean by a low-level tunnel on the north of the Thames, except that from the western districts, which is to be collected at pumping stations, removed from houses, and sold as manure. The sewage from the districts south of the Thames to be united to the northern sewage by an inverted tube through the Thames Tunnel. The outfall in the sea to be at such a distance from the mouth of the Thames as to prevent the formation of a bar.	- - - -	- - Proposes that storm water should flow through proper channels into the river.
Morewood, W. (Pages 404 & 450.)	Proposes to conduct the sewage through two tunnels, constructed under the streets, and to discharge it into the Thames at Barking Creek, 13 miles below Westminster Bridge.	—	—
Morris, William	Proposes a plan for the embankment of the Thames from Battersea Bridge to Greenwich, with main low-level intercepting sewers, and a single continuation to filtering beds and deodorising works, 14 miles below London Bridge.	- - - -	- - - -
Place, G. G.	Proposes to convey the sewage by a large drain along the banks of the Thames to a reservoir, where it is allowed to settle, and the water to run off into the Thames; the solid portion to accumulate for two years in the reservoir, and then another to be opened. Three reservoirs in all are to be provided, so as to render it unnecessary to remove the silt from the first, until it had become dry and hard. Estimated cost of 7,000,000 *l.*	- - - -	- - - -
Rice, James	Would remove the sewage by means of two tunnels, one on each side of the river, into which the Thames water is to be admitted at intervals for cleansing them; the tunnels to conduct the sewage to pits, where it is to be filtered, and the water to pass into a lake, there to undergo further purification and pass off into the river. When the pits are full, new ones are to be excavated.	- - - -	- - - -

Appendix X—*continued.*

either with a Main Drain on each Side of the River, or with one Central Drain, &c.—*continued.*

Whether any, and if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE. Without Deodorisation.	UTILISATION OF SEWAGE. With Deodorisation.	REMARKS.
- - The sewage in this drain to be propelled at a greater rate than its gravity would permit of by paddle-wheels, which would also propel the gases.	- - Proposes to construct works across the river, low down, to keep the water from flowing out with the tide, and thus prevent the mud from being uncovered; four sets of floodgates being provided for the passage of vessels, or for letting the water in and out.	- - - - - - - -	- - The gases which are in the main drain are at its outfall to be passed through a cistern of water, in which chemical re-agents are to be present; any that remained being passed through red-hot tubes, suitably constructed fires, and up a tall chimney. The sewage to be mixed with quicklime, charcoal, and plaster of Paris, all powdered, and run into covered pits of a conical form, leading one into another, the further ones being filled first. When hardened, to be dredged out by machinery, and loaded into railway trucks.	—
—	—	—	—	—
—	—	—	—	—
- - - -	- - - -	- - Proposes that the sewage should be utilised in its passage through Surrey and Kent.	—	—
- - - -	- - Would have an embankment on both sides of the river.	—	—	—
- - - -	- - - -	- - Proposes to fertilize the Goodwin Sands with the sewage, and to plant a belt of fir trees on them.	—	—
- - The same amount of pumping as in Mr. Bazalgette's plan would be necessary.	—	—	—	—
- - Duplicate pumps to be provided for pumping part of the sewage at high water, allowing the remainder to run out at low water.	- - - -	- - Pumping stations to be provided at interest, at which farmers may purchase liquid sewage; and facilities to be afforded to parties desirous of manufacturing guano from sewage.	—	—
—	—	—	—	—
- - - -	- - Proposes embankment of Thames.	- - - - - - - -	- - Proposes works for deodorisation of sewage.	—
- - - -	- - - -	- - Proposes to sell the silt, when dry and hard, for manure; and expects to realize from 4 to 6 per cent. on the outlay.	—	—
- - - -	- - - -	- - The contents of the pits to be applied to chemical and agricultural purposes.	—	—

(*continued.*)

Appendix X—*continued.*

TABLE, No 5, *continued.*—Plans which propose that the Mouths of existing Sewers should be connected either with a Main Drain on each Side of the River, or with one Central Drain, &c.—*continued.*

NAMES.	GENERAL DESCRIPTION of proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from River Water is intended.	Whether System provides that Storm Water shall flow into the Thames.	Whether any, and, if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE. Without Deodorisation.	UTILISATION OF SEWAGE. With Deodorisation.	REMARKS.
Rice, M. B. H. -	Proposes to construct two sewers, one on each side of the river, into which the Thames is to flow through valves, at high water, to clean them. The tunnels to be emptied into meres or settling pits, in which the solid part is to subside, and the liquid to pass into the river.	- - - -	- - - -	- - - -	- - - -	-- The solid portion to be removed from the pit when it is full, and converted into manure. Considers that manufactories for the purpose would spring up in the neighbourhood.	—	—
Roberts, C. H. - -	Proposes that the sewage should be intercepted from the Thames by a sewer parallel to the river.	- - - -	- - - -	- - - -	-- The intercepting sewer to be combined with the construction of quays.	- - - - - - - -	-- Proposes to alter the chimnies of all the houses in London, so that they shall be led into the sewers, a down draught being maintained by means of a fan kept in motion by a steam-engine, of which one is furnished to each block of houses. The smoke would deodorise the gases from the sewage, and would then be passed over the fire attached to the steam-engine.	—
Sanders, the Rev. J. -	Proposes that sub-aqueous iron ducts, capable of receiving the whole sewage, should be submerged beneath the stream, and buried in the solid bed of the river. These channels to be constructed of boiler plates in a square form, but the bottom, tops, and sides being curved outwards; the one for the north side to commence with a sectional area of 12 feet, to increase to 160 feet, the southern channel to commence with an area of 12 feet, to increase to 40 feet. The excavation for placing these ducts to be performed by dredging. At some point east of London the southern culvert to be carried across the river, to join the northern channel. The channel to run from Putney to the "Lower Hope," where it is to discharge into a large reservoir, and receive the drainage of all towns on its route; water towers being provided at intervals to admit the Thames at high water, for the purpose of flushing the channels. All existing private drains emptying into the river to be turned into the public drains, and the sewage from these to be carried by iron pipes into the new ducts in the river.	- - - -	- - - -	-- The sewage to be pumped from the reservoir into the river at the turn of the tide, or run out at low water.	- - - -	-- Persons owning farms along the banks of the river to be at liberty to pump up the sewage from the channels for agricultural purposes, at rates and on conditions to be settled by the authorities.	—	—
Taylor, John - -	Proposes a main sewer along the margin of the river, to convey the whole of the sewage by gravitation to the sea; the sewer to be cleansed by admitting the river through sluices.	- - - -	- - - -	- - - -	-- Proposes embankment of Thames.	—	—	—
Taylor, I. N., Rear-Admiral, C. B.	Proposes main culverts on either side of the river to receive the sewage, the southern drainage being brought across the river. The united sewage to be taken in a culvert to the German Ocean, near the Blackwater. The culverts to be constructed, the lower part of iron, the upper of brick. The main culvert to follow the sinuosities of the ground, the sewage being forced up one inclined plane by a large wheel, and allowed to gravitate down the next.	- - - -	- - - -	-- Proposes to raise the sewage by large wheels and inclined planes.	- - - -	- - - - - - - -	-- Proposes to establish deodorising works, to convert the sewage into manure.	—
Thornton & Jackson - (Pages 424 and 466.)	Proposes to convey a deep main sewer on the south side of the river, from Kensington Canal to Erith Reach. It passes under the Thames at Galleon's Reach, and to Plumstead Marshes, when it is joined by a deep main from the south side. From this point this enlarged main sewer is carried to Erith Reach, whence it is connected with large reservoirs. The deep main would be 40 feet below high water at Kensington, and would fall to 70 feet below high water at Erith. Proposes to construct two covered reservoirs at Erith Reach, each to be six acres in extent, and 24 feet deep, with a capacity of 40,000,000 gallons. The sewage to be lifted 60 feet into these reservoirs, and to be allowed to filter.	- - - -	- - - -	-- The sewage raised from five wells, each with two pumps worked with engines of 250-horse power; thus 1,250-horse power is required in all.	- - - -	-- Considers that a deodorisation may be desirable on sanitary grounds, and in that respect to profit.	- - - - - - - -	-- This scheme is very complete; the estimated cost is 5,200,000 *l.*, and Messrs. Thornton & Jackson would be willing to maintain the works and pump the sewage for 147,600 *l.* per annum.
Thrupp, W. H. -	Proposes to run the sewage of the south side of London into the Commercial Docks, which he considers could be obtained for a moderate sum; and thinks that the sewage of the north side might be run into the Victoria Docks.	- - - -	- - - -	- - - -	- - - -	-- Proposes to remove the deposit in covered lighters with lime, to be used in the neighbouring market gardens.	—	—
Titheridge, W. H. W.	Proposes that the main sewers should be constructed by the side of the Thames, in connexion with a Thames embankment on either shore, and that the sewage should be taken to two reservoirs to be deodorised.	- - - -	- - - -	- - - -	-- Proposes to embank the Thames on both sides.	- - - - - - - -	-- Would run the sewage into reservoirs, and then treat it so as to deprive it of its noxious qualities without impairing its fertilising ones, and at the same time render it easily portable by sea or land, but does not explain how.	—
Tozer, Thomas - -	Proposes to run, 1st, a sewer on the south from Chelsea to Greenwich and Woolwich, to take the sewage of Clapham, Brixton, Camberwell, and Lewisham, and to have an outfall somewhere beyond the metropolis, in accordance with the Act; the sewage to be deodorised, and the fluid portion to pass by percolation into the river. 2d, a sewer along the river, from Vauxhall to within a quarter of a mile of the Thames Tunnel; then to pass through Rotherhithe Marshes, across Limehouse Reach, and through the Isle of Dogs, to cross the river again at Blackwall, and join the first sewer. 3d, a sewer on the north of the river from Battersea Bridge to near the Thames Tunnel, and to join the first sewer on the southern bank at Rotherhithe, and again at Limehouse. 4th, a sewer from Hammersmith, to join the sewer at Battersea Bridge. The sewers to be of brick, except in some special parts, when galvanised iron, one inch thick, is to be used. The drainage of the north of Islington, Whitechapel, Hackney, and Dalston to be carried to the Essex coast.	- - - -	- - - -	- - - -	- - - -	- - - - - - - -	-- Proposes deodorisation, and the solid portion to be removed and dried by the application of heat.	—

Appendix X—*continued.*

Appendix X—*continued.*

TABLE, No. 5, *continued.*—Plans which propose that the Mouths of existing Sewers should be connected

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Trego, William	Proposes to construct main lines of sewers on each side of the Thames, following the course of the river; which are to conduct the sewage into filtering beds of rough gravel and fine sand 12 feet thick, the upper surface of which is six inches above Trinity high-water mark; the sewage is pumped into these, and the filtered water passes off into a large reservoir, connected by a canal with the river, which will form a dock for boats, which are to come to take away the manure formed by the sewage deposit.	- - - -	- - - -
Waldron, William	Proposes a scheme for dividing the river into tidal Thames and stream Thames, which will intercept the sewage from flowing into the river, and by some deodorising works render it not only innocuous but potable.	—	—
Burge, Earle, & Ward, Messrs.	Intercepts the sewage north of the Thames, and carries it through one-half of the Thames Tunnel to join the southern drainage. The combined stream of north and south drainage is to be conveyed to some point on the south coast, and run into the sea.	- - - -	- - - -
Wildman, John	Proposes to intercept the sewage at a low level by a sewer constructed on the fore-shore of the river.	- - - -	- - - -
Worsley, Sir William, Bart. (Pages 438 and 470.)	Proposes to convey the sewage by a main culvert from Battersea, chiefly along the bed of the river, to a cesspool in the Greenwich Marshes, whence it is to flow into the river at the turn of the tide. This scheme is included in a comprehensive project for altering the bed of the river, and beautifying the metropolis.	—	—
Wright, H. G., M. D.	Intercepts the sewage apparently by a low level sewer, but does not enter upon the subject of the position or number of its outfalls.	- - - -	- - - -

TABLE, No. 6.—Plans which propose to intercept a Portion of the Sewage by a high Level intercepting gravitate to deodorising Works, or to an

Alison, Alex.	Proposes to intercept from the Thames only so much of the sewage as can be removed by gravitation to Barking, or further down the river; leaving the remainder to flow into the Thames. He also proposes the drainage of the Essex and Kent Marshes.	- - - -	- - - -
Barn, Charles	Proposes to divide London into three main districts, viz., 1st northern upland district, comprising all above 30 feet above H. W. M.. 2d. north marsh district, extending from the boundary of north upland district to the north shore of Thames. 3d. south marsh district comprising all districts south of Thames, including Greenwich and Woolwich; sewage of 1st district to be conveyed under ground to Bow Church and then on arches across the River Lea to Plaistow, and then into a chief main sewer, or reservoir which conducts it to the confluence of the River Roding with the Thames at Barking; the sewage from the third district to be brought across the river by a large syphon, and joined to the sewage from the second district in a well at Plaistow, and there to be pumped into the chief main sewer or reservoir. The sewage to be discharged during the first two or four hours after high water.	- - - -	- Proposes that storm outlets be provided at several places.
Denton, J. Bailey (Pages 362 and 440.)	Calls attention to the similarity between his plan submitted in 1849, and the plan adopted by the Metropolitan Board of Works; except that he proposed to take the sewage of the district to the west of Millbank Penitentiary, direct to Deptford, by crossing the river near the new bridge. Would combine with any system of the drainage of London, the drainage of the marsh lands in the bounds of the city conservancy, in order to provide for the extension of the outfall.	- - - -	- - - -
Husband, William (Page 389.)	Proposes to convey the north-western sewage across the Thames, near Chelsea through a submerged pipe, and then to lift it into the main high level sewer on the south side, in order to relieve the low level or city sewer on the north side. Proposes to convey the sewage from Hungerford Bridge to London Bridge (at that part of the river where the construction of a sewer would most interfere with the traffic), through a wrought iron tube, receiving in its course water from the intermediate sewers. Suggests that, with regard to the discharge of sewage, a double outfall would have fewer objections than a single. That the discharge, if equally divided on either side of the river, would be 50,000,000 gallons; half of which would be accomplished by gravitation; the other half to be raised to the average height of 45 feet by power. To lift this fluid, pumps would be unsuited; from the fact of so much solid matter being mixed with it; that the valves of pumps would soon become choked and often broken. The machine which appears best adapted for lifting sewage is the "taper screw," driven by steam engines, being a modification of the open screw.	- - - -	- - - -

Appendix X.—*continued.*

either with a Main Drain on each Side of the River, or with one Central Drain, &c.—*continued.*

Whether any, and if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE. Without Deodorisation.	UTILISATION OF SEWAGE. With Deodorisation.	REMARKS.
- - - -	- - - -	- - - - - - - -	- - Proposes that the sewage should be filtered through lime of a depth of one foot, and peat charcoal three feet deep. The deposit to be sold as manure at 3*l.* per ton.	—
—	—	—	—	—
- - - -	- - - -	- - Proposes to form stations on the line for the purpose of supplying sewage for agricultural purposes.	—	—
- - - -	- The proposed sewer to be a sub-structure for an embankment of the river.	—	—	—
—	—	—	—	—
- - - -	- - Proposes to carry a sewer under new quays along the Thames.	- - Apparently proposes to sell the product for manure.	—	—

Sewer, the remainder to be received in and raised by artificial means from a low Level, so as to enable it to Outfall down the River, or to the Sea Coast.

- - - -	- Would embank the river on both sides; so as to enclose all mud banks.	—	—	—
- - - -	- - - -	- - Proposes manure works on trial near the Surrey Docks; for conversion of sewage into solid manure, or for forcing sewage through pipes for irrigation. Pipes for irrigation by gravitation to be laid from the chief main sewer, or reservoir.	—	—
- - - -	- - - -	- - Proposes that sewage be used for irrigation.	—	—
- - That the "taper screw" propelled by steam engines, should be used instead of pumps for the raising of sewage; these are used near Delft and Rotterdam, in Holland, with the greatest success. The course of the water through the machine being in a line with the sewer, the friction of large substances passing through it would be very slight; the form of the screw being taper, the channel of course increases towards the top. The great durability of the screw, though of wood, is also a recommendation, the weight of water being carried by the cast iron cradle in which the iron screw moves. A screw of 11 feet diameter would lift 20,000,000 gallons of water in eight hours. The cost of machinery, fixed complete, about 560,000 *l.*	- - - -	- - Deodorisation not entered upon.	—	—

(continued)

Appendix X.—*continued.*

TABLE, No. 6, *continued.*—Plans which propose to intercept a Portion of the Sewage by a high Level intercepting

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Jackson, James Young	Adopts Mr. Bazalgette's plan, except that he contemplates the utilisation of the sewage at the outfall.	- - - - -	- - Storm-water to flow into the Thames.
M'Clean, J. R. - - (pages 402 and 448.)	Proposes to pump the whole of the southern sewage across the river at Southwark-bridge, and to pass it into Mr. Bazalgette's northern system, through the Aldersgate-street branch, and then to take the sewage at Mr. Bazalgette's pumping station at Abbey Mills, and to convey it by one sewer to an outfall on the Essex coast, between the mouth of the Crouch and the mouth of the Blackwater.	- - Provides for removing a proportion of rain water.	- - - -
Mitchell, Joseph -	Proposes to connect the construction of a high level intercepting sewer, with the construction of a railway through London; and adopts the plan of the Metropolitan Board of Works for removing the remainder. The main sewer between London and the outfall, being at such a depth as to enable adjoining land to be irrigated by means of sluices.	- - - -	- - - -
Murray, J., and Mylne, R. W. (pages 410 and 460.)	Propose to divide each side of the Thames into three drainage areas. On the north side to remove by gravitation the sewage intercepted by high-level sewers, and convey it over Hackney Marsh, near Temple Mills, by an aqueduct, to a point beyond Barking, to be there united with the sewage of a low-level district (bounded on the west by Grosvenor Canal and Grosvenor-place), which would be pumped from near Abbey Mills. The remainder of the drainage of the west district to be conveyed under the river at Battersea to the south side, and then lifted into a high-level intercepting sewer at Wandsworth Common, which is also to receive the sewage of the western area of the south side; whilst that of Battersea, Lambeth, Southwark and Deptford, would be conveyed by a low-level drain to near Whitepost-lane, and there raised into the high-level sewer; the united sewage to be conveyed to near Plumstead (where it is to receive the drainage of Greenwich and Woolwich), and thence by Erith, to the mouth of the Darent, and be discharged into the Thames.	- - - -	- - - -
Richardson, William, and Clark, G. (page 416.)	Propose to collect the sewage from the works proposed by Mr. Bazalgette, into two reservoirs; one for the north side of the river and the other for the south side, and to pump it from these reservoirs into two sewers, which are to convey the northern sewage to below Southend Pier, and the southern to Yantlet; these sewers to be above ground, and to be constructed of iron, lined with pottery, and to be so inclined as to allow the sewage to gravitate to the sea. Consider that the above-ground main would be cheaper than an ordinary canal or sewer; while it will afford facilities for taking the sewage for irrigation, or for the manufacture of manure.	- - - -	- - - -
Treeby, T. W. G. - (page 469.)	Proposes to convey the northern sewage in a main sewer, commencing at Albion-street, Oxford-street, along Oxford-street and Holborn, and across the Fleet Valley by a bridge, through Newgate-street, Cornhill, Whitechapel to Bow Creek, and finally to discharge at a point a mile from the sea near Shoebury Common, the lower level to be pumped, the southern drainage to be all pumped and conveyed to Yantlet Creek. He also combines a railway with the sewer from Paddington to the City.	- - - -	- - - -

TABLE, No. 7.—Miscellaneous Plans. - - - - - - - -

Allingham, Edward -	Proposes that all communication between the sewers and the river should be cut off, and the sewage preserved for manure.	- - - -	- - - -
Archer, Chas. Maybury	Proposes to construct a vast atmospheric tube for the conveyance of the sewage on one or both sides of the river, from Putney to a grand terminus, or deodorising reservoir on the sea coast.	- - - -	- - - -
Banister, Elizabeth R.	Proposes to construct tanks in each house for the reception of the sewage, which is to be turned off into main-street sewers; these sewers to radiate from all parts of London, fertilising the country on each side of the Thames, and afterwards to flow into some distant river, or in the sea. Would also construct reservoirs, at convenient distances, along the sewers, from which farmers may obtain liquid manure at a cheap rate.	- - - -	- - - -
Boyd, James - -	Proposes to remove the sewage by a conduit in connection with a ship canal to Shoreham.	—	—

Appendix X.—*continued.*

Sewer, the remainder to be received in and raised by artificial means from a low Level, &c.—*continued.*

Whether any, and if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE. Without Deodorisation.	UTILISATION OF SEWAGE. With Deodorisation.	REMARKS.
- - - - -	- - - - -	- - Would construct reservoirs at Mr. Bazalgette's outfalls, in which the solid portion may settle, and the liquid run off into the Thames at Erith.	—	—
- - In addition to the pumping required for the northern sewage by Mr. Bazalgette's plan, he would lift the whole southern sewage 60 feet.	- - - -	- - Proposes that sewage shall be used for irrigation.	—	—
- - Estimated cost of raising 1,000 gallons of sewage 60 feet high at 1 *s.* 2 *d.*, and proposes to raise all the sewage to this height.	- - - -	- - Proposes that the sewage shall be applied to the irrigation of land.	—	—
- - The sewage in the lower level of the west district, north side, and all on the south side, to be pumped.	—	—	—	—
- - - - -	- - - - -	- - Propose the irrigation of land by sewage water.	—	—
- - The sewage in the lower level of the north side and all on the south side to be pumped.	—	—	—	—

- - - - - - - - - TABLE, No. 7.—Miscellaneous Plans.

- - - - -	- - - - -	- - Proposes sewage should be preserved for manure.	—	—
- - - - -	- - - - -	- - - - - - - -	Proposes to deodorise.	—
- - - - -	- - - - -	- - - - - - - -	- - Proposes that the sewage be applied to the irrigation of land.	—
—	—	—	—	—

Appendix X.—*continued.*

TABLE, No. 7, *continued.*—Miscellaneous Plans.

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Brown, W.	Suggests, in reference to the sewage, that the water of Deptford Creek should be kept in by lock-gates, the lock being built exactly in a line with the intercepting tunnel.	—	—
Chamberlain, Humphrey.	Would convey the sewage by a sewer to Maplin Sands.	- - - -	- - - -
Cheavin, S.	Proposes a main-chain sewer or sewers to collect the deposit from branch sewers, leading into cesspools, with tanks above, into which the deposit is to be thrown by means of steam-engines, the waste to be carried off from the tanks into a main outlet sewer. The tanks, which are proposed to be constructed of brickwork, to be provided with square delivery-pipes, opening by means of a level, to allow the manure to pass into covered carts.	—	—
Chillingworth, W.	Removes the sewage by a conduit on the north side of the Thames to the sea, and by one on the south side to the Nore.	—	—
Clack, George	Proposes to construct two sewers under the Thames, one close to each bank, commencing at Richmond, to some place down the river. Proposes to convey the sewage by these sewers to tanks formed at the side of the river.	—	—
Clifton, H. C.	Would remove the northern sewage by a canal towards Tilbury and Stanford-le-Hope, to large cesspools in the chalk, and allow the great part of the liquid to pass off by absorption into the soil, the surplus water running into the river. The southern sewage to be removed to the gravelly soil of Surrey.	- - - -	- - - -
Cotton, William	Proposes to cut a canal from London to Portsmouth at the sea-level, so that the salt water shall flow continually through and purify the Thames without the necessity of additional sewers.	—	—
Coxworthy, Franklin	Refers to his plans and memoranda sent in 1849 to the Commissioners of Sewers, in which he proposes to appropriate the sewage to the production of food. Would retain the sewage within the sewers, and would divert the sewage of the north of the Thames to the River Lea, and to the westward up the Thames. Believes that sewage cannot be chemically precipitated and deodorised without poisoning the river.	- - - -	- - - -
C. R.	Proposes to intercept the sewage at a low level, and receive it in iron reservoirs on each side of the river, from which water obtained from the Thames forces it into a lock, where it is to settle and be removed by barges to drying grounds in the marshes.	- - - -	- - - -
Devey, G., and Wyld George, M. D.	Propose to deodorise sewage and ventilate sewers, by passing all the smoke of London into the sewers. That all chimneys be connected with the main sewer by descending flues, and that at suitable places central engines should be established for creating the necessary vacuums, so as to maintain a continual current.	—	—
Dixon, F. G.	Proposes first to deodorise, and then to get rid of the sewage in toto by burning, and asks for Government aid to commence experiments on the power of fire to consume solid sewage. Suggests that the locality for the operation might be Erith—encloses letters from Sir C. E. Smith.	- - - -	- - - -
Dunn, Matthias	Proposes to obtain an unlimited supply of water by sinking a shaft in some commanding position to the level of the Thames, between which and the shaft a tunnel should be made, and the mouth of the tunnel to receive the water at half-tide. Proposes by means of a powerful steam engine to raise the water and flush the sewers during the time of ebb tide.	—	—
Dyer, John	Proposes to cleanse the metropolis of sewage, and to improve the navigation of the river at the same time, by constructing self-acting locks, dams, and weirs above Battersea and Chelsea Bridges. These would create a flushing of the Thames, which would carry the floating matter and sewage eight or ten miles further to seaward every tide, and prevent it from polluting London on its passage.	- - - -	- - - -
Elliot, John	Intercepts the sewage on both sides the river by a sewer, which is to be arranged so as to allow it to be flushed by the admission of the tide at high water, and also proposes that the secondary sewers, such as the Ranelagh, Fleet, &c., shall be flushed by means of water admitted into them from a pipe passing from the river and connected with the heads of each; he does not explain where the outfall is to be.	—	—
Francis, Alfred	Proposes that large reservoirs shall be formed in Barking and Plumstead Marshes, which are to be half filled with salt water before the sewage is run into them.	- - - -	- - - -

Appendix X.—*continued.*

- - - - - - - TABLE, No. 7, *continued.*—Miscellaneous Plans.

Whether any, and if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE.		REMARKS.
		Without Deodorisation.	With Deodorisation.	
—	—	—	—	—
- - - -	- - - -	- - The sewage to flow over the Maplin Sands, which are to be enclosed and raised by the gradual deposit.	—	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
- - - -	- - - -	- - Proposes that the residue of solid matter left in the sewer after the liquid is absorbed, should be periodically cleared out and applied as manure.	—	—
—	—	—	—	—
- - - -	- - - -	- - Proposes to use sewage for fertilising purposes.	—	—
- - To be pumped from reservoirs into barges, and from barges on to the drying grounds.	- - -	- - - - - - - -	- - To be deodorised in the marshes by peat and charcoal, and sold for manure.	—
—	—	—	—	—
- - - -	- - - -	- - - - - - - -	Proposes to deodorise by fire.	—
—	—	—	—	—
- - - -	- - - -	- - Objects strongly to deodorisation by any Government plan.	- - Suggests that deodorisation might be carried out by private speculation.	—
—	—	—	—	—
- - - -	- - - -	- - Considers that the salt water would improve the sewage for agricultural purposes.	—	—

(continued)

Appendix X.—*continued.*

TABLE, No. 7, *continued.*—Miscellaneous Plans.

NAME.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Francis, Charles	Thinks that if the river were equalized in width, it would possess power to be its own scavenger and that of the metropolis.	- - - -	- - - -
Freebody, Wm. Yates	Proposes to bring a supply of water by a canal from Windsor to a point between West Drayton and Harmondsworth, and raise it to a reservoir 70 feet high. This reservoir to be connected with the Paddington Canal, and the water conveyed to a second reservoir, north of Westbourne Green, 80 feet above high-level mark, from whence the sewers are to be flushed into the river. Proposes to embank the Thames, and also to flush the channel of the river, by placing across it, at a point between Battersea and Wandsworth, a solid dam of masonry pierced by seven locks. Proposes to deodorise the sewage, by establishing stations at convenient localities throughout the metropolitan area.	- - - -	- - - -
Gregory, Peter	This is a scheme chiefly for improving and beautifying London; the improvements being carried into effect in conjunction with the sewers.	- - - -	- - - -
Hall, Marshall, M. D.	Proposes to convey the excreta into large reservoirs on the banks of the Thames, whence it is to be removed by railway waggons at night.	- - The drains from the water-closets only are to be conducted to the reservoirs, the other water is to flow into the reservoir.	- - - -
Harrison, Newton	Proposes to construct sewers radiating in four directions out of London, east, west, north and south. The Thames to flush them.	- - - -	- - - -
Higgs, Wm.	Proposes sewage should be deodorised by means of milk of lime, and to use the solid portion for manure.	- - - -	- - - -
Highmore, W., M. D.	Appears to contemplate solely disinfecting the sewage to prevent epidemics without attempting to utilise the product.	- - - -	- - - -
Hodgkin, Thomas, M.D.	Observes that he wholly disapproves of the plan for carrying the sewage through tunnels to the sea. Thinks that it will be injurious to the public health, as from the levels of the districts to be drained, it would necessarily produce large accumulations of offensive matter.	—	—
Hughes, Samuel (pages 387 & 446.)	Proposes existing sewers for rainfall, and new sewers for house drainage.	- - Preserves existing sewers for rainfall.	- - Storm water to flow into the Thames.
Kemp, Henry	Proposes to deodorise sewage by the use of charcoal from pyritic peat.	- - - -	- - - -
Leslie, Alexander (page 391.)	Proposes that the sewage of water-closets should be applied to the irrigation of land.	- - Separates the house sewage from the rainfall, and allows the latter to run into the river.	- - - -
Light, Edwin	Proposes to pump the sewage into reservoirs when it is to be heated as described in a subsequent column. The southern sewage to be brought across the river by the Thames Tunnel.	- - - -	- - - -
Maberley, Rev. F. H.	Proposes to pass the sewage from existing sewers, or from new main sewers into sunken arched vaults, made air and water tight, and to be raised through funnels by which it is filtered. The deposit would be raised by an endless chain of scoops into receptacles for drying or preparing for removal.	- - - -	- - - -
Marsden, Charles	This is a plan for ventilating sewers, by drawing air from various parts by means of a fan, worked by steam or water power in a central position.	—	—
Murray, Sir James	Proposes to deodorise the sewage by means of a large number of stations in London, and to obtain a source of power from the materials used.	- - - -	- - - -
North, Thomas	Proposes a plan of deodorisation by fire - - - - - -	- - - -	- - - -
Oldham, E. W.	Proposes to separate sewage from surface water - - - -	- - Separates sewage from surface water.	—

Appendix X.—*continued.*

TABLE, No. 7, *continued.*—Miscellaneous Plans.

Whether any, and if so, what Method of pumping or moving Sewage by Mechanical Means is proposed.	Proposing Embankment of Thames.	UTILISATION OF SEWAGE. Without Deodorisation.	UTILISATION OF SEWAGE. With Deodorisation.	REMARKS.
- - - -	- - Would embank the Thames.	—	—	—
- - - -	- - Proposes embankment of Thames.	- - - - - - - -	Would deodorise.	—
- - - -	- - - -			
- - - -	- - Contemplates the embankment of the Thames, and additional bridges across it.	—	—	—
- - - -	- - - -	- - The solid matter from the reservoirs to be removed in railway waggons to the country for agricultural purposes.	—	—
- - - -	- - - -	- - Appears to contemplate the utilisation of sewage.	—	—
- - - -	- - - -	- - - - - - - -	Proposes to deodorise.	—
- - - -	- - - -	- - - - - - - -	- - Deodorises, by supplying chloride of lime, or some other chloride, to every water-closet in the metropolis.	—
—	—	—	—	—
—	—	—	—	—
- - - -	- - - -	- - - - - - - -	- - Deodorises by charcoal from pyritic peat.	—
- - - -	- - - -	- - The sewage from water closets to be applied to the irrigation of land.	—	—
- - Would pump the whole sewage.	- - - -	- - - - - - - -	- - The sewage to be run into settling beds, and after having deposited the solid matter, to be passed into filtering beds filled with chalk, lime, and burnt bones. The filtered liquid to pass into the river; the solid remains forming manure.	—
- - - -	- - - -	- - - - - - - -	- - Filters the sewage through gravel, sand, or other purifying or deodorising matter, and considers that the deposit will be a valuable manure.	—
—	—	—	—	—
- - - -	- - - -	- - - - - - - -	- - Employs magnesian limestone for the deodorisation.	—
- - - -	- - - -	- - - - - - - -	- - Deodorises by fire, but does not particularise; estimated cost 1,000,000*l.*	—
—	—	—	—	—

(*continued*)

Appendix X.—*continued.*

TABLE, No. 7, *continued.*—Miscellaneous Plans.

NAMES.	GENERAL DESCRIPTION of Proposed System of Intercepting and Removing the Sewage.	Whether Separation of House Sewage from Rain Water is intended.	Whether System provides that Storm Water shall flow into the Thames.
Perry, Collingwood	Proposes to deodorise sewage in filtering chambers, the deposit to be used as manure, the liquid to be run into the river.		
Perris, H.	Intercepts the northern sewage, and conducts it to a point in Thames-street, where it is to be deodorised, and the fluid to be carried across the river by a new bridge to be erected. The southern sewage to be also intercepted and brought to the same place, and the united stream to be conveyed to a reservoir in Bugsby's Marshes, in which the southern sewage is to be deodorised, and the liquid from both to be run into the Thames at high water.		
Roberts, Moses	Intercepts the sewage by a sewer from Bayswater to Thames Haven. He, however, thinks that the sewage might be filtered, and the water be run into the river at some nearer point.	—	—
Rogers, Jasper (pages 421 & 461.)	Proposes, first, that patent tide-valves should be attached to the mouth of every sewer, so as to prevent the evils arising both from the ingress of tidal waters and from the outflow of drainage waters. Secondly, the application of filtering and vacuum chambers to the house-refuse mains. The quantity of solids which would pass into each chamber would not be more than five tons a day, which would be drawn up by the Archimedean screw. Explains that the filtering bed acts upwards, the fluid being made to pass through the pores of the charcoal; and that charcoal, used as a filtering medium, not only performs its object of deodorisation perfectly, but becomes, through the matter attached to it, of double its original value. States, that it will be feasible to construct the "filtering chambers" under the surface at the end of the streets through which each main sewer passes, and close to the river. In conclusion, proposes to undertake a contract for constructing the above filtering and vacuum chambers (house-refuse mains communicating with them), and for supplying the whole of the "deodorising materials." The contract to be for 50 years, the whole of the sewage being for that time the property of the contractors; at the end of that time the whole to be handed over to the Commissioners.		
Slate, Archibald (page 439.)	Proposes to raise the sewage by means of a wheel, combining the powers of the ancient Persian wheel and the modern dredging machine, constructed in a building hermetically sealed, so that no effluvia from the sewage can escape. Encloses drawing of wheel.	—	—
Smith, Edmund	Proposes to give the main sewers a fall of 10 feet per mile, and, in order to attain this, to provide a sufficient number of lifts at convenient places. He also proposes to provide means for catching the sediment at intervals.	—	—
Smith, H.	Would have the northern sewage carried across the river in an iron sewer, and united with the southern sewage, and taken by a canal to the sea, near Brighton, to discharge from one outfall at low-water mark.	—	—
Spoor, Edward	Proposes to construct deep sewers under the pavements of streets to receive the sewage, running at right angles for the main trunk drain. They are to have no communication whatever with the surface of the street. He would periodically assist the flow of sewage in these main sewers, by placing immediately above them, at advantageous points, a smaller class of drains, which are to collect the surface water into covered reservoirs, whence it is to be discharged into the deep drains, which will, he argues, by the force of the column of water, be freed from all sedimentary deposits, and all gases generated within the void of the sewers.	Would separate house sewage from rain water.	—
Terry, Charles	Proposes to purify the Thames by ejecting into it 2,000 tons of chloride of sodium per week, which would cost about 39,000 *l.* per ann.	—	—
Warrington, Colonel	Proposes to construct, at very short distances, reservoirs of 21 feet in length, 6 feet in depth, and 4 feet wide, through which the sewage should pass. Proposes that the sewage should be allowed to settle in the reservoirs, the water pumped off, and the solid mixed with chalk, lime, and ashes, and carted away in bags to barges.	—	—

Appendix X—*continued.*

TABLE, No. 7, *continued.*—Miscellaneous Plans.

Whether any, and, if so, what Method of Pumping or Moving Sewage by Mechanical Means is proposed.	Proposed Embankment of Thames.	UTILISATION OF SEWAGE.		REMARKS.
		Without Deodorisation.	With Deodorisation.	
			Deodorises and filters the sewage in filtering chambers, mixing the sewage as it flows with dust from ashes and dry powdered clay. This unites with the feculent matter, and precipitates. The water passes off through a filter of ashes covered with straw and kept in its place by a wire grating, and is run into the river.	—
			Proposes deodorisation, but does not state the means to be employed.	—
—	—	—	—	—
			Proposes to deodorise with peat charcoal, and use the sewage as manure.	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—

Appendix X.

2.—Copy of Advertisement issued by the Referees, inviting Plans.

MAIN DRAINAGE OF THE METROPOLIS.

Notice.

The plans for the main drainage of the Metropolis having been referred to Captain Douglas Galton, R. E., James Simpson, Esq., C. E., and Thomas E. Blackwell, Esq., C. E.; notice is hereby given, that all persons desirous of communicating with those gentlemen upon the subject, may direct letters, plans, &c. to them at their office, No. 29, Great George-street, Westminster, on or before 28th February next.

The following conditions must be observed:—

All communications to contain the names and addresses of the parties forwarding them, and to be written on half-sheets of foolscap paper, on one side only, with two-inch margin on the left.

If plans are sent in, those plans which are district plans must be on a scale not less than four inches to the mile.

Sections of lines of drainage, present and proposed, to be on a scale of 20 feet to an inch vertical, and not less than four inches to a mile horizontal, and to have the gradients marked on them in all cases, with the heights in feet and inches at every change of gradient.

A blue line, to denote Trinity high-water mark, to be shown on all sections.

Drawings of works must be on a scale of one-eighth of an inch to a foot.

29, Great George-street, Westminster,
10th January 1857

Note.—The references to places, sections, &c. in these papers refer to the original drawings, and not to the reduced plans published.

Plans of Drainage. Text of Plans. Mr. *J. B. Denton*, C. E.

3.—Text of certain Plans of Drainage submitted to the Referees, with Letters, &c., bearing on the Proposals.

(1.) Mr. J. B. Denton, C. E.*

To the Commissioners appointed for considering the Plans, &c., proposed for the Drainage of the Metropolis.

Gentlemen, 52, Parliament-street, Westminster, 27 February 1857.

As one of the three competitors of 1849, whose designs were signalised by special reference in the Report of the Examiners, and one who has devoted much time and attention to the subject of drainage generally, I hope you will permit me to address you on two or three points.

I would beg first to call your attention to the remarkable similitude of the general features of Mr. Bazalgette's scheme, as set forth in his two reports, dated severally the 3d April 1856 (south of the Thames), and the 22d of May 1856 (north of the Thames), to those described by me in the suggestions I laid before the Court of Sewers on October 12th, 1849, in pursuance of the resolution of the Court on the 20th August 1849, by which the public were solicited to send in to the Commissioners plans and suggestions for the drainage of the Metropolis.

In two very important points Mr. Bazalgette has not followed the suggestions I then ventured to make, and it is with a view to call your particular attention to those omissions, that I now presume to trouble you.

But I do hope you will deem it consistent with your duties to do justice to the competitors of 1849. It is very possible that other designs may be even more like that which you may ultimately recommend than mine, in which case it is to be hoped that, for the sake of professional men generally, you will bring the fact under the notice of the Government. At present I merely submit that in every main point Mr. Bazalgette's scheme is a counterpart of mine, and that will be manifest directly the two are placed in juxtaposition.

You will observe, that whilst recommending, as did Mr. Bazalgette, Barking Creek and Plumstead Marshes as the points of outfall, I suggested that the operations of the Commissioners should extend to the drainage of the Thames Marshes, "as far as the limits of the City conservancy" extend seaward, whereby a wide area for the utilization of the sewage would be gained, at the same time that provision would be made for the possible necessity of carrying forward the outfalls themselves.

In making this suggestion, I anticipated, and still believe, that the time is not far distant when the sewage of towns will be deodorised and applied.

If the solid matter be separated from the liquid, there will always remain in suspension within the latter a fertilizing ingredient, which will make it valuable for irrigation beyond the simple properties of water, and I submit that it is the duty of the Metropolitan Board of Works to comprehend, in its operations, the drainage of these marshes, and those of the Lea, for the three following reasons: first, to provide for the extension of the outfalls, if unforeseen circumstances demand it; second, to render healthy the marshes themselves, which, for want of combined and systematic drainage,

* *See* Minutes of Mr. Denton's Evidence, page 440.

Appendix X. Plans of Drainage. Text of Plans. Mr. *J. B. Denton*, C. E.

drainage, are at present very much the reverse; and, third, to create a market for the refuse liquid discharged from the sewers after the solid has been precipitated, and the liquid deodorized.

The next point to which I desire to draw your attention is the difference between Mr. Bazalgette's mode of discharging the sewage of Westminster and Kensington, and that suggested by me.

Mr. Bazalgette purposes to conduct the whole of the sewage of the Western Division, from Brentford to Charing Cross, round by the north side of the Thames, through the city, to Rainham Marsh.

I submitted to the Court of Sewers in 1849, and beg now respectfully to repeat it, that the most effective, and the least expensive mode of discharging the sewage of the 20 square miles lying to the west of the Penitentiary, would be by a course as nearly straight as possible from Hammersmith to Deptford, passing under the river at the point (Horse Ferry), where the new bridge is proposed to be built, with tributaries or branches, as required, along the bank of the river between Brentford and the point of crossing.

It is hardly necessary for me to add, that I am quite conscious of many minor inaccuracies in my proposal of 1849, arising from the want of detail information. It is only with main principles that I then dealt, and venture now to deal, and it is only upon such ground that I presume to speak of Mr. Bazalgette's scheme.

Having visited Lombardy, and examined the drainage of Milan, and the irrigation of the Valley of the Po, I have no hesitation in saying that, although the Lombardian works do not here apply as an example for us to follow, they afford a precedent suggestion of many details by which we might profitably connect the sewerage of the Metropolis with the drainage and irrigation of adjacent marshes.

I beg to forward you the plan, &c., sent in to the Court of Sewers in 1849, and to subscribe myself

Yours, &c.
(signed) *J. Bailey Denton.*

(2.) Mr. R. Dover.*

(i.) Text of Plan.

Mr. *R. Dover.*

Gentlemen, 27, Baker-street, Portman-square, 16 January 1857.

The public is informed that you are a committee to examine and report upon the plan B* of the Metropolitan Board of Works, and any other "better calculated" to prevent all or any part of the sewage of this Metropolis from flowing or passing into the Thames; also, that you have been requested by Her Majesty's First Commissioner of Works "not to confine yourselves" to the plan submitted by the Metropolitan Board; but either to devise a better scheme, or to "give your attention to the various plans which doubtless will be laid before you," for the immediate accomplishment of the above important and vital object; because "a strong feeling seems to be entertained by members of the Metropolitan Board, and others, that the sewage of this Metropolis may be made a source of profit."

Public protests and objections have been made by very many members of the Metropolitan Board, &c. against this plan B*, on the grounds that it will prove altogether useless, baneful, and a perfect waste of the public money. And that the filth of London, detained for hours in putrescent reservoirs, and then discharged into the river at any one spot, with all its noxious qualifications perniciously concentrated, will be most fatally detrimental to the inhabitants, most ruinous to the commerce of this city, and a perfect curse to the hundreds of thousands of persons engaged upon or living contiguous to our river.

The only rational mode of disposing of the sewage of London, and preventing all these evils, is its deodorization, and conversion thereby into a blessing! and the useful "source of profit" recommended so particularly to your special consideration for the public welfare; and this is also the earnest desire of the community, now expressed daily almost, in the newspapers. The literal intention of the Legislature, and Government also, in the Act which created the Metropolitan Board of Works was, and manifestly is still, that the Thames should be no longer polluted with sewage. All agreeing also, that there should be the least possible delay in converting the sewage into a really valuable agricultural and commercial commodity; which must be the objects that Sir Benjamin Hall has in view, by his "request that you will, in your report, set forth any better scheme" than plan B†.

And as Her Majesty's First Commissioner further particularly requested that "you will report your views at the earliest period, consistent with the full consideration of the subject," I beg to hand you, herewith, the copy of a letter (Document A.) that I addressed to him on the 12th ult., relative to my system for the deodorization and utilization of the sewage of London; to which he replied immediately, suggesting that I should lay it before the Metropolitan Board of Works; therefore, I infer that he also considers the sewage can be made profitable to the community. But as you, gentlemen, are now empowered to adjudge, for the public welfare, not only their plan B*, but also all "the various plans which, doubtless, will be laid before you," I consider it proper to acquaint you with the following further particulars, viz.:

First. That the highly talented Liebig, and others, have stated that "the sewage of London, mixed with a combination of chemical agents, would be one of the most valuable manures in the world." Therefore, I press upon your attention the analysis (per Document B.) of the residuum of the sewage deodorised by my process (witnessed, approved, and certified, per Document C.† &c., by so very many persons of education and intelligence; the press, several members of the Board of Works, the engineer and other officers of the late Commission of Sewers, and although last, not least important, some hundreds of ratepayers), as a most conclusive proof of its sanitary and national importance; and the correctness also of the "strong feeling entertained by members of the Metropolitan Board, and others, that the sewage of the Metropolis may be made a source of profit." And it is to be hoped that you will see how much the public welfare depends upon the earliest

* *See* Minutes of Mr. Dover's Evidence, page 443.
† Document C., containing testimonials, not printed.

Appendix X.
Plans of Drainage.
Text of Plans.
Mr. *R. Dover.*

earliest possible realisation (on a scale equal to the interception of the discharge of one sewer) of such system by the Government, on account of the incapacity of the Metropolitan Board; and before any elongated cesspools, pestilential sewage reservoirs, or other equally useless, baneful, costly and unprofitable works are attempted.

Secondly. That pure air and pure water being indispensable to the public health and comfort, as light is to the very existence of mankind, "the Thames should be no longer polluted with sewage," because cholera results from either imbibing water or inhaling air tainted with it. And the means that will preserve the Thames, and all other rivers and streams from pollution, with sanitary and national pecuniary gain, being at the immediate command of the Government, by whom you are appointed, the public may reasonably expect, from the eulogiums passed upon you by the public press, that the bricks and mortar schemes of their interested advocates will neither be unduly countenanced by you, or permitted to prejudice any longer the health, happiness and pockets also of the many millions of persons in these realms.

Thirdly. That the works (*vide* sketch, Document D.) required to prevent the sewage of London flowing into the Thames, without any alteration of the present sewers, are neither large, complex or costly, and can be constructed over any sewer, or at its exit, or in their environs, if more convenient. The mechanical arrangements also, peculiar to my system, afford every declivity and other facilities for sewers, without any tunnelling operations; consequently, perfect drainage of the entire Metropolis can be established in the shortest period of time, and at very small cost. The instant the sewage arrives at the works, its deodorization is effected, further decomposition is arrested, and every exhalation ceases; because my chemical preparation fixes and renders all its ammoniacal and putrescent matters inert, until drilled into or spread upon the earth. The salubrity of this filtered water renders it particularly valuable in all cleansing purposes, as well as flushing or purifying foul or stagnant sewers. The "more dense sewage deodorised" discharges itself, in less than two minutes, into the filter under the reservoir, so that these important sanitary operations are uninterrupted; and the "residuum" is as quickly removed for mixing, and dries itself without the emission of the slightest odour.

Permanent works which will effectually prevent the pollution of the Thames, by the deodorization of all the sewage of London, and the manufacture of its residuum into a really valuable agricultural fertiliser, can be constructed of indestructible materials within one year, for a rate of 3 *d.* in the pound only, for a very limited period of years; after which, all these works would consequently be, like the sewers and sewage, the property of the ratepayers; who would then derive an annual income from them, in perpetuity, of five per cent. at the very least.

Fourthly. The chemical agents which I use to deodorise or fix the ammoniacal and putrescent matters in the sewage, are all more or less fertilising agents, and, in combination with the matters in the sewage, convert themselves also into a really valuable, portable and inodorous manure; they are hydro-chloric acid, proto-sulphate of iron, and chloride of sodium. [Hydro-chloric acid, because, for fixing ammonia, it is preferable for several reasons; being more easily used, and requiring very little care to mix with the solution containing ammoniacal matters; added to which, the small quantity that I use is even less, by three-fourths, than is prescribed for a young child in cases of stomach debility. Proto-sulphate of iron, because it is the best salt for fixing ammonia, and because a small quantity of this salt confers upon the soil properties that render it appropriate for several plants. And chloride of sodium, on account of its chlorine, and because it is a valuable manure also; indeed, on plants manured with a small quantity of common salt, cattle thrive better than on those not so manured].

Lime I do not use in any form, for the many reasons stated by Ure, Thomson, Turner, Reid, Solly, Liebig, &c. &c., and because it decomposes all the salts of ammonia; combining with the acid which they contain, and expelling the ammonia in the state of gas, thereby reducing the agricultural value of the residuum to two or three shillings only per ton, as stated publicly at the Society of Arts, on the 10th ult. Nor wood-ashes, because they also act on the putrefactive matters in sewage as disadvantageously as lime. The alkali generally contained in wood-ashes accelerates decomposition, but occasions loss of ammonia. Animal and extrementitious matters yield ammonia, the substance of which is indispensable to the formation of gluten, albumen, fibrin and casein, the most important of the constituents of vegetables; therefore, as the strength of man and animals depends mainly on muscle, and the formation of muscle is greatly dependent on the amount of organic matter containing nitrogen in their food, it is a matter of the first importance not to deodorise sewage with lime, but those chemical agents only which will preserve in food the above "indispensable constituents."

Several portions of London, in Westminster, and in Surrey also, are below high-water mark; therefore as the sewage will not flow or gravitate upwards naturally, the public will entirely delude themselves if they suppose, for a single moment, that the sewage will be of any agricultural value after it has been pumped and re-pumped, at enormous cost, through a succession of elongated cesspools; the facts being, that most if not all the solid matters will deposit, and very soon choke them up, and that the gaseous portions will be oxidized. Added to which, "engineering difficulties" were stated by the chairman of the Metropolitan Board, to be in the way of carrying the sewage to a point lower down the Thames than Plumstead; these "difficulties" are, I believe, insuperable. But there can be no doubt of their increasing immensely the enormous and profitless estimated cost.

Nature never intended the sewage to be the curse of either this Metropolis or the surrounding country; and the health of the community demands, peremptorily, that it shall not be disembogued into any part of the Thames. In fact, the perseverance in this baneful and wasteful idea, by so many Commissioners of Sewers, fully accounts for their frequent and summary dismissal, and ought to have been a sufficient warning to even the majority of the "Metropolitan Board of Works."

I cannot but think you will see, that upon the proper principles of deodorising the sewage, the defecation of London is not a dream, but a thing to be accomplished easily! also that it (the sewage) can be made a "source of profit" by your adjudging this subject with a view to the public welfare, and inducing the Government to take the evil in time, and be earnest in the matter (they being in reality the only authority capable and qualified to deal with it). You will confer on the community a most important benefit, and entitle yourselves, not only to distinctive honour, but the most ample reward of the entire community.

So

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So pure and salubrious is the water of the sewage deodorised and filtered by my process, that it will remain unaltered in either a closed or open vessel, for any length of time, whether in a cellar or an attic; indeed it was this very limpid peculiarity and salubrious condition of the aqueous part of the 500 gallons of sewage I operated on before Professor Faraday, very soon after his letter to "The Times," on the 9th July 1855, that he said, "There can be no two opinions of the great sanitary importance of this system."

Abundantly and conclusively I have proved, I think, that, without the least alteration of the present sewers, the sewage of London can be effectually prevented commingling with, and polluting the Thames, by my mechanical arrangements; and, summarily deodorised by certain chemical agents, which, with the residuum, or polluting matters, become a "really valuable" agricultural fertiliser (worth, per analysis, quite 4 *l.* per ton); whilst the aqueous portion filters off limpid and salubrious. It is also proved "abundantly and conclusively," that all these operations are, by my system, perfectly non-offensive; indeed it is a fact (proved at Berwick-street, Soho, about two years since), that cholera was arrested and annihilated by the antiseptic chemical agents I employ.

I have only to add, that instead of this residuum of the sewage being the curse that plan B* of the Metropolitan Board would make it, if treated upon proper principles, it can be converted into a complete blessing; and will restore to our fields the special food of the plants which nourish animal life; and whilst creating an abundance of healthful and profitable employment for all the Queen's industrious and deserving subjects, it can also be made the "source of profit" to the ratepayers and other members of the community, that Her Majesty's First Commissioner of Works has so patriotically directed your special attention to, in order to its earliest possible realization.

I have, &c.
(signed) *Richard Dover.*

To Captain Douglas Galton, R.E.
James Simpson, Esq., C.E.
Thomas E. Blackwell, Esq., C.E.

DOCUMENT A.

Sir, 27, Baker-street, Portman-square, December 12, 1856.

THE intentions of the Legislature, as well as the desire of the community, that the Thames should be no longer polluted with sewage, were manifested by the Act which created the Metropolitan Board of Works; but the public career of this Board has exhibited, either their complete incapacity to accomplish it—or, the very strong determination of the majority of its members to trifle with or elude this vital question.

To the ratepayers and other inhabitants of London it will be very advantageous if no sewage is discharged into the Thames, unless deprived previously of its noxious qualities; also that every plan proposed for the disposal of the sewage of the Metropolis shall be subject to three immediately practicable conditions; viz:

1st. That the sewage water, before its discharge into the Thames, shall be thoroughly deodorised and limpid.

2dly. That the operations required to deodorise the sewage and separate the residuum, shall be so conducted that no nuisance shall arise therefrom in the neighbourhood.

3dly. That the residuum (or valuable fertilising matters with which the Thames is now polluted so fatally), shall be converted into an available and profitable agricultural and commercial commodity.

I beg to inform you that I have demonstrated practically how, without any alteration of the present sewers, the pollution of the Thames with sewage can be prevented; how its aqueous portion can be filtered off, uninterruptedly, both limpid and salubrious; and how its residuum can be manufactured profitably into a portable, inodorous and valuable agricultural fertiliser.

The accomplishment of all the foregoing important sanitary and national benefits, and pecuniary advantages to the ratepayers, is proved conclusively by the enclosed certificates; I solicit also your particular attention to the accompanying sample of my deodorised sewage residuum, as well as to its value by analysis, and the many other particulars; under the impression that you are not indifferent to any improvements by which such great and immediate benefits and gains can accrue to the community, and will give them your patronage.

I shall be prepared to lay before you every further information on this subject, whenever you desire it.

I have, &c.
(signed) *Richard Dover.*

To the Right Hon. Sir Benjamin Hall, Bart., M.P.,
Her Majesty's First Commissioner of Works.

P.S.—Permanent works, to prevent the pollution of the Thames, by the deodorization of the sewage of London, and manufacture of its residuum into a valuable agricultural fertiliser, can be constructed of indestructible materials in one year, for a rate of only 3 *d.* in the pound, for the limited period of ten years; after which they (these works) would all be, like the sewers and sewage, the property of the ratepayers; and from which an annual return would accrue, in perpetuity, of five per cent. at the very least.

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Mr. *R. Dover.*

DOCUMENT B.

ANALYSIS of Mr. *Dover*'s Sewage (Guano) Residuum.

Moisture	7·67 per cent.
Organic matter, containing 2·63 per cent. of Nitrogen	46·74 „
Insoluble Residue (Silica)	31·64 „
Sesquioxide of Iron	7·62 „
Sulphate of Lime	2·68 „
Carbonate of Lime	2·86 „
Carbonate of Magnesia	·31 „
Loss	·48 „
	100·00

(signed) *Henry Medlock,*
29, Great Marlborough-street, London, November 8, 1855.

Received two guineas.
(Stamp) H. M.

(A true copy.)
Richard Dover,
16 January 1857.

DOCUMENT C.*

DOCUMENT D.†

(ii.) from Mr. *Dover*, in Answer to Inquiry as to the Quantity of Materials required by his Process.

Dear Sir, 27, Baker-street, Portman-square, March 24, 1857.

IN reply to your note of yesterday, I beg to state, for the information of the referees of the Main Drainage of the Metropolis,—

1st. That each ton of the sewage, average quality, discharged from the sewers of London, if deodorised according to my system, will yield 7½ lbs. of manure; consequently 300 tons of sewage will, in round numbers, produce a ton of manure.

2dly. That the quantity of deodorising materials required to convert the putrescent and other ammoniacal matters in the aforesaid 300 tons of sewage, will be, 600 lbs. hydrochloric acid, 56 lbs. proto-sulphate of iron, 40 lbs. chloride of sodium; and,

3dly. That I will make it convenient to wait upon the referees on Wednesday the 1st April, at two o'clock, P.M., punctually, to give them any information that I possess.

I beg to enclose, for the use of the referees and yourself, the periodical containing the first part of the "Memoire upon the Nature and the Origin of the Alluvions at the Mouths of the Rivers which fall into the British Channel on the French Shore." I should have sent it to you sooner, but that I have not been able to find the following Number.

I am, &c.
(signed) *Richard Dover.*

H. C. Saunders, Esq.

(3.) MR. J. GIBBS, C.E.

Mr. *J. Gibbs*, C.E.

To the Referees for ascertaining the best means of effecting the Drainage of London.

Gentlemen,

I HAVE paid considerable attention to this question for some years past, as will appear by the following statement.

In the year 1849 I sent the printed statement, No. 1, accompanying this document, to the Commissioners for Draining London, together with a map of the districts proposed to be supplied with sewage.

On the introduction of a Bill into Parliament for draining London, I gave evidence thereon, as may be seen by reference to the printed minutes.

On the rejection of this Bill, I drew up a plan for dividing London into drainage districts, and placing the outfall drainage under a separate Commission, under the direction and control of the Board of Works; this plan was sent to Lord Palmerston, and forms the basis of the present arrangement.

Seeing the difficulty of raising sufficient capital for carrying out the great scheme of drainage, I devised a plan for lessening the capital required and more effectually applying the material to the land. This plan was laid before the Board of Health some time since, and forms the basis of what I now submit to your consideration.

The

* Document C., containing Testimonials, not printed.
† For Document D., *see* Plate 1 to this Appendix.

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Mr. *J. Gibbs*, C.E.

The proposal I now make for the main drainage of London, simply resolves itself into the following propositions:—

1st. To collect the sewage at or near the outlets by intercepting sewers.

2d. To divide the Metropolis into districts, each district having its intercepting sewer, and its deodorising and pumping establishment.

3d. The concentrated material or precipitate, being $\frac{1}{300}$ part of the sewage to be pumped into one common main pipe, and either laid over the lands of the Bagshot district, the marshes and neighbouring lands of Kent and Essex, or discharged into the River Thames at one of the lower reaches; the deodorised sewage to be discharged into the river.

4th. To carry out that part of the scheme which relates to the application of the sewage to agricultural purposes, I propose that a land improvement association be formed to co-operate with the Commissioners, the Commissioners guaranteeing four per cent. on the capital, and then dividing profit with the company, and although the ultimate advantage of the undertaking will be very large, and the works required will be on a vast scale, yet it is not necessary that the land question be carried out at once, for the system of deodorising here proposed may be acted upon previous to the agricultural division of the subject being adopted.

The following are the considerations submitted to the Board of Health, relative to the deodorising sewer water, and applying the results to land to increase its fertility, and which considerations form my proposition for draining the Metropolis.

It is allowed by all parties, that the sewage of towns is of immense value in an agricultural point of view, if properly and cheaply applied to the soil; the Board of Health have collected a number of valuable facts on the application of liquid manure, and we are bound to say, the facts collected by them on this subject, are of a most interesting character. Many proposals have been heretofore enunciated on this subject, and some attempts of a practical nature have been made, to carry out a system of recovering the valuable constituents of sewage water, but up to this time nothing has been done to show that it can be managed with profit. On the one hand, it has been attempted to transmit the sewage of London, in its most diluted state, into the suburban districts, to be disposed of as an article of commerce; on the other hand, it has been proposed to precipitate the constituents and then dry them, and in that state to transmit them to the agriculturist in a portable form.

The first of these proposals involves the necessity of transmitting a vast and useless volume of water; now, as the average of the valuable constituents is not more than $\frac{1}{100}$ part of the whole, the works consequently required for the transmission of this vast body of liquid, must be of dimensions equivalent to the whole bulk of sewage, by which means a body of water would needlessly have to be pumped out of London equalling that pumped in.

The second proposal involves a large amount of manipulation, but will nevertheless leave a good profit, and is convenient.

But the proposal now made is to precipitate the valuable constituents by which it will be reduced to $\frac{1}{300}$ of its original bulk, and so transfer only the smaller volume to the agricultural districts for distribution over such waste lands as are convenient for the operation. This process so far lessens the cost of the first outlay for works, and the annual expenditure, that liquid manure may be transferred with advantage through pipes to a distance of 60 or 70 miles, and then leave a large profit to repay the outlay; the process is briefly as follows:

If sewer water be simply run into tanks, and a given quantity of lime water be added, according to Higgs'* process, in a few minutes the solid constituents of the sewer water, and nearly all its valuable constituents, will sink, and the sewer water in its clarified state may be run off into its natural channel, the residuum will be then only $\frac{1}{300}$ of the whole, and yet is sufficiently limpid to be pumped through pipes, without any sensible detraction of the pumping power; 10 tons of this liquid will keep an acre of land in the highest state of agricultural perfection, and be equal to 300 tons of sewer-water per acre; of course it would be requisite to dilute this liquid manure to its original state, when applied to land as a liquid manure; but it may be applied in its normal state to land recently ploughed, and before the crop is put into the ground.

The application of this question to the Metropolitan districts would be as follows:

Several establishments would have to be erected to precipitate the sewage water; this could be done by intercepting, but not otherwise interfering with, the flow of the present sewers. Main pipes of 30 inches diameter will be sufficient for exhausting and transferring the precipitate, not only of all the sewage of London at present existing, but will also be sufficiently large to convey any increase for some time to come; this main would consist of two branches, one on the north and one on the south (which would be united into one pipe at Brentford); if the concentrated sewage is sent to the Bagshot district, this united pipe would then be carried on and over the waste lands of Bagshot and Chobham, where there is an area of 75,000 acres of sandy soil uncultivated, but is nevertheless well fitted for the reception of liquid manure, and without which is of little value.

The diameter of the pipe required for 75,000 acres of this waste land, and 25,000 acres of partially cultivated land added thereto, making in all 100,000 acres, would only be of a diameter of 30 inches; but after this land shall have been cultivated for three or four years, a branch may be made from the pipe, of a diameter equal to two-thirds of its area, for fertilising new districts which exist near to and on the south side of Farnham, and along the chalk downs; all such land as is once recovered may be afterwards sustained in the highest state of fertility by the application of only one-third the amount of the fertilising matter required at first.

To accomplish this object, the material precipitated from 900 tons of sewer water would have to be applied per acre for the first three years, after which the precipitation from 300 tons would be consumed annually, which 300 tons would be sufficient to maintain the land in the very highest state of perfection, without resorting to either guano, oilcake, bone, or other refreshers. An estimate has been made of the cost of supplying this district of 100,000 acres with manure in the manner stated, and is as follows:—

DEAD

* Other processes may be preferable.

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DEAD CAPITAL.

	£.
Collecting by interception the matter from the sewers into 10 establishments, three on the south and seven on the north	170,000
Ten pumping engines, of an average power of 120 horses	112,000
Precipitating tanks and elevating pumps, and artificial discharges of the deodorised sewage water into the River Thames, the tanks to be of an aggregate area of 2 acres, arched over, and combined with ammoniacal condensers	158,000
Main pipe on the north and south side, and the united pipe to the Bagshot station	268,960
A pumping establishment, near Staines, for a second elevation	41,000
Note.—It is believed that a large quantity of the concentrated sewage may be sold in its progress through the district, in which case there would be no reason for keeping the pipe at a pressure requisite for the elevation and friction of the whole, to meet which contingency the pumping is divided into two lifts.	
Lateral mains through Bagshot district, 40 miles of 12-inch pipe	70,400
Distributing pipes into and over the several farms	200,000
Hose pipes for applying the sewage	5,000
Farm-tanks for containing the surplus sewage, and auxiliary power on farms for distributing liquid manure through the same mains in a dilute form	100,000
Fences, drains and roads, and laying out farms, varying in extent from 500 to 1,000 acres	200,000
Farm-buildings commensurate with the improvement of the land	150,000
Breaking up land to prepare it to receive the manure	500,000
Junctions, nozzles, hydrants and other small works	20,000
£.	1,995,360

COST OF ANNUAL WORKINGS.

	£.
Lime, 34,675 tons, at 7 *s.*	12,136
Coals for engines	2,409
Wages to engine-men and labourers	3,744
Incidental cost to engines	1,022
Renewals	1,200
Turncocks and inspectors	800
Management	5,000
Interest on dead capital in machinery, works and pipes	99,768
£.	126,079

Note.—Renewals of hose-pipes and application of manure to land are charged to cultivation; one man and one boy will apply sewage to six acres per day, in its diluted form.

	£.
COST OF WASTE LAND per Acre, 17 *l.*	1,700,000
DEAD CAPITAL, as stated before	1,995,360
£.	3,695,360

The annual cost, including interest, divided by the acreage, will give an annual charge for manuring of nearly 1 *l.* 5 *s.* 2 *d.* per acre.

Land having so large a supply of manure must be worth from 50 *s.* to 100 *s.*, for rental and manure, per annum; taking 75 *s.* as the price, it will make a clear income of *l.* per annum on the outlay, or per cent. leaving a portionate use of the pipeage and works available for new districts, as follows:—

	Acres.	
Land reclaimed the first three years	100,000	on which this estimate is made.
" next three years	66,000	
" next three years	44,000,	no profit estimated upon.
" next three years	29,600	
	239,600 Acres.	

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It is clear that an undertaking for freeing London of its pollutions must be a very large one, as this estimate shows; and under proper management, a most profitable one, possessing great national value in many respects; but still doubt might exist whether so large an undertaking could be managed: but as the extent of an undertaking is relative only, and is more dependent on the means to undertake than on the power to execute in the hands of a proper direction and executive, it would succeed, no matter how large it may become hereafter; and as the pipeage proposed to be used is not more extensive than that of some of the water companies of London, it may safely be assumed, that to the point of cultivation a body or company could encompass everything. And even so far as cultivation is concerned, there could be no difficulty by subdividing labour, if the future tenants were made the agents or bailiffs for managing the farms for the first three years, at fixed salaries; with the understanding that on the expiration of that time they were to be valued into the possession. Then by this means a mass of agricultural co-operation would be brought to bear on the operations and interest of the company, so as to realise the ultimate profit contemplated; and which co-operation could only be obtained from the expectation of the superior farm agents becoming permanent tenants at the earliest and most proper period; and in some cases, no doubt, tenants might be found to take land the moment the fertilising liquid is laid on, but it would be more discreet to wait for the lands arriving at a good re-producing result before the rent is permanently fixed.

From what has been said, it must be clear that this important matter might be advanced by a company co-operating with the Board of Works; turning the sewage to a profitable account, not alone by its sale, but by assuming the form of a land association for redeeming waste, the obtaining of manure being only an accessory, though an indispensable auxiliary to the improvements.

The Bagshot district is a sandy soil, so completely destitute of calcareous and other matter useful for vegetation, that it is incapable of growing crops, unless fertilisers are brought upon it. The higher ground is dry and porous, some of the lower ground is peaty, from the difficulty of the water finding an outlet, but one deep drain per acre restores this lower ground to dryness; all the ground requires subsoil ploughing or trenching, and so far as the cost of tilling the ground afterwards is concerned, it can be done at a small expense; no soil is less fitted in its present state to repay for cultivation, but no district is better adapted to receive the liquid manure, and then to repay for its application, on account of its porous and consequently absorbent character.

The same observations as have been made respecting the Bagshot district are applicable to the supply of concentrated sewage to the marshes below London, provided these marshes are first drained; and should an objection be raised against the Board of Works, either of themselves or by co-operation, allowing a company to undertake the application of the sewage and the purchase of land, still the concentrating and deodorising the sewage according to this method will be the least expensive, even if the concentrated material is allowed to run waste in one of the lower reaches of the Thames, as the following estimate will show:

	£.
Collecting Sewers	170,000
Precipitating tanks and land	158,000
Pumping engines, land and erections	112,000
Main pipes and outlets in the lower reaches of the river	268,000
£.	708,000

21, Abingdon-street, 28 February 1857. (signed) *Joseph Gibbs.*

(4.) MR. L. GISBORNE, C.E.*

Mr. *L. Gisborne.*

Gentlemen, 6, Duke-street, Adelphi, London, 13 March 1857.

I HAVE the honour to enclose a statement,† accompanied by a plan, relative to a design for the embankment of the Thames, between Lambeth and London Bridge, which bears directly upon the sanitary question of the metropolis, and the formation of a low sewer along the north bank of the river.

I have brought this project under the notice of the Government and that of the Metropolitan Board of Works: it is my wish to be favoured with an opportunity of attending before you to show the detailed plans which have been prepared, and explain the importance of the whole design, and its bearing upon the subject you have been specially commissioned to inquire into, and report upon.

Your, &c.

To the Referees of the Main Drainage of the Metropolis. (signed) *Lionel Gisborne.*

(5.) MESSRS. GOTTO AND STOTHERT.‡

Messrs. *Gotto & Stothert.*

35 A, Great George-street, Westminster, 28 February 1857.

THE drainage of London, comprehensively viewed as involving works of substantial reform, which are to exercise a direct and extensive influence on the health and comfort of millions of people, becomes replete with interest.

The experience of the past, and the recent rapid development of knowledge, afford sufficient materials by which to arrive at a decisive settlement of this question; and yet the vast magnitude of the Metropolis, and the vital nature of the subject, impart to its consideration an importance and greatness that might well deter those unfamiliar with the extensive and intricate works already existing, and the further and future drainage requirements, though otherwise skilled in science, and taught

* *See* Minutes of Mr. Gisborne's Evidence, page 443.
† The pamphlet enclosed by Mr. Gisborne has not been reprinted.
‡ *See* Minutes of Messrs. Gotto and Stothert's Evidence, page 444.

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taught by experience from venturing upon so difficult and complicated an undertaking as that of devising a plan for the drainage of London.

But when so much and such eminent engineering talent has been exhausted in the investigation, further attempt might appear to border on presumption.

Some practical experience, however, in the sewers of London, many years' study of the subject, and a silent but attentive observation from month to month and year to year of all that has occurred from the time it first prominently occupied the public mind till now, together with the invitation of the Government Referees, have induced us to put into a practical shape the result of the experience and knowledge we have acquired, assured that the subject will meet with that careful, patient and impartial investigation its public importance demands.

The stipulated 38 days, however, are manifestly inadequate to complete (in the midst of ordinary professional engagements) the details of so great an undertaking, involving elaborate calculations; and it is hoped, therefore, that any incompleteness will be regarded with indulgence.

The main object sought to be attained by these arrangements is,

To reduce the rate of mortality in this city, as well as to increase the fertility of agricultural districts, which involves—

1st. The interception of the sewage from the river.

2d. The conversion of it into such a manure as shall really possess a substantial commercial value.

The conditions that ought obviously to govern an acceptable plan for the interception of the sewage of London from the River Thames we venture to enumerate and explain, as follows:

1st. That clear filtered water alone should be allowed to flow into the Thames (except during unusual storms), and that for this purpose the sewage should be chemically dealt with.

The public very reasonably require that the adopted plan shall not only be practicable and, if possible, economical, but it positively must not be a nuisance.

To avoid this, it has been suggested that the sewage should be sent into the Thames as far down as Sea Reach; and it is clearly advisable, that if it is to be discharged in its normal and foul condition, the farther it is carried away the better for the health of London. But this extension is not only attended with a vast present outlay on both sides of the river of about 87,000 *l.* per mile, but the permanent annual cost is increased in like proportion for pumping, at the rate of 1,960 *l.* per mile.

And after all, whether the sewage is shot into the river at Blackwall, Barking, Erith or Sea Reach at high, mean, or low water, it will be of little avail; the fact remains unaltered; the river is not purified, and the sewage, if of any value, is wasted.

The whole necessity for this doubtful, though costly work, would be obviated, if the sewage is disinfected and deodorised, and only clear, filtered water is allowed to flow into the Thames.

Thus the sewage manure question meets us at the very threshold of the inquiry. Upon it depends the position of outfall and the cost of the works, while various new elements, amounting to principles, become involved in the preparation of the plan of drainage.

So much time, labour and talent have of late years been directed to the development of this subject, with results so plainly demonstrating its practicability as to render it impossible to disconnect the idea of drainage of London from the deodorising process; and the necessity has become so urgent and apparent, that by rejecting it formidable difficulties begin immediately to accumulate and embarrass the inquiry; to remove which, recourse must be had to expedients and contrivances alike clumsy and expensive. For these reasons, Mr. Frank Foster found it expedient to suggest sewage manure works at Hammersmith; subsequent officers of the Commissioners of Sewers at Kensington Creek, Old Ford, and Greenwich, in all of which latter recommendations Sir William Cubitt and Mr. Robert Stephenson concur.

2dly. Another condition is, that the outfall, instead of being in one spot, should be so placed as to divide the sewage into somewhat equal and more manageable quantities, and that it should be brought to the places where it can be profitably employed to promote vegetation.

After mature deliberation and examination of the several sites presenting themselves, we agree in the suggestions of Sir William Cubitt and Mr. Stephenson, that the mouth of the Kensington Canal, the Bank of the River Lea, the Deptford Creek at Greenwich, with the addition of another depôt at Battersea Creek, are suitable sites for sewage manure works; they have water carriage for materials incidental to the manufacture; each spot has available vacant ground, and is in the immediate vicinity of market gardens and grass lands beyond the metropolitan area, and where the manure can be used.

The process is conducted without the least smell, but should there be anything objectionable in the bare idea of sewage manure works, an examination of either of these localities will convince the mind of the impossibility of increasing the nuisances already existing.

One of the many difficulties besetting the settlement of this question, that of dealing with the sewage in such monster masses as would be the consequence of bringing it to one spot, is amongst the most formidable. A reservoir 1½ mile long, 70 feet wide, and 13 feet deep, has even been contemplated for one side of the river only.

To entertain such a plan would be to shut out the probability of the sewage of London being discharged into the Thames in any other than its dangerously unwholesome condition; to confer upon the River Thames, in perpetuity, the office of being the "drain pool" of the metropolis, as well as to exclude the opportunity of the profitable disposal of the sewage for agricultural purposes.

To avoid this difficulty, and its consequences, the sewage must be dealt with in reasonable detail, and for this purpose we have divided London into four separate areas, each having a depôt or point of outfall respectively as before described, and by this means the sewage can be chemically treated in manageable quantities, and in so perfectly inoffensive a manner as to render unnecessary the extension of the outlets beyond the Rivers Lea and Ravensbourne on the east, and the Kensington Canal and Battersea Creek on the west.

The regulation prevalent throughout nature of giving and receiving is of strong application to the circumstances attending the relation in which man and the lower animals stand to the land on which

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which they live; and it has long been acknowledged to be most desirable to reduce to a practicable shape this principle in application to town sewage.

The system of Mr. Henry Stothert, of Bath, is that adopted in this plan; it is about to be carried into effect in Chelmsford, in Essex, and has been shown to be not only practicable, inoffensive, and producing manure of agricultural value, but that the sewage can be dealt with as fast as it is produced, rendering store reservoirs of unadulterated sewage filth wholly unnecessary.

It is proposed to pump the supernatant water to a distance, for purposes of irrigation, or for flushing the sewers, and the remainder to pass into the river; the solid portions being retained as a basis for the manufacture of a portable manure.

This plan has been investigated by the Brazilian Government, and they have sanctioned its application to the imperial city of that empire, containing a population of 350,000 persons.

3d. It is essential that a constant current towards the outlets alluded to under condition, No. 2, and a continuous discharge into the river, be kept up in all the main lines.

This is necessary to avoid ponding up the sewage, awaiting a particular condition of the tide.

4th. The low districts should be limited to the smallest possible areas, to avoid unnecessary pumping, by constructing catch-water sewers along the sides of the hills, having a free and natural discharge at all times above the level of high water.

We lay some stress upon this point, because pumping involves expensive works in first outlay, and permanent annual cost.

In applying this condition to the plan now submitted, it will be seen that the invert level of all the catch-water sewers is placed at 14 feet above Ordnance datum, or 1 ft. 6 in. above high water; and that gradually rising from this level along the sides of the hills, the high-level sewers intercept so much of the drainage of London as leaves a smaller pumping area than has ever yet been suggested.

5thly. The low level sewers should have a free discharge at low water, that there may be power of scouring out at every spring tide the whole lengths of the deepest main sewers.

Immediately the sewers are deprived of the means of being naturally scoured out with abundant supplies of water, many serious risks of stoppage and failure, with consequent inconceivable calamities arising out of possible accidents to pumps, and other causes, are incurred, and these increase the further the sewers are carried; risks of failure which ought not to attach to any plan purporting to be a satisfactory settlement of drainage of London.

We have, therefore, fixed the outlet level of the invert of all the low-level sewers at 9 ft. 6 in. below Ordnance datum, or about low water of spring tides.

6thly. That the existing sewers in the densely built parts of London where the mass of the population reside, should not be disturbed, but means provided for their ventilation, and for scouring them as frequently as required.

London has been styled the best drained city in the world; there are costly drainage works already existing which have been from time to time extended and improved, till they are not now less than 1,300 miles in extent, and yet there are some enthusiastic and impractical minds to whom these works are as nothing, and they absurdly propose to drain all London anew by a separate system of sewers.

The knowledge that the existence of cesspools under our houses impairs the chances of life, has given rise to the necessity of doing away with these nuisances as speedily as possible; and it has grown into an established rule, that house refuse as soon as it is produced, should be kept in motion towards a place where it can be inoffensively dealt with and converted into a suitable form for application to the land.

By using the existing sewers as channels for this purpose, it was soon found that the street gullies became so offensive as in effect to be merely removing the evil—in a less degree certainly—but still removing the evil from a confined sphere of more intense influence to circumstances under which it would have a wider and more diffusive range; thence arose the numberless schemes for trapping gullies and ventilating sewers, not in the hope of totally curing these cesspool exhalations, but to mitigate the evil; the whole plainly indicating something radically wrong, and calling for more perfect arrangements for new districts.

But while we do not propose to disturb the present sewers, it is a matter of grave importance to do the best we can under the circumstances for keeping the existing sewers as sweet and well ventilated as possible.

From the experience we have had of this growing evil in the sewers of London, the extent of which it is fearful to contemplate; we are led to propose that the sewers should be flushed by water from the Regent's Canal on the north side, and for which it will be seen that we shall give the company an equivalent in rain water at their highest level; on the south side the rain water high level sewers will communicate with the whole net work of the low level sewers, so that these additional waters can be sent through them at any spring tide.

It would however, be far preferable to use for this purpose, the supernatant water from the deodorising works which are so strongly impregnated with salts in solution, and impart to it the property of deodorising and arresting fermentation without precipitating the sewage; and it is proposed therefore to pump up with the spare steam power, occasionally from each depôt, through cast iron pipes, this water to a sufficient height, to command the sewers requiring flushing. By this arrangement, an economy of deodorising powder will be effected at the depôt.

We recommend also flap traps at the connexion of the gully drains with the sewers in preference to the water traps; for it is found that the former secure a circulation of air in the sewers, the down draft from the street passing into the sewers, dilating the foul air and escaping by the ventilating shafts.

By these means the existing sewers will be cleansed, deodorised and ventilated.

We have dwelt upon this part of the subject, because it is of increasing importance, and because its present annual cost is very large; namely, raking inside the sewers, and flushing with sewage itself, cost the Commissioners at one time about 25,000 *l.* per annum.

7thly. That in the outlying districts where there is no extensive existing drainage, the natural water-courses should be made available to carry off the chief part of the unpolluted rain-fall, and that provision be only otherwise made for house drainage and such rain water as falls upon back yards and roofs.

In dealing with a collection of cities with their several suburbs, such as London now consists of, we find the circumstances obtaining in the several parts so various, and possessing such distinct peculiarities, that it is not probable any one principle can be laid down which will apply to all.

The suburban districts with an average population, scarcely exceeding 6,000 per square mile, with no system of sewers existing, afford some grounds for hesitating to introduce the same system that would suit the more densely built parts with populations ranging as high as 150,000 per square mile, and having an elaborate and costly system of sewers in full work; and even with the prospective increase of nearly five times the present population which we propose to provide for these parts, they will still maintain their suburban character. The scarcity of population in some such districts, induced Mr. Foster to adopt the plan here recommended, of partially separating the rainfall from the sewage.

Remembering the misgiving and dismay that pervaded the public mind, and with which the existing sewers were regarded as each visitation of the cholera gave emphasis to the fact that death kept more than pace with the most strenuous efforts of public authorities, when in one place at Poplar, 20 persons died in 22 houses in a fortnight, and at the time of the inquest upon the body of a flushing man, four more were awaiting burial:

And contemplating the extent of the evil already attained by using the 1,300 miles of existing sewers, communicating with every street, for carrying away cesspool abominations, and what it will become when every cesspool in London is abolished, a state of things that cannot be altered, but must be submitted to: we say it is of serious importance, and we are bound not to continue and perpetuate the same evils in districts where sound principles are not compromised by existing works, which have cost millions, and cannot be altered, save at the expense of millions more, and at an amount of inconvenience to the public and tradespeople that could not be represented at a money value.

And as new drainage is or will be required in these outlying districts, it is desirable that it should be done upon a preconceived and well-considered plan, that the evils of piece-meal work which has up to the present time pervaded the drainage of London for centuries past, may be arrested at some definite line.

It is, therefore, proposed to provide outfalls for house-drainage, and back roof and yard water, improving the natural open water-courses, to enable them more effectually to carry off the majority of the rain-fall.

After a most careful examination of the ground, it appears, on the whole, that the line marked on the accompanying plan* meets the requirements of the case.

* *See* Plate 2.

It separates the suburban districts (coloured yellow and green) from those where we do not propose to interfere with the sewers (coloured red and blue), except so far as is necessary, to respond to the cry of all London to have its river cleansed, and the demand of the low districts for an outfall.

This circumscribing line may be described as follows:

It proceeds on the north side, along the Regent's Canal, to Camden Town; thence along the southern water-shed of the Hackney Brook Valley to the Regent's Canal again at Cambridge Heath; along the Regent's Canal again to the Blackwall Railway, and along that line to the River Lea, at Bow.

On the south, a straight line from Battersea to Deptford and the River, will generally indicate the line of separation.

The valley line of the Counters Creek, crossing the River to Battersea, marks the division on the west.

By the plan of separation we here propose for the outlying districts, they will be free from the offensive gully nuisance.

We get rid of the heavy matter, such as road grit and detritus, and we reduce the state of dilution of the sewage, and make it more manageable at the deodorising establishments.

8thly. That due provision be made in the capacity, fall and depth of each sewer for a prospective increase of building and population in the suburbs of London, and for the interception of the deepest existing sewers in the low districts.

And this is manifestly a consideration of great importance, involving the prospective increase of population; an increase, however, that will materially affect suburban districts only.

And we have deemed it expedient and wise to allow for such a prospective increase as shall settle the question of drainage for a century to come, at least; always bearing in mind that in proportion as rural districts gradually become transformed into suburban areas, and these again become more thickly built on, so, in like ratio, the rain-water passes off more rapidly into the sewers, for which due provision must be made.

We assume that in such parts as the City of London there will be no increase; that the less thickly built on areas will gradually attain that standard, and we estimate the future population of outlying districts at from 20,000 to 30,000 persons per square mile, or on an average of five times the present population in such places.

House-drainage is, of course, dependent on water-supply, and we provide for the removal of 30 gallons per day per person, and half of it to be carried off in six hours; this quantity is the same as provided by the plan of the Metropolitan Board of Works, and must be admitted to be on a most liberal scale, for we know that much is lost in evaporation and absorption; so that the draining away of 30 gallons may be said to represent not less than a water-supply of 40 gallons per head per day, that is nearly three times the quantity the water companies supplied in 1840 per head.

It is found that about 15 gallons per head per person flow through the sewers from the houses, so that we have provided a large margin for a more abundant use of water.

We

We agree in the general opinion that it is expedient to provide for the average rain-fall throughout the year; namely, one quarter of an inch rain-fall in 24 hours for town portions; and as it has been ascertained from observation that only one-fourth of the rain-fall from town areas reaches the sewers at the period of the greatest flow, the quantity provided to be taken off is equivalent to one inch in 24 hours.

In rural districts of such soil, inclination, and general character as those surrounding London, it is ascertained that about one-tenth of the rain-fall finds its way into the sewer at the period of the greatest flow.

The natural channels of these districts we intend should carry off the bulk of this quantity; but we must provide, in the house drainage sewers for carrying off the rain falling on the back roofs and yards of the prospective houses; and, with this view, we have made a very large estimate of 1-32d of an inch per day over the whole area. Now, it is not probable even when the contemplated prospective number of houses are built and inhabited, that their brick roofs and yards will represent more than one-eighth the whole area; so that, by taking 1-32d part of this we shall be making the same allowance for the covered surface we have to deal with in the suburban districts, as we do in the dense city portions; namely, one quarter of an inch in 24 hours.

These form the elements of the calculations on the sizes for the sewers.

It will be seen that we have correct data for the denser parts of London; and if we take care, and keep on the right side, in respect of the outlying districts, as we believe we do, certain provision may be anticipated by this plan for all future requirements.

The smallest of the main sewers hereinafter proposed will be large enough for a man to get into and examine; from this size they will be graduated to the work they have to do.

It is intended, also, that the outlet of the present sewers shall be continued to low water, and act as flood discharges below the points of interception during those rare occasions when the rain-fall is heavier than the proposed sewers are calculated to carry off.

It will be seen that the low level lines have been laid down as close to the river's edge as practicable, considering the heavy warehouses, narrow streets, and bad ground; in order to reduce the area between such sewer and the river to the smallest possible limit, because the drainage of such area must be reversed, and as a new system for such small areas must be provided, it is intended that they shall carry off only refuse drainage and rain-water from back roofs and yards, while the remainder of the rain-water will pass off through the present sewers direct into the river.

Having now explained the condition that ought to govern a perfect plan for the drainage of London, we proceed to describe, as shortly as possible, the manner in which the plan we propose complies with such conditions. The separated outlying districts are coloured yellow and green on general plan; the former discharged by gravitation above high water, and the latter requiring to be pumped. The areas coloured red and blue will be drained of rain-fall as well as sewage, the former discharging above high water, and the latter requiring to be pumped.

A careful consideration of the surface of the metropolitan area will show, of course, the river and its marshes as the most prominent feature.

These marshes extend far above London, and are nearly on the same level above as they are below. And it is worthy of notice that the Fulham and Battersea marshes are about six feet below the level of Hungerford Wharf.

The annexed plan shows the part of London anciently covered by each tide, and presents a broad expanse of water 1½ miles wide, as high up as Fulham, before the embankments were made to confine the river to its present narrow limits; and this will, moreover, show the similarity of level of the upper and lower marshes, and explain the costly nature and difficulty of draining the extreme western parts through the centre to the east of London.

Hesitation, inconvenience, difficulty and extreme cost, have embarrassed every such attempt arising out of the necessity of pumping the same sewage several times, and the unmanageable quantity of sewage collected at one spot; and have resulted in either incomplete drainage provision for the western parts, or if so provided, it is attended with undue, extravagant and wholly unwarrantable outlay.

All this proceeds from the habit of looking at London in all its greatness, and as a whole.

The difficulties disappear if we take it in moderate detail.

The river already divides London into north and south portions; the chief valley line, on the north, is the Fleet, and that on the south the Effra.

A line following the western watershed of the Fleet from Hampstead to the river, and extending across to the other side along Blackfriars-road to and along the eastern watershed of the Effra will divide the whole into four separate cities for the purposes of drainage, an arrangement we have adopted; and the following is a description, in detail, of the manner in which they are proposed to be dealt with.

North-West District.

The north-west district extends to the watershed on the north, and as far west as Brentford; it includes four principal valleys, running from the north towards the south, and drained by the King's Scholars' Pond, the Ranelagh, the Counters Creek and the Stamford Brook, having their rise in the Hampstead Hills, and their outlet into the river at Vauxhall Bridge, Chelsea Hospital, Kensington Canal and Hammersmith Creek respectively.

Its total area is 34 square miles, of which, 24 square miles are outlying districts, and will have the rain-fall partially separated from the sewage. The drainage of 21 square miles will discharge by gravitation at all times, above high-water mark; and the sewage and rain-fall of 2⅓ square miles, together with the sewage only of 10¼ square miles, will require to be pumped up to discharge above high water.

The outfall and deodorising depôt for this district will be nearly central; namely, at the mouth of the Kensington Canal, where the clear filtered water will alone be allowed to discharge into the river at all times of the tide and above high water. There will be also a flushing outlet provided to low water, to be used only for occasional flushings with clean and deodorised water from the depôt and the Regent's Canal; and there will be required 227 horse-power to raise the drainage of the low areas in this district. From this point, and at a level of 14 feet above Ordnance datum,

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a main intercepting sewer for sewage and rainfall will be constructed up the Fulham-road to Brompton, crossing the upper part of Lowndes-square, the north corner of the Palace Gardens, through the Green Park, Pall Mall, the Strand, turning northward up the valley of the Fleet to Ray-street. In its course it intercepts the Brompton sewers, the Ranelagh, the King's Scholars' Pond, and crosses over the Regent-street sewer, which is diverted into it at a higher level. It also intercepts the Northumberland-street, Strand, and Essex-street sewers, and acts as a catch-water along the western bank of the Fleet. The length of this sewer is 4⅝ miles, and it is calculated to discharge 8,542 cubic feet per minute, has a fall of from two to six feet per mile, and its size varies from eight feet diameter to a 3′ 9″ × 2′ 6″ sewer; and it drains sewage and rainfall from 6¾ square miles, and the sewage only from 5 square miles.

From near the outlet of this sewer at Brompton Cemetery, a high level line extends along the eastern bank of the Counters Creek Valley as far as the Hippodrome at Notting Hill; up to this point it takes rain-water and house drainage, whence it turns westward across Wormwood Scrubs and performs the duty of a house drainage catch-water sewer to the Hammersmith district, taking the line of East Acton and Gunnersbury, terminating at Boston House, near the Brent, on the Brentford and Hanwell Road.

The length of this sewer is 7⅝ miles, and it is large enough to discharge 2,311 cubic feet per minute; its inclination commences at the rate of two feet per mile, terminating at four feet per mile. Its size at the outlet is 4 ft. 3 in. diameter, and at its head 3 ft. 9 in. × 2 ft. 6 in. This sewer drains sewage and rain-fall from one square mile, and sewage only from 8¾ square miles.

There are three low-level lines in this district, one leaves the outlet at a level of 9 ft. 6 in. below datum, or low water, at spring tides, taking an easterly direction along the river bank, past Chelsea, and after intercepting the Ranelagh, continues along Lupus street to Vauxhall Bridge, to avoid the bend in the river at that place, thence in front of the Penitentiary, along Abingdon-street to Bridge-street, where it is continued in a cast-iron pipe inside the Victoria-street sewer to Percy Wharf, whence it takes the river bank, being only a few feet below the mud, just deep enough to pick up all the outlets between Hungerford and Blackfriars Bridges, at the latter of which it terminates. This sewer is only 3′ 6″ diameter at its head, and will not be deep enough along the river bank to be interfered with by the quicksands and treacherous ground that would render so difficult, and perhaps impossible, the construction of a large and deep sewer as was at one time contemplated.

In relation to the Victoria-street sewer it must always be a continual expense and a source of anxiety, from Parliament street to the river, as was fully explained when a late commission peremptorily ordered it to be executed against the remonstrances and protests of its officers; we propose, therefore, to fill it up with concrete, except so much as will be occupied by the iron pipe already mentioned.

The length of the present sewer through Victoria-street will have its current reversed, which can very easily be done, the fall in the whole length of that piece being only 2 feet 10 inches; it will then be continued under the King's Scholars' Pond sewer, down the Queen's-road, and discharge into the Chelsea sewer just described; thus affording an opportunity of deep drainage very much required through the middle of the Westminster low district.

The main low-level line will be 4¾ miles long, capable of discharging 2,079 cubic feet per minute, with an inclination of from two feet to three feet per mile, and will be 4 feet 9 inches diameter at outlet, and will drain sewage and rain-fall from 2½ square miles.

A small part of the area drained by this sewer lying between Lupus-street, Pimlico, and the river, will have its drainage reversed by a new system of sewers, using the present ones for the discharge of rain water direct into the river.

For the next low-level line the recently constructed Counters Creek Extension will be adopted, the old part of it to discharge, as at former times, into the Kensington Canal, but henceforth only rain-fall; and continuing the new line for house drainage up the valley along Addison-road to Notting Dale. The length of the new part of this sewer will be 1¾ mile, and its size will be 3′ 9″ × 2′ 6″, with a fall of seven feet per mile.

The Hammersmith and Brentford low-level line is a house drainage sewer, and drains 9¼ square miles, leaving the depôt at the level of low water; crosses under the Kensington Canal, passes by Walham Green close to the river, through Hammersmith, and Chiswick, to Brentford, where it terminates near the River Brent. It is six miles long, will discharge 1,771 cubic feet per minute, its inclination being from three to four feet per mile, and 4′ 3″ diameter at outlet, and 3′ 9″ × 2′ 6″ at its upper end.

The rain water from the upper separated district from Hampstead and Camden Town on the east, to Kensal Green on the west, containing about six square miles, will be discharged into the Regent's Canal. The supply of water to that canal at present costs the company a large annual sum, so that this arrangement will be of considerable advantage to them, and would compensate for using occasionally some of the water along the line of that canal for flushing purposes.

The existing open watercourses will be straightened and otherwise improved, to carry off the rain water throughout the separated districts, and the low parts under the influence of the tides, will be relieved by short lengths of sewers having an intermittent discharge.

The house drainage of this area will be conducted by new sewers to the line of separation, and discharged into the present sewers below the said line, and carried off by the high-level sewers to the outlet above high water.

North-Eastern District.

The north-eastern district includes the valley of the fleet, and extends eastward to the River Lea, being bounded on the north by the Hampstead and Highgate range, and on the south by the River Thames. This district includes the City of London, besides the valley of the Fleet, which descends from the north to the south, having its outlet at Blackfriars' Bridge. A very important part of this area is occupied by the valley of the Hackney Brook, which takes an easterly direction, falling into the River Lea at Old Ford. The London Bridge sewer is likewise an important line, receiving its drainage from two branches coming out of Hoxton and Islington respectively, uniting in Pitfield-street, whence it falls into the Thames near London Bridge. That part of the district about Stepney, Poplar, Blackwall and Limehouse, is very low, and drained by various sewers, under the influence of every tide, and urgently requires relief.

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The outfall and depôt of this district is placed at Bromley, near four miles. The discharge of the supernatant water will be into the Bow Creek, at the tail of the mills, continuously, and at all times of the tide, with flushing outlet continued under the creek, and along its east bank to the Thames at low water, between the mouth of the creek and the Victoria Docks. This sewer will only be used at certain intervals on occasional spring tides, and for flushing purposes alone, and then clean and deodorised water will be used, and 145 horse power will be provided at this depôt, to raise the sewage from the low district.

It will be observed by the small general plan, that the upper part of Fleet Valley north of the Regent's Canal is intended to have the rain-water partly separated from the house drainage; and it is proposed to provide a house drainage outfall for this purpose, discharging into the Fleet at the point where it crosses under the canal. The present sewers and open watercourses above this point will have to convey rain-water, and they will discharge into the Regent's Canal as before described in a parallel case in the north-western district.

The Hackney Brook drainage area will be provided with a house drainage high level sewer starting from the depôt at 14 on the Ordnance datum line, on 18 inches above high water, and passing through Bow, Hackney, Stoke Newington, terminates at Lower Holloway, at a point whence the ground rises in all other directions.

This line follows the general direction of, and is in fact a substitute for the Hackney Brook, as regards foul drainage; and, therefore, the old watercourse being straightened and relieved, will be all that is required to carry off the remainder of the rain-fall which it is not intended to admit into the house drainage sewer.

The area drained by the sewer, and discharging above high water is 8¼ square miles.

The length of the sewer is 6½ miles, and is capable of discharging 2,134 cubic feet per minute, with an inclination of from 4 feet per mile to 14⅓ feet per mile, and a diameter at outlet of 4′ 6″, and at the head it will be 3′ 9″ × 2′ 6″.

There will also be a low level line starting from the depôt at low water level, to provide house drainage outfall for the strip of land bordering the Hackney Cut and River Lea, amounting to 1½ square miles.

For the relief of the Hackney Brook itself, besides straightening it, and putting in an invert, it is proposed to provide two overflow lines; the upper taking the whole of the water at a point in the fields, between Abney Park Cemetery and Upper Clapton, and conveying them by a sewer in nearly a straight line towards the Lea, across and under the Upper Clapton-road, through certain brick fields, and into a short open cut to be made from the Lea above Lea Bridge across the marsh to the foot of the hill. This sewer will have a fall of 30 feet in half a mile. It may be observed that the East London Water Works Company have cut off all communication from this part of the River Lea, and take their supply many miles further up; and that it is only intended to discharge rain water at this place.

The second overflow is intended to arrest the remainder of the water from flowing through the district below the level of high water, as is at present the case; and this will be effected by a short but straight sewer from the brook at Church-road, Hackney, under the railway, into a short embanked open cut, to be connected with and forming a branch of the Hackney Cut.

There will then remain but a very small area in the Hackney marshes at or below high water now subject to frequent floods, and altogether in an unhealthy condition. It is proposed to relieve this area, by constructing, in the place of the present lower part of the Hackney Brook, a sewer, discharging into the River Lea below Three Mills, by which means we obtain an additional fall of about eight or nine feet. This sewer will have an intermittent discharge, and be continued upwards into the Hackney marshes.

The remainder of the sewers of this district carry off all the rain-fall, as well as sewage, from the densely built and thickly populated area.

The middle high level line drains the sewage and rain-fall from an area of 8⅝ square miles, together with sewage only from 3⅓ square miles, and discharges continuously above high water. It commences at 14 on the datum at Bromley, passing under the Regent's Canal, and then takes nearly the same line as the low level sewer of the Metropolitan Board of Works Plan; namely, along Back-road, Great Tower-street and Cannon-street, passing over the London Bridge sewer, which is diverted into this line from Finsbury-square; it continues southward of St. Paul's, along the eastern bank, and up the valley of the Fleet to Bagnigge-Wells-road, where that main valley line is taken up.

The length of this important sewer is 5½ miles; it is capable of discharging 10,064 cubic feet per minute; its inclination is two feet per mile at the commencement, and it terminates with a fall of 17 feet per mile. Its size at outlet is 9 feet diameter, and at the head 6 feet.

The above described provision leaves only 3¾ square miles of low district, the sewage and rain-fall of which will have to be pumped; and for the drainage of this, the low level sewer commences at the depôt at Bromley, at 8 feet 6 inches below datum, or one foot above low water, and passes along the East India Dock-road, under the Limehouse Cut and Regent's Canal, along Broad-street, St. George's-street, north of the Tower, along Thames-street to Blackfriars Bridge, picking up the London Bridge and Fleet sewers, near their outlets. There are two branches for the drainage of the Isle of Dogs and the area between the London Docks and the Thames.

The remainder of the drainage between the sewer and the Thames from the Tower to Blackfriars-bridge will be dealt with as described for a similar part in the north-western district.

The length of this sewer is 5½ miles, having an inclination of from two to three feet per mile, and being 5′ 0″ diameter at outlet, and 3′ 9″ × 2′ 6″ at head. It will discharge 2,246 cubic feet per minute.

This completes the drainage of the north side of the river.

South-West District.

The south-west district is bounded by the watershed on the south, represented by a line along the north fence of the Richmond Park, passing between Putney Heath and Wimbledon Common to Garret's Mill, on the Wandle, thence by Tooting, Streatham, Norwood, to Dulwich Hill. The Dulwich-road east watershed of the Effra and Blackfriars-road, forms the eastern boundary, while the Thames circumscribes the district on the north and west, as far as Richmond. It consists of

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of valleys running generally from the south towards the north, and drained by the Effra, Falcon Brook, Wandle and the Roehampton stream, discharging into the Thames at Vauxhall Bridge, Battersea Creek, Wandsworth and Putney respectively.

It contains 19¼ square miles, of which it is proposed to separate, as before described, the sewage from the rain-fall over 15⅓ square miles, this area being rural district; leaving only 4 square miles of town portion from which the rain-fall as well as sewage will be drained; the whole of this latter, together with 4¼ square miles of the separated district will have to be pumped.

The depôt for this district is at the centre of its entire length; namely, Battersea Creek, where there is open space suitable, as before described, for the purpose. The Creek will be improved and continued into the open space above mentioned, and receive the clear supernatant water at all times above the level of high water. There will also be constructed a flushing outlet to low water from the low level lines, to be used only for periodical flushings with large bodies of clean and deodorised water from the depôts, and also from the natural watercourses collected into the high level catch-water sewer.

The pumping power required to lift the low-level drainage is 176 horse power.

From the depôt there will be constructed a double catch-water sewer, one for rainwater and the other for house drainage, as described. Starting at 14 on Ordnance datum they pass under the railway, then over the Falcon Brook, take the general line of the Wandsworth-road as far as Clapham, thence they turn off towards Brixton and intercept the Effra, near Brixton Church. The Falcon Brook is diverted into the rainwater sewer from a higher point.

This double sewer circumscribes the thickly built area; its length is 2¾ miles, and it drains an area of 7⅔ square miles.

The house drainage sewer will discharge 1,447 cubic feet per minute, and will be 4′ 0″ diameter at outlet, and 3′ 6″ at head.

The rainwater sewer will discharge direct into the river without passing through the deodorising works, 1,155 cubic feet per minute, and will be 4′ 0″ diameter at outlet, and 3′ 6″ at head; their inclinations being from two to four feet per mile.

The present line of the Effra and Falcon Brook, below the point of interception, will be improved, straightened and made available for a flood discharge.

The Lambeth low level sewer leaves the outlet works at low water line and passes along the Battersea-road and along the streets skirting the river by Vauxhall, Westminster and Waterloo Bridges, and as far as Blackfriars Bridge.

The principal outlets into the river that require to be intercepted along this line, besides the Effra, are the Heath Wall sewer, which is for the most part a foul open ditch, the Arnold sewer, and the Dover level sewer between Waterloo and Blackfriars Bridges.

There will be a Battersea branch to this sewer, discharging into it at the outlet works.

The length of this sewer is 4⅔ miles, and it drains four square miles; it will discharge 2,417 cubic feet per minute, has an inclination of from two to three feet per mile, and is 5′ 0″ diameter at outlet, and 3′ 9″ × 2′ 6″ at head.

The other high level sewer is to take house drainage, with such proportion of rain-fall as before described; it rises in an opposite direction, namely, from east to west; from the depôt at Battersea Creek, at 14 on the datum, it passes under the railway, over the Wandle, through Wandsworth, the upper part of Putney and East Sheen, to the river at Richmond. It drains 3½ square miles, is 6¼ miles long, will discharge 551 cubic feet per minute when the district is populated to the contemplated extent, falls from two to four feet per mile, and is 3′ 9″ × 2′ 6″ throughout its entire length.

The corresponding low-level sewer is also for house-drainage, falls in the same, and takes a parallel direction to that last described; the level of the outlet is low water. It passes through Wandsworth, under the Wandle, close to the river by Putney, along the Barnes-road, and across the common, close to the river again, through Mortlake, and terminates at the lower part of Richmond.

It drains 4½ square miles, has a fall of from 2 to 4 feet per mile, is 6¼ miles long and is 3′ 9″ × 2′ 6″ for its entire length, and is to discharge 700 cubic feet per minute.

As in other similar districts, the water-courses will be straightened and improved to carry off the rain-water.

South-East District.

The last district we have to describe is the south-eastern, bounded on the west by the last-named district, on the north by the river, on the south by a line from Dulwich Hill to Sydenham Station, and by Bell Green and South End on the Ravensbourne River to the east.

It is proposed to include Greenwich, Kidbrooke and Lea; but the sewers are to be laid at such a depth that they may be extended, so as to bring in the drainage of Woolwich, if at any future time it should be thought desirable.

Exclusive of this latter, however, the district contains 18⅓ square miles.

The sewage will be separated from the rain-water over 10 square miles of this area; and over the remaining 8⅓ square miles, being the thickly-built part, of which all the rain-water as well as house-drainage will be provided for; and this area, together with the house-drainage of one square mile of the separated district, will have to be pumped.

The depôt, or outlet works for this district is placed on the east side of Deptford Creek, on a vacant piece of ground most suitable for the purpose.

The clear, purified water alone will discharge into the Deptford Creek above high water, but at all times of the tide; and a flushing outlet will be constructed, as before described, in each of the other districts. It will require 316 horse-power to lift the sewage at this station.

The peculiarity of this district is, that it comprises a large, thickly-built, and very low area between the Surrey Canal and the river, which is imperfectly drained by four principal sewers; namely, the Earl, the Duffield, Great St. John, and Battle Bridge sewers, all having intermittent discharge through outlets being only a little above low water; and here, beyond all other parts of London, the chief inconvenience has been experienced from the water from the high ground on the south flooding the low district just described.

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To prevent this, it is proposed to construct a double high level catch-water, as described in last district; the rain-water sewer will discharge into the creek below the mill at all times of the tide, and the house-drainage sewer will leave the depôt at 14 on datum, cross over the creek at Deptford Bridge, and join with the rain-water sewer. They will be constructed side by side in the same trench along the Deptford Road to New Cross, under the two railways; thence, leaving the road, they will pass under private ground through Peckham, intercepting the Peckham Rye sewer behind Camberwell Church, along the road to Brixton, terminating at the east water-shed of the Effra.

The sewers will drain nine square miles, and their length will be four miles. Their inclination from two feet to four feet per mile.

The house-drainage sewer will be 4′ 0″ diameter at outlet, and 3′ 9″ × 2′ 6″ at upper end, and will discharge 1,529 cubic feet per minute.

The rain-water sewer will be 4′ 0″ diameter throughout.

The low level line for this district is to take all the rainfall as well as sewage, and will drain 8½ square miles. It will commence at the level of low water, pass under the Deptford Creek, along the lower Deptford-road to Rotherhithe, thence under the mill stream and St. Saviour's Dock, following the streets as close as is safe to the river, past the London and Southwark Bridges to Blackfriars Bridge, where it terminates.

In its course it picks up all the sewers, including the deepest, namely the Earl sewer, that now by intermittent discharge, flow into the river.

There will be two branches to intercept the drainage from the river by the Commercial Docks.

The length of the sewer is 4¾ miles; its inclination from two feet to four feet per mile.

It will discharge 6,475 cubic feet per minute, and its size at outlet is 7′ 6″ diameter, and at upper end, 4′ 0″ diameter.

There will be a low level sewer falling to the same depôt in an opposite direction to these already described, for the drainage of Greenwich; which may, if required, be continued to Woolwich.

This completes the drainage as proposed for the south side of the Thames.

It will be observed that in a few places on the sections, the crown of the sewer is above the surface; the chief of these is at the outlets where it is intended to raise the sites for the sewage manure works, and in the remaining places the raising the road will be a public improvement.

We are aware that the district here embraced is larger than the area under the jurisdiction of the Metropolitan Board of Works, which contains about 127 square miles, 300,000 houses, and 3,000,000 of population, and extends no further westward than Putney, and Roehampton on the south of the river, and Fulham on the north; while we have deemed it expedient to make provision in the depth and size of sewers, and in the arrangement at the outlets for the area as far west as, and including, Richmond on the south and Brentford on the north, as these are places which will no doubt ultimately come within the influence of the London drainage.

It must be borne in mind that the quantity of drainage provided for in this plan is prospective, and will not be realised for very many years, and although in the matter of sewers it is desirable, and indeed essential, to provide present capacity adequate to meet this ultimate contingency; because such works cannot well be added to, but in case of insufficiency must be done over again; yet this is not so with regard to the disinfecting works, the tanks and machinery of which at each depôt will be constructed in divisions to meet the variable quantities of sewage that reach the outlet at various times of each day. For instance, during the night one precipitating tank might be sufficient, while at noon, 10 or 15 may be required to be in operation.

It will be seen therefore, how easily additional accommodation may be made from year to year, to provide for the growing requirements of London.

It is proposed however, to provide at present the full steam power necessary for pumping the calculated prospective quantity of sewage from the low districts, because the spare power will be required in the operations of disinfecting.

It only remains now to explain that should it be deemed expedient to remove the sewage to a greater distance from London than is herein described, it is contemplated to force it through cast iron pipes into the country as far as necessary. There are tracts of waste and sterile land suitable for the purpose sufficiently near each depôt, that would thus be reclaimed with pecuniary advantage.

It is so well known, that it need scarcely be here dwelt upon, that by this means a comparatively small pipe just under the surface, will deliver that which would require a large and expensive sewer, as proposed in the Metropolitan Board of Work's plan.

Mr. Frank Forster well understood this question, and proposed similar appliances for the extension of the drainage of the Surrey and Kent districts.

We wish it to be clearly understood, that we are fully satisfied the sewage disinfecting works will be no nuisance at all at Fulham, Bromley, Battersea and Deptford, and that no benefit will result if they are 20 miles from London. We only allude to this pumping as a practical alternative if it should be necessary to satisfying a mere groundless notion possessing the public mind.

And we maintain that, in either case, the plan we now submit is the best suited for the drainage of London, and the interception of the sewage from the Thames.

The estimates, and other detailed information, are in the form of an Appendix.

We have only to add, in conclusion, that should this plan be entertained, and it be found convenient and desirable by the authorities, a company will be formed which would undertake the profitable manufacture of the sewage into manure, and consider it one element of return upon a capital, fixed upon the basis of the estimated cost of these works.

Recapitulation of Advantages gained by this Plan.

1. That by dividing London into four parts, including Richmond and Brentford on the west, and Greenwich on the east, and dealing with each as a separate and distinct place, we can discharge in the least costly manner, above high water, the drainage of the largest possible area, and reduce the drainage of the area, requiring costly pumping, to the most limited extent.

2. That this plan provides ample and complete drainage for all parts of the metropolis and its outlying districts, for the future increase of population and extension of building, and perfectly intercepts the sewage from the Thames.

3. The flooding of low districts by the water flowing off the area of the land above, will be entirely prevented.

4. That only clear, filtered water will pass into the Thames at four outlets, and that only when it is not required for agriculture or flushing.

5. The sewage is divided into quantities capable of being chemically dealt with for the above-named purposes.

6. That there will always be a constant current in the sewers, the high-level lines discharging above high water, and the low-level lines being raised by steam-power to the same level. There will be, therefore, no reservoirs, ponding-up the sewage twice in every 24 hours, awaiting the turn of the tides.

7. None of the low-level sewers will be below low water, and therefore they will all have a free discharge, and the opportunity of being scoured out at that level; whereby the serious risk of failure attending the carrying of sewers below low water will be avoided.

8. The 1,300 miles of existing sewers will not be disturbed; but better outfalls provided for them, and they will be cleansed by copious bodies of water, deodorised and ventilated.

9. The outlying districts, at present undrained, or imperfectly so, will be provided with a system of drainage upon sound principles, preserving the purity of the natural water-courses, and doing away with the difficult gully nuisance.

10. The adoption of a plan of disinfection that perfectly deodorises and filters the sewage as rapidly as it is conveyed to the outlet by the sewers; that performs the operation inoffensively, and produces a manure of agricultural value.

Gotto & Stothert.

Description of Deodorising Apparatus.

From the plans, sections and report delivered, it will be apparent that it is proposed to gather the whole of the sewage of the Metropolis into four stations, where it will be deodorised and rendered innocuous.

The accompanying plan* shows one of these stations, viz., that for the north-west district, near the mouth of the Kensington Canal. At this point no less than five sewers are brought together, two by gravitation, emptying themselves into an iron trough 18 inches above high water-mark, and three by low sewers, that will admit of their being flushed out at a level above low spring tides, and the contents of which sewers will be pumped up to the level of those falling by gravitation; the whole of the sewage of this district will then be mixed and merged together, and flow through troughs at right angles to the trough in which it is gathered.

On these last-mentioned troughs are fixed sluice valves for letting a defined quantity of sewage into each mixing machine, where it is incorporated with a due proportion of powder, whence it passes by its own gravity into the deposit beds beyond.

The mixing is effected by steam-power. The powder is composed mainly of lime, sulphate of alumina and charcoal, and each article has its duty to perform. The lime prepares the sewage to be acted upon by the sulphate of alumina, and as this is always advisable to be administered first, it is mixed in the first compartment of the mixing machine, after which the sulphate of alumina and charcoal are added and incorporated.

By such means a two-fold object is obtained, viz., that of deodorising the sewage and arresting decomposition, and when the grosser matters are separated from the sewage, the clear water may be transmitted to a distance, and used for irrigating lands without inconvenience. Too much importance cannot be attached to this circumstance, for all the evils arising from employing sewage in its normal condition, are here prevented; the gases are absorbed by one element in the powder, whilst decomposition is stayed by another, and this circumstance allows the opportunity of using the supernatant water upon lands, with no more injury to health than the use of so much common water. The effect of using this water upon land is surprising; this is not to be wondered at, when it is considered that in addition to the valuable salts held in common sewage, we improve its quality by the very articles employed as deodorants.

The sewage, when mixed with its proportion of powder, flow together into the deposit beds, whence the more solid particles are allowed quietly to subside, and the water is made to pass upwards through a filter, at the extreme end of the bed from whence it enters; it is then clear and bright, and although holding many of the most valuable salts in solution, it is apparently like common water, with little or no smell to it; nevertheless, it is most valuable for purposes of irrigation; at present this liquid may not meet with its due appreciation, and until its value is fully understood, it is proposed to allow it to go into the river at all the four stations, except that portion that may be used for flushing purposes. Two deposit beds are proposed for each mixing machine, so that whilst one is being filled with deposit, the other is being emptied. In order to render the deposit as dry as possible before it is removed from the bed, it is proposed to have the entire area floored with tiles similar to kiln tiles; these tiles rest on sand, and beneath this sand is coarse gravel; and under that, stones, falling into a centre gutter, which terminates with a pipe and sluice cock outside the tank; these sluice cocks are always closed, except when the deposit has to be removed, when they are opened, and the water contained in the deposit is strained off through the filtering medium until it is tolerably compact, when it is removed by a dredging machine through the end of the deposit bed into trucks, and conveyed away by a tramroad to places for manipulation, or a portion mixed with tan, peat or other woody fibrous matter, for being converted into charcoal.

The

* Plan not engraved.

The minute details in the general arrangement have not escaped attention, so as to secure good action and ease of working. Cages are fixed at the entrances to catch the grosser matters, whilst the whole arrangement is regulated by sluice valves, placed in such positions as to allow for making repairs, extensions, &c.

It will be seen that the whole of the foregoing process is simple, continuous and self-acting, the sewage being chemically dealt with as fast as it reaches the depôt, the only mechanical power employed being that necessary to mix the powders with the sewage.

For the reasons above stated, it has not been considered necessary to estimate at present the cost of forcing the supernatant water into districts where it may be most profitably employed for agricultural purposes, although it must be borne in mind that for 50 years to come the spare engine power provided and included in the estimate, will be sufficient to pump such a quantity as would be likely to be used for irrigation at present.

The capabilities of the appliances contemplated at each station to deodorise the quantity of sewage that would flow to each district, will appear from the following explanation.

The calculations made for the size of the sewers embrace a very large prospective population, such as will not be attained for at least 50 years; and they are intended to carry off the sewage equal to 30 gallons per head per day, or rather half that quantity in six hours, together with ¼-inch of rainfall spread equally over the 24 hours.

The result of these considerations produces a quantity due to the several stations, as follows:

	Cubic Feet per Minute.		
	Sewage.	Rain.	Total.
North-west - - -	7,817	7,056	14,873
North-east - - -	9,824	4,948	14,772
South-west - - -	2,900	2,212	5,112
South-east - - -	4,463	3,653	8,116

But, while it is essential that sewers which cannot be enlarged without being re-constructed, should be capacious enough to meet any prospective increase, it is manifestly unnecessary to make present provision in dealing with the sewage when brought to the station for such an ultimate contingency; because, from the nature of the work, the tanks for this purpose may at any time be indefinitely increased.

It is, therefore, proposed to construct at present 20 double tanks for each of the north-west and north-east stations, six for the south-west, and ten tanks for the south-east stations.

Estimates.—*Gotto & Stothert*'s Plan.

North East Division:

	Yards run.	Per Yard. £. s. d.	£. s. d.	£. s. d.
Hackney Brook - -	4,900 of 4′ 6″ diameter, 20 ft. deep -	at 2 18 9	14,393 15 –	
	6,533 of 3′ 9″ × 2′ 6″ „ -	at 2 1 9	13,637 12 9	
Rain-water outlets, Stoke Newington and Hackney.	1,870 of 4′ 0″ diameter „ -	at 2 13 2	4,971 1 4	
	833 of open cut embanked - -	at 2 – –	1,666 – –	
	3⅓ acres land - - - - - -		1,000 – –	
	Deepening, straightening, and putting in invert to present Hackney Brook - - - - -		13,800 – –	
Lea, low level house-drainage.	1,870 of 3′ 9″ × 2′ 6″ 20 ft. deep -	at 2 1 9	3,903 12 6	
Lea, low level rain-water -	2,280 of 7′ 0″ circular, including sluice	at 5 – –	11,400 – –	
				64,772 1 7
High level sewer - -	1,667 of 9′ 0″ diameter, 20 ft. deep -	at 7 – 5	11,703 14 7	
	1,700 of 8′ 6″ „ „ -	at 6 14 2	11,404 3 4	
	1,440 of 7′ 6″ „ „ -	at 6 1 5	8,742 – –	
	1,540 of 7′ 0″ „ „ -	at 5 13 3	8,720 5 –	
	3,300 of 6′ 0″ „ „ -	at 5 – 9	16,623 15 –	
London Bridge Branch -	1,667 of 4′ 6″ „ „ -	at 2 18 9	4,896 16 –	
				62,090 13 11
Low level sewer - -	1,467 of 5′ 0″ „ 30 ft. deep -	at 3 16 6	5,611 5 6	
	3,950 of 4′ 0″ „ „ -	at 3 5 10	13,002 1 8	
	3,673 of 3′ 9″ × 2′ 6″ „ -	at 2 10 9	9,320 4 9	
London Docks, and Isle of Dogs Branch.	5,200 of 3′ 9″ × 2′ 6″ 20 ft. deep -	at 2 1 9	10,855 – –	
	Extra for syphons - - - - - -		2,000 – –	
	Reversing drainage, tower to Blackfriars Bridge -		6,000 – –	

(*continued*)

Appendix X—*continued.*

ESTIMATES—*Gotto & Stothert's* Plan—*continued.*

		Yards run.	Per Yard. £. s. d.	£. s. d.	£. s. d.
North-east Division—*continued.*					
Low level flushing outlet -	3,163 of 5′ 6″ diameter, 19 ft. deep -		at 3 10 –	11,090 10 –	
	Extra for carrying flushing sewer to low water - -			2,000 – –	
					59,879 1 11
	Side entrances - - - - - - - -			- - -	3,080 – –
	Continuing flood outlet to low water - - -			- - -	5,000 – –
	Sewage works, including land - - Sewage works 120,000 – – / Land - - 10,000 – –			130,000 – –	
	145 H. P. in duplicate=290 H. P., at £. 60, including engines, pumps, boilers and houses - - -			17,400 – –	
					147,400 – –
	House-drainage, outfall above Regent's Canal, viz., upper part of Fleet Valley - - - - - -			20,500 – –	
	Connecting rain-water sewers with canal, and making flushing outlet - - - - - - - -			1,000 – –	
					21,500 – –
	Cast-iron pipe and pumps for flushing - - -			- - -	30,250 – –
	Add, 10 per cent. for concrete, contingencies, &c. -			- - -	39,397 3 8
	„ 10 per cent. for compensation, land, &c. - -			- - -	39,397 3 8
				£.	472,766 4 9
North-west District:					
High level sewer (Strand)	500 of 9′ 0″ diameter, 17′ 0″ deep -		at 6 11 5	3,285 8 4	
	2,840 of 8′ 0″ „ „ -		at 6 1 0	17,182 – –	
	1,233 of 7′ 6″ „ „ -		at 5 19 –	7,336 7 –	
	1,367 of 5′ 6″ „ „ -		at 3 8 6	4,681 19 6	
	1,600 of 4′ 6″×2′ 9″ „ -		at 2 3 –	3,440 – –	
	1,167 of 3′ 9″×2′ 6″ „ -		at 1 18 9	2,261 1 3	
Regent-street Branch -	1,450 of 4′ 6″ diameter, 28′ 0″ deep -		at 3 10 –	5,075 – –	
					43,261 16 1
Low level sewer (Westminster).	2,473 of 4′ 9″ diameter, 20′ 0″ deep -		at 3 2 –	7,666 6 –	
	1,567 of 4′ 6″ „ „ -		at 2 18 9	4,603 1 3	
	2,033 of 4′ 6″×2′ 9″ „ -		at 2 6 –	4,675 18 –	
	1,033 of 3′ 6″ iron-pipe, 8′ 0″ deep - / 1,200 concrete for Victoria-street sewer, including laying pipe - - - - - - - -		at 8 – –	17,864 – –	
Victoria-street Branch -	1,400 underpinning old sewer - -		at 1 – –	1,400 – –	
	1,967 continuation to main line -		at 2 – –	3,934 – –	
	Reversing drainage, Lupus-street - - - -			3,000 – –	
					43,143 5 3
Counters Creek Extension	3,117 of 3′ 9″×2′ 6″ 15′ 0″ deep -		at 1 16 9	5,727 9 9	
	Reinstating old connexion of Counters Creek with Canal - - - - - - - - -			500 – –	
					6,227 9 9
Brentford low level - -	933 of 4′ 6″ diameter, 20′ 0″ deep -		at 2 18 9	2,740 13 9	
	4,167 of 4′ 0″ „ „ -		at 2 13 2	11,077 5 6	
	5,473 of 3′ 9″×2′ 6″ „ -		at 2 1 9	11,424 17 9	
	Cast-iron pipe under Hammersmith Creek and Kensington Creek - - - - - - - -			590 – –	
					25,742 17 –
Hollands and Acton, high level.	480 of 4′ 3″ diameter, 14′ 0″ deep -		at 2 9 –	1,176 – –	
	4,433 of 4′ 6″×2′ 9″ „ -		at 2 – –	8,866 – –	
	3,520 of 4′ 6″×2′ 9″ „ -		at 2 – –	7,040 – –	
	4,800 of 3′ 9″×2′ 6″ „ -		at 1 16 –	8,640 – –	
					25,722 – –
Rain-water sewer - -	5,280 of 6′ 0″ sewer for R. W. of marshes, Fulham and Chiswick, including sluices - -		at 4 – –	21,120 – –	
	Straightening and putting in invert to watercourses -			5,000 – –	
					26,120 – –
Low level flushing outlet -	500 of 6′ 6″ diameter, 26′ 0″ deep -		at 6 – –	3,000 – –	
	Carrying same to low water - - - - -			1,500 – –	
					4,500 – –
	Sewage works - - - - - - - -			120,000 – –	
	Land - - - - - - - - -			10,000 – –	
	227 H. P. in duplicate=454 H. P., at £. 60, including engines, pumps, boilers, and houses - - -			27,240 – –	
					157,240 – –

Appendix X—*continued.*

ESTIMATES—*Gotto & Stothert's* Plan—*continued.*

		Yards Run.	Per Yard. £. s. d.	£. s. d.	£. s. d.
North-west District—*continued.*					
Low level flushing outlet—*continued.*	Carrying flood outlets to low water - - - -			- - -	2,000 – –
	House-drainage, outfall for separated district above Regent's Canal - - - - - - - -			46,500 – –	
	Connecting rain-water sewers with Canal, and providing flushing outlet - - - - - - -			1,000 – –	
					47,500 – –
	Side entrances, &c. &c. - - - - - - -			- - -	4,220 – –
	Cast-iron pipe, and pumps for deodorised water for flushing - - - - - - - - -			- - -	16,530 – –
	Add 10 per cent. for contingencies and concrete -			- - -	40,220 14 9
	„ 10 per cent. for compensation and land - -			- - -	40,220 14 9
				£.	482,648 17 7
South-east District.					
High level sewer, Peckham.	1,833 of 4′ 0″ diameter, 18′ 0″ deep -		at 2 10 6	4,628 6 6	
	3,033 of 3′ 9″ „ „ -		at 2 8 –	7,279 4 –	
	2,400 of 3′ 9″×2′ 6″ „ -		at 2 – –	4,800 – –	
	Cast-iron pipe over Ravensbourne - - - -			250 – –	
	Ditto - under Railways - - - - -			500 – –	
					17,457 10 6
Low level sewer, Bermondsey.	2,573 of 7′ 6″ diameter, 20′ 0″ deep -		at 6 1 5	15,620 5 1	
	2,033 of 7′ 0″ „ „ -		at 5 13 3	11,511 17 3	
	617 of 6′ 0″ „ „ -		at 5 – 9	3,108 2 9	
	1,467 of 5′ 0″ „ „ -		at 3 3 6	4,657 14 6	
	1,117 of 4′ 0″ „ „ -		at 2 13 2	2,978 13 2	
	Extra for iron pipes under St. Saviour's Dock - -			1,800 – –	
	Cast-iron pipe under Ravensbourne - - - -			700 – –	
Rotherhithe and Commercial Docks Branch.	5,100 of 3′ 9″×2′ 6″, 20′ 0′ deep -		at 2 1 9	10,646 5 –	
					50,022 17 9
Greenwich low level -	2,933 of 3′ 9″×2′ 6″, 25′ 0″ deep -		at 2 6 –	6,745 18 –	
Greenwich high level -	800 of „ 20′ 0″ „ -		at 2 1 9	1,670 – –	
					8,415 18 –
Rain-water - - -	6,599 of 4′ 0″ diameter, 18′ 0″ deep -		at 2 10 6	16,662 9 –	
	Cast iron pipe under two railways - - - -			500 – –	
	Connecting rain-water sewers with rain catch-water sewer, and providing flushing outlet - - -			1,000 – –	
	Straightening and putting in invert to watercourses -			2,000 – –	
					20,162 9 –
Low level flushing sewer -	667 of 7′ 6″ diameter, 24′ 0″ deep -		at 6 10 –	4,335 10 –	
	Carrying same to low-water - - - - -			1,800 – –	
					6,135 10 –
	Continuing flood outlets to low water - - -			- - -	4,000 – –
	House-drainage outlet for separated districts - -			10,000 – –	
	Reversing drainage by river - - - - -			2,000 – –	
					12,000 – –
	Side entrances, &c. &c. - - - - - -			- - -	2,780 – –
	Sewage works - - - - - - - - -			80,000 – –	
	Land - - - - - - - - -			5,000 – –	
	316 H. P. in duplicate=632 H. P. at 60 *l.*, including engines, pumps, boilers and houses - - -			37,920 – –	
					122,920 – –
	Cast-iron pipes and pumps for flushing with deodorised water - - - - - - - - -			- - -	18,625 – –
	Add 10 per cent. for contingencies and concrete -			- - -	26,251 18 6
	„ 10 per cent. for compensation and land - -			- - -	26,251 18 6
				£.	315,023 2 3

(*continued*)

Appendix X—*continued.*

Estimates—*Gotto & Stothert's* Plan—*continued.*

South-west District.	Yards run.	Per Yard.	£. s. d.	£. s. d.
High level sewer, Brixton -	3,533 of 4′ 0″ diameter, 18′ 0″ deep -	at 2 10 6	8,920 16 6	
	1,467 of 3′ 6″ „ „ -	at 2 6 –	3,374 2 –	
				12,291 18 6
Low level sewer, Vauxhall -	2,767 of 5′ 0″ „ 20′ 0″ „ -	at 3 3 6	8,785 – –	
	1,807 of 4′ 6″ „ „ -	at 2 18 9	5,308 1 3	
	833 of 4′ 0″ „ „ -	at 2 13 2	2,214 3 –	
	2,400 of 3′ 9″ × 2′ 6″ „ -	at 2 1 9	5,010 – –	
Battersea Branch - -	1,500 of „ „ -	at 2 1 9	3,131 – –	
				24,448 4 3
High level sewer, Richmond.	11,033 of „ „ -	at 2 1 9	23,031 7 9	
	Extra on aqueduct over Wandle - - - -		1,000 – –	
				24,031 7 9
Low level sewer, Richmond.	11,033 of 3′ 9″ × 2′ 6″, 27′ 0″ deep -	at 2 8 –	26,479 4 –	
	Cast-iron pipe under Wandle - - - - -		500 – –	
				26,979 4 –
Rain-water - - -	3,000 of 4′ 0″ diameter, 18′ 0″ deep -	at 2 10 6	7,575 – –	
	2,000 of 3′ 6″ „ „ -	at 2 6 0	4,600 – –	
	Straightening, deepening and putting invert to Effra and Falcon Brook watercourses, and other storm overflows - - - - - - - - -		6,000 – –	
	Branch from Falcon Brook at a higher level, and raising road at crossing - - - - -		2,000 – –	
	Connecting rain-water sewers with catchwater and flushing apparatus - - - - - - -		1,000 – –	
				21,175 – –
Flushing outlet - -	433 of 6′ 6″ diameter, 23′ 0″ deep -	at 6 – –	2,598 – –	
	Carrying same to low water - - - - -		1,500 – –	
				4,098 – –
	Carrying flood outlets to low water - - - -		2,000 – –	
	Constructing Effra and Falcon Brook storm outlets -		3,000 – –	
				5,000 – –
	House drainage outfall for separated districts - -		- - -	10,000 – –
	Improvement of Battersea Creek - - - -		- - -	10,000 – –
	Side entrances, &c. &c. - - - - - -		- - -	3,560 – –
	Sewage works - - - - - - - - -		50,000 – –	
	Land - - - - - - - - - -		5,000 – –	
	176 H. P. in duplicate=352 H. P., at 60 *l.*, including engines, pumps, boilers and houses - - -		21,120 – –	
				76,120 – –
	Cast-iron pipes and pumps for flushing - - -		- - -	14,587 – –
	Add 10 per cent. for contingencies and concrete -		- - -	23,220 – –
	„ 10 per cent. for compensation and land - -		- - -	23,229 – –
			£.	278,748 14 6

Summary of Estimates.

	£. s. d.
North-east District - - - - - -	472,766 4 9
North-west District - - - - -	482,648 17 7
South-east District - - - - -	315,023 2 3
South-west District - - - - -	278,748 14 6
£.	1,549,186 19 1

Comparison between *Gotto & Stothert's* Plan and the Official Plan.

NORTH OF THE THAMES.

Gotto & Stothert's Plan.	Official Plan.
High Level Sewer.—Does not interfere with the Lea navigation, except by discharging into it rain-water free from sewage, which is esteemed an advantage.	*High Level Sewer.*—The storm overflow is by two 8 feet sewers into river, but to reach that, the Lea navigation is stopped up by constructing the sewer across the waterway of the Hackney Cut.
The outlet for this area is placed at 18 inches above high water so as to have a free and constant discharge.	Report states that the intercepted drainage of 27 square miles can be drained by gravitation to the level of high water at Barking, but sections show the level of invert to be 8′ 6″ below high water; and if open, the tide would flow up the sewer three miles.
Low Level Sewer.—None of these sewers are below low water, and can therefore be cleaned out, examined and flushed throughout their entire length, and are free from consequences of accidents to engines and floods.	*Low Level Sewer.*—Notwithstanding the necessity insisted on in the Report of preserving a safety-valve into the river at low water, the main line terminates at 6 feet below it, and for 3 miles is below that level; while the western low level at its lowest part is 10 feet below low water, and is also below that level for a distance of 3 miles, all subject to accidents to engines, and floods.
The area requiring to be pumped is 18¼ squa miles.	The area requiring to be pumped is as follows:
	sq. miles. Main low level area - - - 11 Western district requires pumping twice, viz., at King's Scholars' Pond, and at the River Lea, 21½ 43 Square Miles - - - 54
The horse-power required - - - 372	The horse-power required,— At River Lea - - - - 1,184 At King's Scholars' Pond - - 328 1,512
Annual cost of pumping - - - £. 3,720	Annual cost of pumping - - - £. 15,120
All the sewage is deodorised, and is kept in constant motion till the clear filtered water flows into the river.	The reservoir, with settling pits, to hold about 9,000,000 cubic feet of stagnant filth, discharging only a few hours out of the 24, are proposed to be constructed.
The sewage will be converted into a valuable manure.	The entire sewage will be wasted, and a large expense will be incurred in removing and disposing of the deposit on "settling pits."
£. s. d. Estimate - - - - - 955,415 2 4	£. Estimate by Report - - - 1,561,680 Add, for reversing drainage by river bank - - - - - 9,000 Add, for extension to Brentford and Acton - - - - - 31,000 Add, for flushing - - - - 100,000 Add, for extending main outlets to low water - - - - 100,000 Total Estimate - - £. 1,801,680
This Estimate includes deodorising works.	No provision is made in these Estimates for deodorising works.
The same data as to quantity of sewage is applicable to both plans.	

Appendix X.

Plans of Drainage.

Text of Plans.

Messrs. *Gotto & Stothert.*

Comparison between *Gotto & Stothert's* Plan and the Official Plan—*continued.*

SOUTH OF THE THAMES.

Gotto & Stothert's Plan.

High Level Sewer.—The invert of the intercepting sewers are 18 inches above high water, and therefore have a free outlet and continuous flow at all times of the tide, which is always kept out of the sewers.

Low Level Sewer.—The invert of the low level sewer is at the level of low water, and possesses therefore the means of having cleansed it out, and the risk of accidents and floods are provided against.

The area requiring to be pumped, is confined to 18 square miles.

Total horse power required	492

Annual cost of pumping	£. 5,000

No sewage reservoir is required. The whole would be deodorised.

Only clear filtered water will flow into the river.

The sewage will be converted into a manure of commercial value.

Estimate:	£.
South-east District	315,023
South-west District	278,748
£.	593,771

These Estimates include deodorising works.

Official Plan.

High Level Sewer.—The intercepting sewer is said to have a free outlet and a constant discharge by gravitation.

But the invert of outlet is 6 feet below high water, and every tide would flow up the sewer as far as Denmark-hill, a distance of three miles, and also down into the extension to Plumstead Marshes, to the level of low water, unless the tide is kept out by penstocks, in which case this sewer cannot be said to have a free outlet and constant discharge.

Low Level Sewer.—The necessity of "preserving, as a safety valve, a discharge into the river at low water by gravitation in case of accidents to the pumps, as well as during heavy floods," is dwelt on.

But the invert of this sewer is 8′ 6″ below low water at Deptford Creek, and consequently is always liable to the calamitous consequences of accidents to pumps and excessive floods from that creek to Camberwell-road, a distance of 3½ miles.

The areas requiring to be pumped, are as follows:

	sq. miles.
Low level, 22 square miles, pumped twice, namely, at Deptford and Plumstead	44
Pumping Richmond drainage at Putney a third time	3
High level area, said to be drained by gravitation, but requires and is intended to be pumped	19¾
Total Area to be pumped—sq. miles	66¾

Horse-power proposed	1,177
Add, for pumping not provided at Putney	38
Total Horse Power required	1,215

	£.
Annual cost of pumping	12,000
Add, for cost of pumping at Putney	400
Total Annual Cost of Pumping	12,400

Reservoir.—A reservoir of stagnant foul sewage in its normal state is intended, close to Woolwich, to hold 4,000,000 cubic feet, about 1 mile long, 70 feet wide; but from the description in the Report, it appears there would be about twice that quantity accumulating in the interval.

In two hours this large mass of filth would be discharged into the river, at one spot just below Woolwich.

The entire sewage will be wasted.

	£.
Estimate	831,696
Add, for sewers not being extended to Richmond	28,160
Add, for pumping station at Putney and land	5,000
Add, for branch sewers to pick up drainage along river bank or reversing the sewers	35,000
Add, for not deodorising sewers	33,212
£.	933,068

In this Estimate no provision is made for deodorising works.

We have adopted the same data for prospective population, water supply, and the period of the greatest flow, as well as rainfall.

Appendix X.

Plans of Drainage.

Text of Plans.

Mr. *A. Gove.*

(6.)—Mr. Alexander Gove.

Measuring from a point two miles below London Bridge, to a point in the river 30 miles farther down (being what I shall call the 32 miles' point or top of Sea Reach), an untidal canal can be constructed, touching near B asterisk [Erith Reach], and Thurrock of only about 23 miles in length, and thus a water course can be obtained about seven miles shorter, and more direct than the river, and which will accelerate the transit of its waters.

High water and low water, at the 32 miles point, are about one hour and four minutes—say one hour—before the like events at London Bridge.

None of the sewers proposed by the engineers of the Metropolitan Board of Works have the beds of their communications with the tideway below low-water mark*, and consequently the water in these sewers can never by natural means fall so low as low water in the river, but must always (except by the working of expensive and precarious machinery) have the water in them standing above low-water mark by the depth of the streams which they contain, and which will be considerable. By excavating the 23 miles untidal canal above pointed out, below the low-water level, and to a depth as low as the actual bed of the river, if necessary, and having a greater distance between its bottom and top, where covered over, than any proposed by the engineers of the Board, the sewer water in the canal will, when in motion, flow faster, and that motion will be communicated over a much greater length of its waters in less time than in their sewers†; and without any machinery whatever, but self-working gates and sluices, it will, by the accelerations pointed out, and by having communications at B asterisk, Thurrock, the 32 miles point, and other places, if necessary, and by the differences pointed out as to the times of low water, have a considerable part as low, and all, or nearly all, the residue of its waters reduced to within a few inches of low-water level twice a day, and from its capacity for storage, without immoderate increase of top widths, will never rise higher than the level the water in the Board's principal communications from the sewers would be at, when at their lowest point, at two miles below bridge. In this last, I am roughly computing from the quantities given as to Mr. Bazalgette's reservoirs.

Such a canal as I propose would be inexpensive, in comparison with the proposed sewers, as it would not require to have a brick bottom, or anything more than flints, septaria, and other rubbish which may be found in different parts in excavating it, for although its surface velocity will, and even its mean velocity may, be greater than the surface velocity of the Board's proposed principal sewers, yet the bottom velocity may be made such as not to move flints or gravel. It is remarkable that Mr. Bazalgette, in his quotation from Professor Robinson, given in page 12 of his Report of 3d April 1856, to the Metropolitan Board of Works, omits the following passage, which I quote from another source:—

> "Yet no beds are more stable than clay when the velocities do not exceed this" [three inches per second at the bottom], "for the water soon takes away the impalpable particles of the superficial clay, leaving the particles of sand sticking by their lower half in the rest of the clay which they now protect, making a very permanent bottom, if the stream does not bring down gravel or coarse sand, which will rub off this very thin crust, and allow another layer to be worn off."

The author means rolling gravel passing along by some greater velocity, as gravel thrown in and remaining will protect the bottom, as well as the fine sand. An arrangement may also be made by which a considerable part of the sides may also remain without brick-work. In parts, it is probable that few, if any, stones will be found in excavating; and there, and even elsewhere, the excavation might be by steam, and the flints, &c., moved from the parts where they abound to where they are wanting. Dredging or other machines might be used as at the Caledonian Canal.

In such a canal as I propose, the velocity has to be computed by the inclination of its surface and not of its bottom; and a very slight inclination in the former gives considerable motion.

If I am in any way mistaken in my foregoing statements, the disadvantageous error which may be found, may be compensated by the construction of tide reservoirs and tide mills, to be worked four times each day at one or more of the points of junction with the tide—twice on emptying the reservoirs about low tide, and twice on their being filled, about or before high tide—the mills being used to work wheels as in Lincolnshire, or other propelling or pumping machinery; and I submit that without an immoderate increase of top width, not more than about four feet lift, or drive up, would ever be required, and that by that the water in the whole canal would be reduced below low-water mark, while (except in sewers worked by steam, such as that at Bermondsey, where I submit it is not necessary to go their length, or anything near it) the engineers of the Board do not ever reduce the sewage-water at the points of discharge so low as that level with the monstrous machinery they propose. They propose to pump up to, and above high water. I propose to pump or drive at low water, and to bring the water in the canal below that. They propose a lift of 14 feet, and even one of 56 feet, and another of 22½ feet to get to Sea Reach. I submit that if one is necessary at all (and I think it would be well to be prepared with one), a lift, or rather drive of 4 feet, is sufficient, and that if there is a fancy for steam, it may be applied; but that there is a sufficient water power, and that where, according to the plans of the engineers of the Metropolitan Board of Works, thousands of horse power would be required, yet that according to mine, less than a tenth part would suffice. They propose to go far inland to reach Sea Reach. I propose to keep near the river, but not close to it. If pumping at high water is required, of course the 32 miles point (where it does not rise so high as at London Bridge by two feet), is that which is most advantageous into the tide, but it may be done into a low-bottomed reservoir, emptying at low water, and thus requiring but a slight lift or drive when the driving first commences.

In

* Some of their sewers have their bottoms, or inverts, lower, but not their communications, and thus a considerable fall is thrown away.

† This might be ascertained by experiments in the Bridgewater, Grand Junction, Forth and Clyde, Caledonian, or other canals having long levels, or by inquiry at the Engine Houses at Ten Mile Bank, near Little Pool, Isle of Ely, and Deeping Fen, near Spalding, or in these vicinities.

Appendix X.

Plans of Drainage.

Text of Plans.

Mr. *A. Gove.*

In such a canal as I propose, the grosser parts of the sewage may be allowed to subside, and to settle in all or the greater part, and then be removed from its bottom into barges floating in it, or into rail or other carriages.

The bottoms of all the reservoirs I have alluded to, might be carried so low as to increase the storage room, and there might be other appliances in that way.

The higher the tides rise at the springs, the lower the canal can then be drained by tide mills, and the advantage thus obtained could be maintained for some time. The higher the spring tides rise, the lower is the corresponding low water; and the advantage of these two might, in ordinary weather, be probably maintained until next springs. These would be the greatest obstacles of the engineers of the Board, but to me the greatest benefit.

Much of the high-level sewage and the rain water may be used to work the low-level sewers. The householders pay for pumping the water up to great heights, and God gives the rain free; but there is no reason that all of either should be allowed to run to waste. The rain which falls on house tops need not all be allowed to reach even the ground, without yielding up part of its downward force. A heavy shower may be made to produce a great power.

If Sir William Worsley's plan were adopted, of making the upper part of the river a float (I use the Bristol term), say up to only three-quarter tide, and working down to half-tide, very great further power might be obtained. It will not be requisite that the river should be emptied down to low-water mark, when new low-level sewers are made, and the adoption of his scheme, so far, would prevent any great length of upward flood from B asterisk, while the conveyance of the larger portion of the sewage further down would more than compensate, in any case, for the upward flood, be it great or small, and if deposit and settlement were allowed in the canal, but little annoyance would result from the sewage water floating out. I refer, for proof of this, to the state of the water flowing from the soil reservoirs at Paris, and the foul-burn meadows at Edinburgh.

Mr. Austin's proposed sumps, without his pumping-engines, might, on a great scale, such as under Lincoln's-inn Fields, Smithfield, the New Cattle Market, and the like, be useful, as depositing reservoirs, and for storage of storm waters.

As to driving, I may explain that, supposing at one tide the water in the canal is driven out, for a considerable way above the points of adit to 3 feet below low-water mark, and that by the time the tide rises and falls again to a height of 7 feet, the water in the canal rises 6 feet. which will bring it within 4 feet of the 7 feet tide-water—with that difference a very slight power, in comparison with pumping, will drive the canal water into the tide-way, and in a short time the tide will fall nearer to the level of the canal, when the driving-wheel will act as an accelerator, and will require but very slight power until the canal and tide, by the working of the machinery and rise of the tide, is again brought to a difference of 4 feet. This, however, would not be exactly the way of working with a tide-mill. In Lincolnshire there is a wheel which has a 5-feet dip, and which drives against a 10-feet head of water (together 15 feet) with only an 80-horse engine. The width of the wheel, I believe, is 5 feet or more. A difference of only 4 feet in the surface-level of a deep canal will, I submit, give all requisite motion to at least 8 miles of canal.

During this month of January 1857, the morning tides at London Bridge (without taking into account the effects of the wind), rise from 15 feet 7 inches (neaps) to 19 feet 10 inches (springs) above the mean low-water level of spring tides there, and at Sheerness they only rise from 12 feet 7 inches to 16 feet 3 inches above the like level at that place, being a difference, which may be taken for present purposes, as 3 feet between the rise at the one place and the other; and I state, by way of estimate from it, that the rise at London Bridge and at a point 32 miles down the river, measured along its centre, would be 2 feet more at the former than at the latter place. The low-water levels are, I am informed, the reverse of this, but in a much less degree, (a few inches), and it might be found that this difference in the last case might be got rid of by going into the stream; but that is but speculation on my part, and even if the fact is so, it would, judging by the Nore tide, probably be obtained by a loss of time, mentioned in the third paragraph of this paper, but that might be overcome. The facts mentioned in this paragraph, I do not make much use of, but others may be more ingenious.

According to the sections annexed to a report presented to the Metropolitan Board of Works on 22d May 1856, the northern high-level sewage might be employed at all times of the tide to drive forward the sewage of the low levels as far down as at Barking; and there are many other points where the superior water might work forward the inferior. No sewage need be discharged in Barking parish, but such as is required to work forward the lower level.

If the low-level water was thus kept separate from, and not pumped up into, the high level, the aqueduct for the latter from the river Lea to Barking would not require to be so large as that proposed by the Board, and thus it might be kept higher, as the levels allow it, without any increase, but even with a diminution of expense. The main high level, however, might be made to drain a larger circuit than is now proposed by the Board, and its waters might be kept separate, and carried higher than the middle level from the present proposed point of junction. All about the west side of Regent's Park and Kentish Town, and part of Camden Town, and other neighbourhoods not now included, might be made to drain into the high level instead of the waters of these places being allowed to flow down to the middle level, and thus a greater working power would be obtained.

The extension of the low level nearly straight eastwards in the Commercial Road from thee Regent's Canal, instead of turning northward there, as proposed by the Board, would also be beneficial, while it is to be seen from the same sections that the Isle of Dogs Sewer is made lower than is either necessary, or the inhabitants are entitled to, at the general expense; but even if it is allowed to be as low as proposed, would not a single fill of the several locks of the north and south-west India Docks, with the waste water used in working these locks, be sufficient to work that sewer? If not, I do not think that it would require so much as even an inch in depth from the south dock; or if there were difficulty in getting that, the water from the numerous irrigation ditches which the isle contains, would be sufficient. They discharge, I think, several feet above low water.

Alex. Gove.

4, Molesworth Place, Kentish Town Road,
January 1857.

Appendix X.

Plans of Drainage.

Text of Plans.

Mr. *S. Hughes,* C. E.

(7.)—Mr. Samuel Hughes, C. E.*

Gentlemen, 14, Park-street. Westminster, 26 February 1857.

I avail myself of your announcement, to offer a few observations on the Main Drainage of London.

In the scheme which has been approved by the Metropolitan Board, I find it is proposed to provide for the drainage of the Metropolis by a system of intercepting sewers, some of which are formed at high levels, and will discharge by simple gravitation, while others are at low levels, and must have their contents raised by steam power.

The metropolitan area to be dealt with in this manner is no less than 102 square miles, of which 60 are on the north side, and 42 on the south side of the River Thames.

Throughout the whole of this vast area the intercepting sewers are intended to convey not only the sewerage proper, calculated at five cubic feet per day per head of population, with an addition for prospective increase of population, but are also designed to carry off a certain amount of the rainfall.

The proportion of rainfall which the intercepting sewers will be capable of carrying is extremely small, as appears from the calculations made by the Engineer of the Metropolitan Board, that when running brimfull they will only take off, in addition to the sewerage, a rainfall of 1-8th part of an inch in 24 hours on the suburban area, and a quarter of an inch in 24 hours on the urban area.

This amount of rainfall, although I believe it is far below that which should be provided for in a system of drainage uniting the sewerage and the rainfall, appears in round numbers to double the volume which is to be carried in the intercepting sewers, and also to double the volume which has to be pumped up from the low-level intercepting sewers. This is one reason why I shall propose a complete separation of the sewerage water from the rainfall.

The intercepting sewers proposed by the Metropolitan Board being adapted to convey only a small part of the rainfall, will, during many days in each year, be entirely filled, so that it is proposed to discharge the storm-water into the River Thames by means of the existing sewers. I see great difficulties in effecting this, as it appears to involve an immense and complicated system of sluices, which will probably have to be opened and closed by manual labour, and which will require the most incessant and careful watching.

As to the number of days in a year during which more rain falls than 1-8th of an inch, I believe this will be found, from the register of recent years, to be something like 30 or 40; but it is said, in the report of the Engineer of the Metropolitan Board, that an overflow into the River Thames, and consequent discharge of the sewerage into that river, will only occur about 20 or 30 days in the year.

This statement, however, is singularly at variance with the evidence given by the same engineer before the Committee on the Bill of the Great London Drainage Company in 1851. With respect to his low-level sewers, Mr. Bazalgette appears to have followed very much in the footsteps of that company, except that his sewers, instead of a fall of four feet per mile, as theirs had, have only a fall of two feet per mile, and therefore the sizes being equal, will only take about 2-3ds the volume of water. Mr. Bazalgette stated, before the Committee in 1851, that the sewers would probably have to discharge into the Thames during 60 or 70 days in the year; but he now says, that his own sewers, with only half the inclination, will only have to do so during 20 or 30 days.

I append the following statement of the practice followed by some other engineers, to show the very inefficient provision made for the rainfall in the scheme of the Metropolitan Board:

	Rainfall which Sewers should be capable of carrying off in Inches per Hour.	Cubic Feet per Acre which Sewers should be capable of carrying off per Minute.
According to—	*Inches.*	*Cube feet.*
Hawkesley	1·6	96
Phillips	1·0	60
Newlands	1·25	75
Roe	·125	7½
Henry	·181 to ·361	11 to 12
Bazalgette (Suburban)	·005	·315
Ditto - (Urban)	·010	·63
In the Scheme for Northern Drainage of London:		Capacity proposed.
High Level Sewer		1·6
Middle Level		·78
Low Level		1·2
Southern Drainage, High Level		1·01
Low Level		1·28

A comparison

* *See* Minutes of Mr. Hughes' Evidence, p. 446.

A comparison of these figures will show how much smaller than those adopted by other engineers are the sewers provided by Mr. Bazalgette for carrying off the sewerage of London, together with a small part of the rainfall; yet the small amount of rainfall provided for, causes the sewers to be double the capacity they would be if the sewerage only were to be conveyed by them.

For these and other reasons, many of which will be obvious, I propose to separate the rainfall entirely from the sewerage, by constructing distinct small channels for the latter, and allowing the rainfall to be conveyed to the Thames in the existing sewers, as at present.

For this purpose, I would disconnect all house drains from present sewers; but would allow the latter still to be the recipients of all drainage water which they would receive from the rain-water pipes, and through the street gratings and gulleys, and also to be the channels for all the natural streams which anciently found their way to the Thames by open cuts.

Then for the sewerage proper, I would construct one or more impermeable sewers in each street; these to communicate with large main intercepting sewers, which may be constructed nearly in the lines proposed for Mr. Bazalgette's tunnel sewers; the distinction between my scheme and that of the Metropolitan Board being, that my sewers are to carry nothing whatever but the sewerage; that is to say, the waste water from the houses of the Metropolis, containing in suspension the excreta and other matters constituting the sewerage proper.

As I believe this mode of dealing with the drainage of London has been already suggested by other persons, I will not enter at length into any reasons for adopting it, inasmuch as these have probably been brought sufficiently under your notice; I would only mention the following as a few principal points which occur to me in its favour:

1. The facility which it affords for obtaining correct and suitable inclinations in the new channels to be laid down, and thus remedying the multifarious errors in the levels and inclinations of the present brick sewers.

2. The avoidance of all necessity for reversing the inclinations of all the present sewers throughout the area lying between the River Thames and the low-level main sewers proposed by the Metropolitan Board.

3. Avoiding all the difficulty and expense of constructing and working sluices to regulate the communication of the old brick sewers with the new main sewers proposed by the Board, and consequent avoidance of all risk from storm-waters and bursting by means of upward pressure.

4. Preserving the River Thames in its normal state, as the receiver of the water due to its true drainage area, instead of abstracting it to a point altogether below the limits of the Metropolis.

With respect to the question of comparative expense; I have not considered this in detail, but inasmuch as the quantities to be conveyed will not exceed one-half of that for which the sewers proposed by the Metropolitan Board are calculated, it is evident that a very great saving of cost will be effected in the tunnels or main sewers, while the first cost of engine-power, and that of working the engines, will also be diminished nearly one-half.

Against this is to be set the expense of the minor sewers, and the alteration of the house drains.

I believe, judging from the cost of sewerage works in other towns, that a complete system of minor sewers, with all their collateral works, could be executed for 1 *l.* per head of population, or say 2,500,000 *l.* Assuming this to be sufficient, and assuming that one-third only will be saved in the cost of the main sewers, and one-half saved in the cost of engines, also half saved in working the engines, and capitalizing the annual cost of engine-power in the two cases, I find that the scheme of the Metropolitan Board, as developed in Mr. Bazalgette's reports of 3d April 1856 and 22d August 1856, would cost 2,935,776 *l.*, while my scheme would cost 4,285,000 *l.*, being more than a million and a quarter sterling in excess. I venture to submit that the superiority of a scheme which would entirely free the Thames from sewerage, would amply justify this additional outlay.

I do not trouble you with any calculations as to the small increase of rating which this would involve, it being easily derived from the consideration that the whole rateable value of the Metropolis is 12,000,000 sterling, and that, consequently, a rate of 1 *d.* in the pound raises 50,000 *l.*

I will only venture to add one word about the outfall. I think the inhabitants of London will have done all that should be required of them when they discharge the sewerage beyond the limits of the Metropolis. Any extension to the German Ocean or elsewhere should be an expense borne by the nation at large.

I am, &c.
(signed) *Samuel Hughes.*

To Captain Douglas Galton, R. E.
James Simpson, Esq., C. E.
Thomas E. Blackwell, Esq., C. E.

(8.)—Mr. Husband.

(i.) *Plan of Drainage and Lifting Sewage.*

To the Committee of Reference for the *London* Drainage.

Gentlemen,

In so far as the limited time allowed me would permit, I have examined the plans for the sewerage of London, and send you a few ideas on the subject, which occurred to me on the perusal. I have, however, more particularly considered the subject with a view to ascertain the machine best adapted for lifting the sewage from the low levels.

It has occurred to me, that on the north side, the low level or City sewer should be relieved from the south-western water, accumulated over an area of 22 square miles; and by so doing, expensive construction in the low level sewer would be avoided. The most natural and direct manner, probably, is to convey the south-western water across the Thames, near Chelsea, through a submerged pipe, then, pumping it into the main high level sewer on the south side. By this arrangement, the water would probably be about equally divided between the north and south sides.

The most important part of the low level sewer on the north side, is that between Hungerford Bridge and London Bridge; the interference with traffic during its construction would be seriously felt, and its construction otherwise difficult and dangerous, considering the heavy houses in its course, and the badness of the ground in places. This might of course be avoided, by carrying out the Thames embankment scheme, and constructing the sewer on the margin of the river; as, however, this necessary work is likely to be deferred, the alternative seems to be, to convey the sewage from Hungerford Bridge to London Bridge, through a wrought-iron tube, and in its course receive the water from the intermediate sewers. This tube, varying from 5 feet to 6 feet diameter, and 5-8ths of an inch thick, would not cost more with laying down complete, than the projected sewer of equal length, when the reversing the sewers on the Thames side is taken into consideration, and avoid all the danger and inconvenience attending the plan proposed. The tube being on the margin of the river, would fall within the embankment, should that scheme be carried out.

With regard to discharging the sewage into the river, or otherwise; a single outfall, although offering advantages, is less safe than the double outfall, on account of the concentration, and it is more especially objectionable when it is sought to convey the sewage into the City from the south side.

If the sewage be about equally divided between each side of the river, the result would be a discharge of about 50,000,000 gallons on each side, half of which would be accomplished by gravitation, leaving 25,000,000 gallons on each side to be raised the average height of 45 feet.

Taking this as the normal quantity, the power required would be about 236 horse-power each side.

To perform the work in eight hours, 708 horse-power on each side.

But this quantity of water may be increased five times by rain; the excess going into the river, thus making the 100,000,000; 500,000,000 to be discharged in eight hours.

Of this the actual quantity pumped would be, in round numbers, about 200,000,000 gallons in eight hours; and if we take the proportion of three-fifths and two-fifths respectively, we have 120,000,000 on the north side, and 80,000,000 on the south side.

To lift this quantity to an average height of 45 feet, would require,—

North, about 3,402 horse-power.
South, about 2,268 horse-power.

To lift this water, and determine on the machine best fitted to perform the work, it is necessary to consider that the sewage consists of every refuse that can be got into the sewers by an immense population; indeed, in some of the City sewers it is difficult for a man to walk, his legs becoming entangled by ropy-like offal; there are also bricks, wood, and other substances.

It is evident, therefore, that pumps are unsuited for the work; wherever there are valves they must become choked, and the pumps would not be lifting water half the time; there would also be frequent breakage.

I superintended the erection of the pumping machinery for the drainage of the Haerlem Lake, by which machinery we were enabled to pump 500,000,000 gallons of water in 24 hours. Although these pumps eventually accomplished the work, yet there was considerable detention, on account of the pump-valves breaking, although the water was comparatively free from drift wood, &c.

In the London waterworks great care is found necessary to prevent floating substances getting into the pumps, a small piece of wood sometimes occasioning considerable damage.

Scoop-wheels, or a modification of the same, offer many advantages for lifting large quantities of water when the lift is not high; and the water pumped from the Haerlem Lake was lifted a second time into the "Y" by scoop-wheels. One 200 horse-power engine at "Spaerndam," put in working order by myself, drove 10 wheels, 18 feet diameter: and at "Halfweg," a 100 horse-power engine has been erected after my designs, for driving six scoop-wheels, 20 feet diameter; these wheels lifted from two feet to five feet, were rarely out of repair, and have accomplished the work in a satisfactory manner. Gratings were, however, used to keep out the drift wood; and it appears that as the water-way diminishes from the entrance of the water to its eventual discharge, that the water should be cleared from substances liable to choke.

The machine which, under all the circumstances seems best adapted for lifting the sewage, is a modification of the open screw, as used in Holland for drainage purposes. The course of the water through the machine being in a line with the sewer, there will be but little friction in passing large substances through it; and as it is open throughout its whole length, any substance not passing freely can be easily removed.

The accompanying drawing* and model are on a scale of half an inch to the foot, and represent an open screw adapted for the London sewerage; it is constructed taper, and it is intended that the pitch

* *See* Plate 3.

Appendix X.

ns of Drainage.

Text of Plans.

Mr. *Husband.*

pitch shall increase towards the top or discharge: by this arrangement every substance that can enter at the bottom will pass through a channel of gradually increased dimensions, until discharged at the top; this is a great desideratum, and should form an important feature in any machine adapted for lifting sewage.

This machine, constructed full size, would readily pass up substances two feet six inches diameter, irrespective of specific gravity.

Another important advantage in a taper screw is the following: as the quantity of water to lift increases, and the height of lift consequently diminishes, the screw will receive a larger quantity of water, consequently lift more, with a given number of revolutions, thus equalising the load on the engines.

In Holland, at the "Zuidplaets" drainage, near Rotterdam, and at the "Noot Dorp" drainage, near Delft, there are large screws driven by steam-engines, which I had ample opportunity of observing, as the engines were at one time superintended by me. Experiments at the "Zuidplaets" proved that a screw made entirely of wood, working in a brick cradle, raised water with but 10% loss. The screw experimented with was about six feet diameter, and the lift of water varied from six feet to nine feet. This screw equalled about 30 horse-power.

The great durability of the screw, even when constructed entirely of wood, may be attributed, first, to the fact that the weight of water is carried by the cradle, the screw simply sliding it forward; and, secondly, to the simplicity of the machine, which is easily constructed, and readily repaired.

Mr. Simons, Director of the Academy at Delft, &c. &c., and the first living authority on the subject, gives it as his opinion, that the screw is preferable to the scoop wheel, when the lift exceeds six feet; he also states, that in Holland scoop-wheels, lifting five feet to six feet, have been replaced by screws with the best result.

The screw, as proposed, working in a bored cast-iron cradle, the outside edges of the screw being turned, would make a very perfect machine; and the axis of screw once fixed at the correct angle, the space between thread and cradle may be accurately adjusted by sliding the screw in the line of its axis.

A screw 11 feet diameter will lift 20,000,000 gallons of water in eight hours; and is much less expensive than any other water elevator of equal power and effect.

The lift is taken at 15 feet, but this may be increased to 20 feet; it will probably, however, be found advantageous to lift the sewage in its course to the river, and thus take advantage of low lifts to avoid high and expensive aqueducts.

Duplicate engines must, of course, be provided, thus taking the quantity to be lifted in eight hours, as above stated, and height of lift on an average of 45 feet, the cost of machinery, fixed complete, not including masonry, would probably be about 560,000. With pumps the cost would probably be about 10% higher.

As, however, these engines would work with greatly increased power, in cases of emergency, without danger, although not economically; and taking into consideration that there are only about 30 to 40 days in the year when the full power would be required, it is my opinion that the nominal horse-power might be reduced one quarter, thus reducing the outlay nearly in the same proportion. This might be accomplished by providing a spare screw for each pair of engines, and using it only in time of flood. The screw also admits of increased velocity, without any serious loss of power.

Much more might be said on this subject, but experience has already furnished sufficient data to enable engineers to arrive at a pretty accurate conclusion. The whole subject having been from time to time thoroughly investigated.

I am, &c.
(signed) *Wm. Husband.*

London, 4 June 1857.

(ii.) *Notes of Evidence given by* Mr. *Husband.*

Mr. *Husband* attended, 19 May 1857,

Mr. Husband stated, that he strongly recommended scoop-wheels for lifting sewage, on account both of facility and economy of working.

Thought them preferable to screws, as being less likely to be obstructed by large substances passing through the sewers.

Was certain that pumps could never effectually be used for the lifting the London sewage, on account of the grit which would be sure to find its way into and obstruct the action of the pumps.

The velocity in scoop-wheels would be quite sufficient to prevent any deposit at the foot of the wheel, while the case with screws would be very different.

Was strongly in favour of a series of low lifts, as opposed to one or even two high ones.

Another reason for preferring wheels to pumps Mr. Husband said was, that in case of accident one of the former could be thrown out of gear, and the engine continue its work with another wheel, while with a pump the engine is so intimately connected that when the former is stopped the latter must be stopped also.

Mr. Husband, with reference to Mr. Bazalgette's plan, stated that he objected to the aqueduct works on the West Ham Marshes, and also to the carrying all the western drainage through the city, and would therefore prefer carrying the northern drainage across to the south at Clapham, and by lifting it there carry it on with the high level south intercepting sewer.

Mr. Husband promised to commit to writing,* and transmit to the Referees, the subject of the above and other remarks made during the day.

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* *See* preceding Paper, page 389.

Appendix X.

Plans of Drainage.

Text of Plans.

Mr. *A. Leslie.*

(9.)—Mr. Alexander Leslie.

Gentlemen, Burnside of Delgaty, Turriff, 24 January 1857.

To you, as the Engineers commissioned by Sir Benjamin Hall, First Commissioner of Her Majesty's Works, &c., to inquire into the best method of disposing of the sewage of London, I have the honour of submitting the accompanying plan for utilising the sewage of towns.

In this plan provision is not only made for preventing the animal refuse of towns from being washed into neighbouring streams, but also for applying it to the soil in such a manner that a considerable revenue may be expected to arise from what is, in the meantime, a fertile source of discomfort and pecuniary loss.

I am, &c.
(signed) *Alex. Leslie.*

Captain Douglas Galton, R. E.
James Simpson, Esq., C. E.
Thomas E. Blackwell, Esq., C. E.

A Plan for Utilising the Sewage of Towns; with Remarks on its Application to the Case of the Metropolis, by *Alexander Leslie.*

23 January 1857.

We propose in the following pages to determine the best method of applying the refuse of towns to the purposes of agriculture, and of thus putting a stop to the enormous waste of fertilizing matter that at present takes places. Without stopping to comment either on the importance or the difficulty of this problem, we will proceed, in the first place, to inquire into the composition and value of the sewage of towns; we will next give a brief account of the various plans that have been proposed for its utilisation, the trials that have been made, and the causes of their failure; and having thus cleared the way, we will finally endeavour to point out the method by which this great practical difficulty, which has hitherto proved insuperable, may be overcome, and the sewage of towns, instead of running to waste, and creating a nuisance, as at present, may be turned into a source of revenue.

On the composition and value of the sewage of towns.—We may arrive at a knowledge of the average composition of sewage-water in two ways, either directly by comparing the various analyses that have been published, or indirectly by a calculation founded on the composition of human excrements, and the proportion in which they exist in sewage.

1. Several analyses of sewage-water, by various chemists, have been published. All that we are acquainted with we will bring together in a tabular form, giving only those particulars which are necessary to determine the value of the specimens analysed. But, in the first place, we may give a list of the analyses, with such details as are given by the authors with reference to the specimens analysed.

No. 1. Sewer-water from Barrett's-court.

No. 2. Sewer-water from Dorset-square. These specimens were analysed by Professor Way, at the request of the General Board of Health. "The liquid in both cases was fœtid and offensive to the smell, and of a dirty black colour; sulphuretted hydrogen was given off from it in sensible quantity."—Journal of the Royal Agricultural Society of England, Vol. XI., page 770.

No. 3. Sewage from King's Scholars' Pond. Analysed by Messrs. Brande and Cooper; average of 24 samples, one taken during each hour of the day.—Appendix to Report of Select Committee on Metropolitan Sewage Manure, Parl. Paper, 1846, No. 474.

No. 4. Sewer-water from Croydon, taken in the middle of the day; analysed by Professor Way.—Journal of the Royal Agricultural Society of England, Vol. XV., page 155.

No. 5. Sewer-water from Rugby; sample taken at 11 o'clock a. m.; and,

No. 6. Taken at 5 p. m.; both analysed by Professor Way.—Journal of the Royal Agricultural Society of England, Vol. XV., page 155.

No. 7. Mansfield sewage: analysed by Mr. J. T. Cooper, 82, Blackfriars-road, London.—Appendix to Report on Metropolitan Sewage Manure.

No. 8. Edinburgh sewage: analysed by Mr. J. T. Cooper.—Appendix to Report on Metropolitan Sewage Manure.

No. 9. Sewerage-water of Edinburgh: analysed by Mr. Hugh Taylor. This specimen was taken from the mouth of the sewer near Lochend, about one o'clock, p. m., a period of the day, Dr. Anderson remarks, at which it is probably more concentrated than at any other time.—Transactions of the Highland and Agricultural Society, October 1850.

No. 10. Sewerage-water of Morningside: analysed by Mr. Rowney, assistant to Dr. Anderson. This specimen was taken from the tank at the Morningside Lunatic Asylum, in which the whole sewerage of that establishment is collected.—Transactions of the Highland and Agricultural Society, October 1850.

In calculating the value of the various specimens in the following table, we have adopted the valuation of ammonia at 6 *d.*, and of phosphoric acid at 1½ *d.* per lb., first made by Professor Way, and now generally used in fixing the value of manures.

COMPOSITION and VALUE of SEWAGE WATER.

	Per Gallon (70,000 Grains).					Per Ton (2,240 Pounds).				
	Solid Matter.			Ammonia.	Phosphoric Acid.	Ammonia.	Value.	Phosphoric Acid.	Value.	Total Value.
	Soluble.	Insoluble.	Total.							
	Grs.	*Grs.*	*Grs.*	*Grs.*	*Grs.*	*Lbs.*	*d.*	*Lbs.*	*d.*	*d.*
1. Barrett's-court -	243·3	248·96	492·26	41·28	10·44	1·32	7·92	·33	·40	8·32
2. Dorset-square -	109·	100·7	209·7	17·96	4·17	·57	3·45	·13	·19	3·52
3. King's Scholars' Pond - -	74·8	65·54	140·34	3·29	4·7	·105	·63	·15	·22	·85
4. Croydon - -	–	–	53·	2·96	1·54	·094	·56	·05	·07	·63
5. Rugby (11 a.m.)	–	–	42·32	2·41	–	·078	·45	- -	- -	·45
6. Ditto (5 p.m.) -	–	–	61·	·92	·73	·029	·076	·023	·034	·21
7. Mansfield - -	77·3	3·5	80·8	4·02	·45	·128	·768	·014	·021	·789
8. Edinburgh - -	78·	79·	157·	4·45	3·8	·142	·850	·12	·18	1·03
9. Edinburgh - -	–	–	105·2	14·9	6·14	·477	2·86	·196	·294	3·15
10. Morningside -	–	–	132·71	3·18	1·32	·101	·606	·042	·06	·66
11. Birmingham -	–	–	65·8	1·21	·42	·038	·228	·013	·02	·25
Average Value per Ton of Sewage Water - - -										1·8

The composition of sewage-water, as shown in this Table, varies greatly, as might have been expected, and the value per ton ranges from over eight-pence (8·32 *d.*) to less than a farthing (·21 *d.*). The average value of all the specimens analysed is 1·96 *d.*, or nearly two-pence per ton. It is noticeable, that the value of No. 3, the average of 24 samples, one taken during each hour of the day, from one of the sewers of London, is considerably under the average, being ·85 *d.*, or not quite a penny per ton; and that the value of No. 10 is still lower, being ·66 *d.* or little more than a halfpenny per ton.

2. We will now see whether or not the result at which we have thus arrived is confirmed by a calculation found on the composition of human excrements, and the proportion in which they are found in sewage. The value of the sewage of towns depends almost entirely on the amount of human excrements which it contains, the other ingredients being either so small in quantity or so low in value that they may be left out of reckoning altogether. For full and accurate information as to the amount and composition of human excrements we are indebted to Mr. Lawes, of Rothamsted, who has in his paper "On the Sewage of London," read before the Society of Arts, subjected these points to a thorough examination. The results of this elaborate inquiry are given in a condensed form in the following Table.—(Journal of the Society of Arts, Vol. III. 274.)

TABLE showing the Estimated Constituents of the Human Excrements of *London*.

CONSTITUENTS.	Ounces per Head per Day. Average of both Sexes, and all Ages.	Pounds per Head per Annum. Average of both Sexes, and all Ages.	Tons per Annum. Total for both Sexes, and all Ages.
Total dry substance - -	2·01	49·95	51,286 ¾
Mineral matter - - -	·45	10·34	11,536 ¾
Carbon - - - - -	·74	16·85	18,809 ½
Nitrogen - - - -	·35	7·94	8,859 ¾
Nitrogen-Ammonia - -	·42	9·64	10,758 ¼
Phosphates - - - -	·20	4·58	5,108

Mr. Lawes calculates the annual value of the excrements of each person of a town population thus: "Supposing it were possible, which it certainly is not, to separate the constituents from sewage, and isolate them in a pure and dry state, there is no doubt they would sell for about 15 *l.* per ton; and since the excrements of each individual of the population contain in one year 46 lb. of such dry substance, it would take 48 persons to produce one ton of it per annum, and this would give an annual value of about 6 *s.* per head; and, at these rates, the total value of our 51,635 tons of dry substance contained in the excrements of the total population of the Metropolis would realise the sum of 774,525 *l.*" Mr. Lawes states the composition of London sewage thus: "By a return

return presented to the Houses of Parliament, it appears that the water delivered into the Metropolis by the nine water companies, gives an average of from 24 to 25 gallons per head per day on a population of 2½ millions. I find, also, that the average fall of rain over the area supplied by the water companies will give almost exactly a similar amount, namely, between 24 and 25 gallons. The supply of the companies and the rainfall taken together, therefore, give a gross amount of nearly 50 gallons per head per day. But from this a considerable proportion must be deducted for evaporation. Mr. Wicksteed estimates, however, that the supply of the companies will shortly be 36 gallons per head, and as there is no doubt they are preparing generally to increase the present amount, I am inclined to think that by the time any comprehensive scheme for the disposal of the London sewage can be brought into operation, it will not amount to much less than 50 gallons per day for each individual of the population: 50 gallons per head per day would amount to 81¼ tons per head per annum."—(Journal of Society of Arts, Vol. III. p. 276.) Now, as the value of the excrements contained in the whole 81¼ tons is 6 *s.*, the amount contained in each ton would be worth ·88 *d.*, or less than 1 *d.* We think Mr. Lawes has rather over-rated the amount of the sewage; the following is a calculation which we made previous to the publication of Mr. Lawes's paper: The gross daily quantity of water pumped into the Metropolis amounts to upwards of 44 million gallons.—(Report of the General Board of Health on the Supply of Water to the Metropolis, p. 10.) The gross annual amount is over 72 million tons, to this add the rainfall (27 inches over 25 square miles), 40 million tons, and we have a gross total of 112 million tons. In the Appendix to the Report of the Select Committee on Metropolitan Sewage Manure (Parl. Paper, 474, Session 1846), there is a statement by Mr. George Hawkins of the average discharge of sewage, in which the total amount of sewage discharged into the Thames from the sewers of the Metropolis is set down at 265,142 tons per diem, or 96,776,830 tons per annum. When the observations on which this estimate is founded were taken, the weather was dry, and the quantity stated is supposed to have been derived solely from artificial sources, and to be due to house-drainage alone. This estimate applies to the whole district under the jurisdiction of the Metropolitan Commissions of Sewers, supposed to be 43 square miles north, and 15 square miles south of the Thames, or 58 square miles in all. Putting these two estimates together, we think the gross annual amount of the sewage of London cannot be set down at less than 100 million tons. Now if we take the population of London at 2½ millions, there will be, on this supposition, 40 tons of sewage per annum for each inhabitant, and the value per ton will be 1·8 *d.*, or rather more than 1¾ *d.* This result does not differ greatly from that obtained by the first method (1·96 *d.* per ton); and I think we may, without much fear of being under the truth, set down the average value of sewage at 1¾ *d.*, or at most 2 *d.* per ton.

Having thus arrived at definite conclusions as to the value of the sewage of towns, we will now proceed to the discussion of the various plans that have been proposed for its utilisation. These plans have been already examined and reported on by Professor Way in his paper on Town Sewage (Journal of the Roy. Agr. Soc. 1855), and by Dr. Anderson in the Transactions of the Highland and Agricultural Society for March 1854. They may be ranged under two heads, the first including those in which the separation of the valuable matter, in the form of a dry portable manure, is contemplated; the second, those in which the sewage is proposed to be applied to the soil in the liquid state.

On the projects of the first class it is not difficult to come to a decision. What their authors propose to do, either by filtration or precipitation, is to extract from a ton of liquid the fertilising matter it contains, to bring it to the form of a dry portable manure, and then to sell it and to do all this at a cost which will leave a profit on the transaction. As the manure contained in a ton of sewage cannot be valued higher than 2 *d.*, we believe this to be impossible, and in this opinion we are confirmed, both by the reports of the above-named chemists and by the result of experiments made on a large scale. Mr. Thompson, Secretary to the "Manchester Sewage Guano Company," makes the following statement in the Journal of the Society of Arts (copied into the Gardener's Chronicle of December 30, 1854): "We, several years ago, incurred considerable expense in testing the value of liquid sewage, by the erection of suitable charcoal filters, and the precipitation, by lime-water and other means, of the solid matters of the sewage, and succeeded in arresting all the feculent and organic matter, except that which was in a perfect state of solution. The sewage operated upon was of the best description, and had been reported according to chemical analysis to contain an unusual quantity of highly fertilising ingredients. The result obtained, after long and expensive trials, was the perfect filtration of the water, so that, after it had passed the filter, it was clear and transparent, thus effectually obtaining one of the objects in view, but the other equally important point, viz. the securing of the agricultural value of the sewage matter, was very unsatisfactory, as the most valuable chemical salts passed off through the filter in a state of solution with the clear water. Various chemical expedients were adopted to arrest them, but the expense of doing so, in consequence of the bulk of water to be treated, was found to be much greater than their agricultural value. The sewage manure made by the process of simple filtration was only worth 25 *s.* per ton, or little more than the value of the charcoal, and consequently during the years 1850 to 1852 we sold at considerable loss all the manure, so manufactured at that price."

Even were it possible thus to extract the fertilising matter from sewage, it is evident that no equivalent could be given for the sewage, and that consequently no pecuniary advantage would accrue to the town population from this manufacture of manure.

Seeing, then, that the extraction of a portable manure from town sewage is a hopeless undertaking, we turn our attention to the method of applying it to the soil in the liquid state, which is regarded, both by Professor Way and Dr. Anderson, as the only one likely to be attended with success.

The distribution of sewage water in large quantities by means of a flexible hose and jet, was first experimented on by Mr. Henry Thomson, of Clitheroe, in 1842, at the suggestion of Mr. Edwin Chadwick. Mr. Thompson pumped up sewage-water from a well or shaft, into a tank made at the top of a field, about 80 feet above the lower part of the farm, and found that by means of the hose, two men, one to remove the hose and the other to direct the nozzle, could distribute about 2,000 gallons of liquid manure in an hour, which he deemed to be a sufficient dressing of concentrated liquid manure for an acre of grass land. The distribution was effected by means of a hose 2½ inches in

in diameter, and a maximum length of 800 yards. The delivery of 2,000 gallons or 9 tons was accomplished by the labour of two men, and allowing for the labour 2½ *d.* an hour, at a cost of 5 *d.* The water-cart was tried on land immediately adjacent, and by it the delivery of the same quantity cost 5 *s.*; and the expense of leading and spreading an equivalent quantity of stable dung was about 11 *s.* The attention of Mr. P. H. Holland, surgeon, of Manchester, having been directed to this first practical example of the use of hose and jet in the distribution of liquid manure, he carried on experiments with great labour and very successful results, and invented machinery for applying the manure by steam pumps, from a barge on a river or canal. Night-soil or other town manures were diluted in a separate boat or tender, and by means of a hose with several jets, worked by a steam-engine of eight-horse power; 300 tons were distributed per diem. He found it practicable to use the hose in lengths of 1,000 yards on land, with elevations of 30 or 40 feet. Worse land, heavy undrained clay, surcharged with water in a moist climate, with nearly 40 inches annual fall of rain, could scarcely be chosen for the application of manure in the liquid form, yet its fertilising power was everywhere found superior to the ordinary top dressings with manure in the solid form.—(Minutes of Information on the Application of Sewer Water and Town Manures to Agricultural Production, General Board of Health, 1852, p. 12.) A company was formed, and in 1846 sanctioned by Parliament, under the title of the Metropolitan Sewage Manure Company, for the purpose of distributing the sewage of the Metropolis in this way, and the evidence which it brought before a Select Committee of the House of Commons, contains a mass of valuable information on the subject. This company proposed to erect engines collectively of 100-horse power, and by means of these to pump the sewage of the King's Scholars' Pond sewer, through a main-pipe two feet in diameter, 10 miles into the country, where it was to be distributed by service-pipes branching off from the main-pipe into the various farms and fields, and by flexible tubes attached to the extremities of the service-pipes. The annual amount of sewage discharged from the King's Scholars' Pond sewer was estimated at six millions tons; and it was proposed by James Smith, of Deanston, one of the company's engineers, to charge the sewage delivered at the rate of 2 *d.* per ton; and the company's engineers, to charge the sewage delivered at the rate of 2 *d.* per ton; and W. C. Mylne, Esq., another engineer employed by the company, valued it at 3 *d.* or even 4 *d.* per ton. This supply of sewage, it was supposed, would be absorbed by 20,000 acres of land, and the capital requisite for erecting the machinery, laying the pipes, &c., was put at 6 *l.* 6 *s.* per acre; the estimate of the whole by W. C. Mylne, Esq., being as follows:

	£.
Two engines at Pimlico, 100-horse power together, at 70 *l.* per horse-power, including pumps, boilers, &c.	7,000
Building for the same	5,000
24-inch main to Hounslow, 10 miles	50,000
Sluice-cocks, &c.	2,000
Connecting same, and apparatus	10,000
Purchase of land	5,000
Office and establishment, building	3,000
	82,000
Contingencies	8,200
Service-pipes for distribution, 27 miles	30,000
Agency and Parliamentary expenses	5,800
TOTAL £.	126,000

The annual Expenses are stated thus:	£.
Interest on capital, 126,000 *l.*, at 4 per cent.	4,800
Expenses of working the engine	4,000
Repairs and alterations	5,000
Management, attendance, and taxes	12,000
Wear of hose-pipe, and labour of distribution	9,100
TOTAL £.	34,900

The quantity pumped per annum is calculated by Mr. Mylne at 3,588,000 tons, at 3 *d.* per ton £. 44,856
Deduct the working expenses 34,900
And there remains £. 9,956

Clear profit, being about 8 ½ per cent. upon the capital, or including the 4 per cent., already charged upwards of 12 per cent. net.—(Report on Metropolitan Sewage Manure, Parliamentary Paper, Sess. 1846, No. 474). Now the value of this sewage put by Mr. Smith at 2 *d.* and by Mr. Mylne at 3 *d.* per ton, we have already estimated, from the analysis of Messrs. Brande & Cooper at ·85 *d.*, or between ¾ *d.* and 1 *d.* per ton; and we find it estimated by Professor Miller, who gave evidence in behalf of the company, no higher than 1 ½ *d.* per ton. He states the value of the sewage at 64 *l.* per day, and the quantity at 12,000 tons.—(Minutes of Evidence, Questions 567, 568). If we assume the annual amount of sewage flowing into the Thames from this sewer to be 6 million tons, the annual value will be—

According to our estimate, founded on the analysis of Brande & Cooper, ·85 *d.* per ton, £.	21,250
According to Professor Miller's estimate, 1 ¼ *d.* per ton	31,250
According to the estimate of Mr. J. Smith, 2 *d.* per ton	50,000
According to the estimate of Mr. Mylne, 3 *d.* per ton	75,000

It

It would appear, then, at first sight, that had the company's scheme been carried out as originally intended, it would have failed from too high a value having been set upon the sewage. It is possible, however, that it might not have failed, from a circumstance to which we have not yet adverted, and the importance of which can hardly be over-estimated. It is that the fertilising power of manure is greatly increased by its being applied in the liquid state. The value we have assigned to sewage is that which the fertilising matter it contains would possess, if applied to the soil in the form of a dry powder, resembling Peruvian guano. But the immediate effect of a given quantity of manure applied to the soil in the state of solution or intimate mixture with water, is two, three or four times greater than it would be if applied in the form of a dry powder. Now, supposing the adventitious value derived from the mode of application to have been four times greater than its real intrinsic value, a supposition quite consistent with facts, as we shall endeavour to show farther on, a ton of sewage water would not have been valued too high at 3 *d.* The original plan of the company, however, was not carried out. The supply of sewage was taken from another sewer (Walham Green), which is said to contain less fertilising matter than any other in the Metropolis, in consequence of the less density of the population within its area, and the great volume of upland rain-water, and the supply of manure was carried into one of the least suitable districts, namely, to a district already supplied at the cheapest rate with powerful manure, and of that district only a small proportion received the company's supply. The whole of the available capital was expended before the pipes could reach the ordinary farming district, where there appeared to be a demand for it. The consequence was, that the company failed as a commercial speculation, as had been predicted by Mr. Smith, of Deanston, and other competent agriculturists, who withdrew from it. Notwithstanding the limited success of the company's operations, the value of the sewer water, diluted though it was, was clearly proved. On land where town manures had been applied at an expense of 20 *l.* per acre, and labour in working the land to the same extravagant amount, an augmentation of the ordinarily large crops, to the extent of nearly one-third, was obtained. The range of the distribution by the jet was visible in the extra growth of the vegetation, although much of this success was doubtless attributable to the water itself, irrespective of the matter in solution.—(*See* Mr. Lee's Report to the General Board of Health.—Min. on Sewer Water, p. 132.) We see then, that even if this plan had been more successful than it has hitherto proved to be, the value of the sewage water would have been almost, if not entirely, absorbed by the expense of distribution. It follows that this plan, though superior to those which contemplated the extraction of a portable manure from sewage, as presenting a chance of success, in the endeavour to prevent the sewage of towns from running entirely to waste, is by no means satisfactory. In the case of the Manchester Liquid Manure Company, indeed, town manures were purchased and applied by hose and jet with profit; but in this case it was not sewage that was employed but night-soil, which had to be mixed with from three to six times its weight of water before it could be applied to advantage. On the continent, and indeed in this country, there is a traffic in night-soil, which is used either mixed with some absorbent substance as ashes, or with water as liquid manure, or reduced to the state of a dry portable manure by drying, as at Paris. The objection to this mode of dealing with the refuse of towns is, that the retention of such matter under or near human habitations is productive of more damage to the health of the community, than can be counterbalanced by any equivalent in money received for the manure. The immediate removal of all excrementitious matter is an indispensable condition of a proper sanitary state of towns. This condition is secured by the adoption of the water-closet principle, by which the refuse is removed in suspension in water. The advantages of this method of removal are so great, that any plan for the utilising of the refuse to be successful, must take its universal adoption as a starting point.—(Minutes of Information collected with reference to Works for the removal of Soil-water or Drainage of Dwelling-houses and public Edifices, and for the Sewerage and cleansing of Towns.—General Board of Health, 1852.)

Having thus inquired into the composition and value of the sewage of towns, and discussed the various plans that have been proposed, with a view of turning it to account, we now proceed to unfold the method by which we propose to overcome the great practical difficulty that has stood in the way of all previous attempts.

Plan proposed.

1. The practical difficulty to which we have referred, as standing in the way of the profitable application of sewage water is its extreme dilution, of which we may form some idea, from the fact that a ton of it is fairly represented by a ton of water, with one or two pounds of Peruvian guano diffused through it.

2. This difficulty we propose to get rid of by the adoption of a system of pipe drains for the special purpose of receiving and conveying the water from water-closets (water-closet sewage), undiluted by any mixture of waste or rain water, which will continue to flow into the common sewers. There will thus be two distinct sets of channels for the removal of sewage, having no communication with each other, one for the water-closet sewage, containing all the excreta of the population, the other for the common sewage, consisting of waste, rain and drainage water.

3. By thus keeping separate the water-closet and the general sewage, we obtain by one arrangement two great advantages, the great bulk of the sewage, robbed of its elements, both of value and danger, is reduced to the state of mere dirty water, free from all offensive smell, and giving off no deleterious gases; and the remainder is so concentrated, that it may be pumped up, forced through pipes, and delivered by hose and jet in the open country, at a cost comparatively trifling.

4. The amount of water with which the refuse is mixed, will be the smallest by which its complete removal can be effected. A water-closet should act completely, with not more than half a gallon of water.—(Minutes of Information on the Removal of Soil Water, p. 104.) This quantity will probably be found sufficient, in the majority of cases. We will assume, however, that a gallon a head per day is the average quantity used for this purpose. This would amount to 365 gallons, or 32 cwt. per annum, by adding 10½ cwt., the average annual amount of excreta per head, we have a total of 42½ cwt., or a little more than two tons, as the annual amount of the water-closet sewage per head on this plan. We have already ascertained the average annual value of the excreta of the population to be 6 *s.* per head. Taking the average annual amount of water-closet sewage at two tons, it will be worth 3 *s.* per ton.

5. We have assumed that one gallon of water a head per day will be sufficient for the complete removal of the excreta of the population. We find it stated that water running through a 4-inch pipe, laid at an inclination of 1 in 120, completely removed from $\frac{1}{16}$ to $\frac{1}{30}$ of its volume of sand.—(Minutes of Information with reference to Works for the Removal of Soil Water, &c. page 38.) Solid fæces would be removed much more easily than sand, being of much less specific gravity. There would be on an average only $\frac{1}{2}$ lb. of fæces to a gallon of water, the proportion being $\frac{1}{4}$ to 10, or 1 to 40. If the pipes were smooth in the bore, properly jointed, and not too large, and laid at a sufficient inclination, there would be little fear of their being choked by accumulations of deposit. I propose that the pipes be glazed inside, and secured, by using cement at the joints, so as to stand considerable pressure. Contamination of the soil would thus be prevented, and if any obstruction occurred, it might be removed, by forcing water into the pipe. Choking from accumulation seldom takes place in the small iron or lead pipe of the water-closet, and it would take place as seldom in a continuation of this pipe if laid at a proper inclination, and without undue increase of diameter. The whole water-closet sewage of London would pass through an 18-inch pipe.

6. We have now to consider the expense of the plan. Of this it is evident, we can form only a rough estimate. Mr. Rammel, in his report on the cesspool system of Paris, published as an Appendix to the Report of the General Board of Health on the Supply of Water to the Metropolis, sets down the cost for works of construction of a tubular system of refuse drainage at the rate of 4*l.* 3*s.* per house, of eight inhabitants. This estimate, he states, includes, not only the house drains, but also a fair share of the public sewers necessary for the conveyance of the refuse matter away from the habitation to a distant outfall, and is intended to represent the whole cost of the system to an ordinary middle class house, containing eight inhabitants. We have reason to believe, from a statement contained in the Minutes of Information on the removal of Soil Water, that the average expense for main drainage works of the towns drained under the Public Health Act has been under 2*l.* 10*s.* per house. If to this we add 1*l.* for a drain connecting the water-closet or closets with the main drain or sewer, we have a total of 3*l.* 10*s.* We will suppose, however, that 5*l.* per house will be required, a sum more than sufficient for providing a system of channels for the conveyance of the whole of the sewage, having a bulk 20 to 50 times greater than the water-closet sewage, and varying through a much greater range. The expenditure required, in the case of London, would be 1,500,000*l.* (300,000 houses, at 5*l.* each), the interest of which, at 4 per cent., would be 60,000*l.* This sum would be charged against 4,800,000 tons of water-closet sewage, being at the rate of 3*d.* per ton, or 6*d.* per head of the population. If both sets of drains were formed at the same time, the expense would be greatly reduced, and half the sum stated above would probably be sufficient. If we were to charge the outlay for both systems against the water-closet sewage, it would amount to 4½*d.* per ton. If only the expense of forming the channels through which it runs, it would be only 1½*d.* per ton. We believe then that the expense of collecting the water-closet sewage of a town on this plan would range from 1½*d.* to 3*d.* per ton.

7. We come now to the expense of distribution. We have already given, in detail, the estimate of W. C. Mylne, Esq., showing that sewage water might be forced through pipes by steam-power, and distributed in the country at a cost of 3*d.* per ton. We have also stated the estimate of James Smith, Esq. of Deanston, at 2*d.* per ton. This latter estimate has proved correct, where the liquid manure of farms has been distributed on this plan, as in the case of Myremill, a farm in Ayrshire, where 400 acres are laid with pipes for the application of the liquid manure by hose and jet.—(Minutes of Information relating to Sewer Water and Town Manures, page 68.) It is not improbable that were the plan carried into execution on a large scale, the expense might be reduced. Mr. Mechi, in his article on sewage manure, in Morton's Cyclopædia of Agriculture, states the working expenses of distribution by steam power, thus:

	£.	s.	d.	
Coals at 1*s.* per cwt.	–	6	–	
Man at engine	–	1	8	
3 boys, 1 lad, working two jets, and moving the pipes	–	1	6	
	–	1	–	
Wear and tear, and repairs	–	2	6	
7½ per cent. per annum on first cost, 54*l.* per annum, or for 300 days	–	3	7	
£.	–	16	3	per diem.

The quantity delivered would be for 10 working hours, 130 tons of water, but the specific gravity of liquid manure being so much greater, the cost of delivery may be fairly placed at 1½*d.* to 2*d.* per ton. The writer has rather overrated all expenses, to prevent disappointment; and he has also allowed for many stoppages that will naturally occur. In the manufacturing districts, both coals and machinery would be cheaper, but labour dearer. On a very large scale, with economical expanding and condensing engines, and a rigid engineering supervision, the cost of application might be fairly reduced to 1*d.* per ton. We may put down the cost of distributing the water-closet sewage at 2*d.* per ton at the outside.

8. But the water-closet sewage would be in too concentrated a state for application during dry weather, and thus would require occasionally to be diluted, by the addition of water. In reference to this point, we have to state that in the experiments of Mr. Holland, and the practice of the Manchester Liquid Manure Company, a mixture of nightsoil and urine was applied to grass, diluted with three times its weight of water in wet, and with six times its weight in dry weather. In little more than an hour after such application, no offensive smell was perceptible, and the grass was eaten by cattle the next day. Now the water-closet sewage would consist of one part of excrements and three parts of water. It would thus require to be diluted with nearly an equal weight of water when applied to growing crops in dry weather. But it would require no dilution in the following cases: when applied during wet weather, during winter, or before the seed was sown, and when allowed to escape into streams irrigating water meadows. A sample of Flemish manure, analysed by Boussingault, was found to contain 2 per 1,000 of nitrogen. This liquid manure is applied with the greatest benefit to growing crops. Water-closet sewage would contain about 2·5 per 1,000 of nitrogen. The addition of one-fourth of its weight, or half a ton per head of water, would bring it to the Flemish standard. We think then that an allowance of one-half more, or one ton of water per head, would be sufficient for the purpose of dilution, taking into account that there are many cases where it would not be required. The expense of collecting and distributing the water-closet would stand thus:

	Per Ton.		Per Head per Annum.	
	d.	*d.*	*d.*	*d.*
Expense of collection	1½	3	3	6
„ distribution	1	2	2	4
„ dilution	½	1	1	2
Total	3	6	6*d.*	1*s.*

According to this calculation, the whole expense attending the application of the excrements of the town population to the soil will not exceed 1*s.* per head per annum. The annual value of the excrements we have put at 6*s.* per head, so that there will remain a clear revenue of 5*s.* per head per annum, after all expenses are defrayed.

9. We have then the following results:

	Per Annum		
	Gross Value at 6*s.* per Head.	Cost of Collection, Distribution, and Dilution.	Net Revenue.
	£.	£.	£.
Sewage of London, population 2,400,000	720,000	120,000	600,000
Sewage of an average town population, 12,000	3,600	600	3,000
Sewage of the whole town population of Great Britain, 10,500,000	3,150,000	525,000	2,625,000

10. We have proceeded thus far, on the supposition that there will be no loss. That the whole excrements of the population will flow into and through the channels that we have proposed to provide for them, and perhaps we are justified in doing so, seeing that if proper provision be made (for which an outlay of 5*l* per house will be amply sufficient) for the wants of the population, as water-closets public and private, urinals, &c., no loss will take place, except such as is attributable to carelessness. And as any mixture of excrementitious matter with the common sewage would be detrimental to the public health, it would be necessary to reduce it to the smallest limits possible. We shall not enter into any discussion of the plans that may be resorted to for this purpose, but as some loss is perhaps unavoidable, we will set it down at the exaggerated amount of one-fourth of the whole.

11. There will also be some loss during the application or distribution of the sewage. If the sewage were distributed day by day as it was produced, it might be thought that that which was applied during the season, when vegetation was suspended, would be lost. We are not of this opinion. Leaving out of view the admirable researches of Professor Way, on the power of soils to absorb manure, which show that clay soils have the power of retaining the elements of manure, though applied to them in a soluble form, we refer to the practice of the Flemish farmers, who apply their liquid manure in autumn, whether for colza, wheat or oats, before the seed is sown. They find, indeed, that when applied in the spring one-fifth less will suffice; and there can be no doubt that liquid manure is applied to plants with the greatest effect when they are in a state of vigorous growth. It must be taken into account, however, that by manuring highly, vegetation commences earlier in the spring, and is continued later into the autumn than in ordinary circumstances, and that the period during which plants are dormant is much shortened. In water meadows vegetation is never completely suspended, being kept alive by the comparatively high temperature of the water; and it might be advisable to use the sewage for irrigating, by allowing it to escape into the streams of water meadows during stormy weather in winter, and when the ground was thickly covered with snow. It would be necessary to have a reservoir capable of containing the sewage that would accumulate during two or three days; as this would be best placed at the extreme end of one of the main pipes, and at the highest level reached, it would be at the greatest possible distance from the centre of population, and not requiring to be of great extent; its surface might be protected by a film of oil, which would prevent all contact between the atmosphere and the sewage, and consequently all noxious evaporation. A reservoir, an acre in extent and 12 feet deep, would hold the water-closet sewage of London for one day. Reservoirs of large size for holding sewage during winter might be formed in natural hollows at a comparatively small expense, and, not being required during summer, they might then be used for growing grass or other green crops. By these expedients the loss of sewage during distribution might be reduced within very narrow limits; we shall however calculate it at one-fourth of the whole amount.

 12. Having

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12. Having made these allowances for loss, and thus reduced our valuation of the refuse by one-half, or to 3 *s.* per head, we now proceed to show that this half, which we have valued at 3 *s.*, is worth 6 *s.* or more when valued according to the effect which it produces. We have hitherto estimated sewage-water at the value which its ingredients would possess if presented in the form of a dry powder. But the effect which the ingredients of sewage would produce when applied, dissolved in and diffused through a considerable bulk of water, is much greater than would be produced if they were applied in the form of a dry powder. Mr. Kennedy, of Myremill, states that the ordinary effects of guano have been doubled by distribution in solution with water at the right times by the new distributary apparatus.—(Minutes of Information relating to Sewer-water and Town Manures, p. 58.) We find, also, that in Flanders a given quantity of nitrogen in manure is considered to be worth four times as much, in the form of liquid manure, as in the form of farm-yard dung. Boussingault informs us (Rural Economy, Eng. Transl., p. 386), that in Flanders, 22 gallons of Flemish manure, weighing nearly two cwt., are held to be equal to five cwt. of farm-yard dung. The liquid manure which he analysed yielded 2 per 1,000 of nitrogen, while farm-yard manure, in its usual state, contains as much as 4 per 1,000. It follows, that four parts of nitrogen in manure, applied in the liquid state, are equal, in immediate fertilising effect, to 20 parts of manure applied in the solid state. In an experiment made at the instance of James Smith, of Deanston, near Stirling, farm-yard dung and ashes, mixed, were applied to a portion of a field of sandy loam, at the rate of 12 tons per acre, and at a cost of 48 *s.* To another portion 16 tons of the same compost per acre were applied at the cost of 64 *s.*; to a third, guano, two cwt., costing 16 *s.*; to a fourth, guano, four cwt., at a cost of 32 *s.* Another division was manured with sewage-water, at the rate of 16 tons per acre; and, taking it at 3 *d.* per ton, the cost would be 4 *s.* The average produce of the portions manured with dung and guano was 45 bushels of good barley per acre. That where the sewage-water was applied gave 42 bushels per acre; where nothing was applied the yield was 30 bushels per acre. Here we have an increase from sewage-water nearly as great as that produced by farm-yard dung or guano, containing, perhaps, ten times as much nitrogen or ammonia. Thus it appears that the fertilising effect of manures is greatly increased by their being applied in the liquid state; we shall suppose it only to be doubled. In this case, the excrements of an individual, worth on an average 6 *s.* per annum in the state of a dry powder, would be worth 12 *s.* per annum applied to the soil in a state of solution. But we have made a deduction of one-half for loss in collecting and distributing, the remaining half will be worth 6 *s.*; this, then, after all deductions are made, we take to be the annual value of the excrements per head of the town population. We have seen that they may be collected and distributed at an annual cost of 1 *s.* per head; 5 *s.* then may be taken as the annual value per head of the excrements of the town population of this country, after the expenses of collecting and distributing, in the form of water-closet sewage, are defrayed.

13. We have now to make a few remarks as to the crops to which sewage manure may be applied with most advantage. The method of applying sewage by hose and jet is better adapted to green than to grain crops, for the simple reason that but a comparatively small quantity of manure can be applied to the latter without danger of loss from over luxuriance, while the quantity that may be applied to green crops, as turnips and mangold, but especially cabbage and Italian rye-grass, is susceptible of increase to a point far beyond that ordinarily reached. Mr. Lawes calculates that the sewage of London, if applied to grain crops at the rate of half a hundred weight of ammonia per acre, would suffice for 400,000 acres. Mr. Telfer, of Cunning Park, states that he has profitably applied as much as 25 cwt. of guano in a liquid state to an acre of Italian rye-grass, while he has not been able to apply more than eight cwt. per acre to root crops with success. By these applications it appears he has raised as much as 82 tons of Italian rye-grass and 34 tons of mangold per acre. Now if we suppose the excreta of two individuals of a mixed population to amount in a year to a quantity of manure equivalent to 1 cwt. of guano, which is pretty near the truth, a single acre of Italian rye-grass would profitably absorb the sewage of 50 persons, and 50,000 acres the whole sewage of London. We need not stop to demonstrate the strong probability that the cultivation of Italian rye-grass will in a short time supersede that of all other crops over the area to which the sewage of towns is applied. The enormous produce, and the equally enormous appetite for manure which are characteristic of this remarkable plant, prove its fitness for such a situation.

14. To provide a complete distributing apparatus for 50,000 acres would according to Mr. Mylnes's estimate (6 *l.* 6 *s.* per acre) require an outlay of 315,000 *l.*

This estimate (6 *l.* 6 *s.* per acre) has been found considerably to exceed the sum actually required in the case of single farms; the whole outlay on steam-engines, tanks and pipes, fixed and moveable, being—

At Mr. Neilson's, Halewood - - - - -	£.	4	6	11 per acre.
„ Mr. Telfer's, Cunning Park - - - - -		4	4	— „
„ Mr. Kennedy's, Myremill - - - -		3	2	6 „

—(Minutes on Application of Sewer-water, p. 50.) Adopting, however, Mr. Mylnes's estimate, and putting down the expense of the distributary apparatus required for the Metropolis at 315,000 *l.*, and adding to this the expense of laying down the pipes for the conveyance and collection of the water-closet sewage, which we have estimated at 1,500,000 *l.*, we have a total of 1,815,000 *l.*, being the sum required for the execution of our plans in the case of London. When it is remembered that we calculate on a clear annual revenue of 600,000 *l.*, this outlay will appear by no means extravagant.

15. In this calculation we have possibly under-rated the expense of carrying out our plan. Let us, therefore, double our estimate, and add 100,000 *l.* to the annual expenditure. The capital required would be 3,630,000 *l.*, the annual expenditure 220,000 *l.*, and the annual revenue 500,000 *l.* If to this we add the saving arising from the improvement in the health of the metropolitan population, which will follow the carrying out of the plan, we have a sum total of the most satisfactory character.

16. There only remains a single point for our consideration, viz., the necessity of fermenting the sewage previous to application. This subject has been discussed by Mr. Russel, of Kilwhiss, in an able

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able Paper published in the Journal of Agriculture for October 1855, and we are inclined to agree with him, that liquid manure must be fermented before being applied to clay soils; clay having to a certain extent the power of arresting fermentation, and locking up the fertilising elements of manure in a form in which they are not in the most available state for the nourishment of plants. Sandy soils, on the other hand, are favourable to decomposition; they have, as it were, greater powers of digestion, and the previous fermentation of the sewage, when applied to them, is not so indispensable a preliminary. It follows from this, that sewage should be applied in the first instance to the sandy soils within reach. Even on sandy soils fermentation may be desirable, and if it will pay on the small scale it will also pay on the large. Perhaps by heating the sewage the fermentation may be so hastened (as the decomposition of the flax straw is hastened by the heating of the steep-water in Schenck's process) as to allow of the storage room being very materially contracted. By the adoption of proper precautions the prevention of any bad effects that might arise from the fermentation of large masses of liquid sewage may easily be accomplished.

In conclusion I have to remark, that while I am aware that in the idea of separation I have been anticipated, I believe the particular application of it which I have described to be original, and to be the most satisfactory solution of the sewage problem which has yet been made public.

James Simpson, Esq.,
29, Great George-street, Westminster.

(signed) *Alex. Leslie.*

(10.)—Mr. John Leslie.*

Mr. *J. Leslie.*

To Captain *Douglas Galton*, R. E.; *James Simpson*, Esq., C. E.; *Thomas E. Blackwell*, Esq., C. E.

Gentlemen,

The difficult problem of the removal of the sewage of the Metropolis, which the chie commissioner of Her Majesty's works has requested you to aid him in solving, together with your public invitation, induces me to offer for your consideration a very brief outline of my suggestions on the subject.

The great charter of sanitary reform, "The Metropolis Local Management Act," details the area from whence the "sewage" has to be removed, viz. 78,029 acres, of which, however, about 3,500 acres are waters of the Thames, its tributaries, docks and canals.

The rental of the metropolis may be taken at 12,000,000 *l.* sterling per annum, and the per centage of its acreage, population and rental is thus divided,—

	Per Centage of Acreage.	Per Centage of Population.	Per Centage of Rental.
Middlesex, or northern side - - -	41·6345	73·89	75·0
Surrey and Kent, southern side - -	58·3655	26·11	25·0
	100·0000	100·00	100·0

The Surrey and Kent side is nearly five miles longer from west to east than the Middlesex side, a very important element in considering the subsequent observations.

The 135th section of the Metropolis Local Management Act makes it imperative on the Metropolitan Board of Works to "make such sewers and works as they may think necessary for preventing all or any part of the sewage within the Metropolis from flowing or passing into the River Thames in or near the Metropolis." It further enacts, that they shall make "other sewers" for the effectual sewage and drainage of the Metropolis.

As I read the clause, it separates the house sewage proper from the rain-water drainage, and requires them to be removed in separate channels.

I believe that that is the legal reading of the clause; I am satisfied that that mode is the most simple, the most equitable, the most economical, and the most sanitary, preventing the expenditure from being either a nuisance or injurious to health.

First. The most simple; because one line of main intercepting sewer could be constructed on the longest and worst drained side of the Metropolis, so as to "benefit" the whole of the metropolitan population, and by one financial operation charging the 12,000,000 of rental with the repayment of the principal and interest in any given number of years which Parliament might sanction.

Second.—The most equitable; because every ratepayer in the whole metropolitan area would contribute his proportion of the expenditure for the common "benefit" of all, and which he, as one of the metropolitan population, would derive from every fraction of that expenditure, leaving the legal power of charge to the sewers-rate "benefit" beyond a doubt.

Third.—The most economical; because the original cost of construction, and the annual constant supervision of one line of main interception "sewage" channel must be less than that of two lines, a northern and a southern line. Again, what "benefit" can be shown to the metropolitan ratepayers from the expenditure in collecting all the rain-waters which fall in Fulham and Wandsworth, and east of those places, carrying the rain-water in brick channels, and pumping up those rain-waters several times before they are permitted to fall into the river?

Fourth.—

* *See* Minutes of Mr. Leslie's Evidence, page 448.

Fourth.—The most sanitary; because the separation plan would abolish the cesspools and reservoirs system, substituting the immediate removal of the sewage from every house as fast as it was generated, and by its continuous movement in the street sewers to the discharge outlet, preventing deposit in any of the sewers. My plan further comprehends the great sanitary advantage of disconnecting all gully gratings and other openings from the street into any of the sewage channels; the present system being maintained at an immense expenditure, creating great causes of offence, and of disease, in the Metropolis.

Further, the separation of the sewage from the rain-water channels would greatly aid the navigation of the Thames, and also its scouring power, as the land and rain-waters would pass immediately into the Thames or its tributaries in the locality where it has fallen; and, consequently, this separation would enable a very much reduced size of "sewage" channel to be effectual. Again, the maximum sewage and house water is a known daily quantity; my data for which is as follows:—

	Lbs.
Solid discharge from each person in 24 hours	0·375
Fluid ditto	2·5
Expected house water supply to every individual man, woman and child of the whole population, five cubic feet each in 24 hours	312·5
	315·375

This quantity, 5·046 cubic feet, multiplied by 3,500,000 men, women and children, the anticipated increased population of the metropolitan area 50 years hence, would give each minute's discharge 12,264 cubic feet, a present population of 2,500,000, would give each minute's discharge 8,760 cubic feet.

These quantities are purposely exaggerated. The ordinary formula shows that a 10-feet internal diameter sewer, with an inclination of two feet per mile, will, when four-fifths full, discharge about 12,900 cubic feet per minute, being nearly 700 cubic feet per minute more than the exaggerated calculated quantity of "sewage" from 3½ millions of metropolitan population; and the same formula shows, that with six feet depth of stream in a 10-feet sewer, same inclination, the discharge would be more than the whole "sewage" from a present population of 2½ millions.

But to this calculated discharge must be added at least 40 per cent. for the momentum of an inclined plane of 36 miles in length, falling uniformly two feet per mile, receiving fresh increments of water in its progress.

Having shown that the daily house sewage and house water supplies are a known maximum quantity, and that a 10 feet sewer is adequate to their discharge, I now proceed to show that rain-water is not a daily, not a weekly, nor a monthly, but known only as a yearly quantity of about 24 inches, falling at long intervals of dry weather, in occasional heavy storms, and, consequently, ought to be taken into the river or its tributaries by the shortest possible channels, forming a system of mere surface drainage, under the management of the local vestries and district boards; this again would effect a great economy, both in parochial and sewers-rates.

Another powerful reason for the separate system as in the fact that the great bulk of the Metropolitan population is in a comparatively small acreage of the whole metropolis, and contiguous to the Thames; while there are 63,129 acres of the whole metropolis, with an average of 11·56 persons to each acre, in which average the following are included. (The greatest population of the whole of these 63,129 acres is in Lambeth, with 4,015 acres and 34·7 persons to each acre.)

Registration District.	Acreage.	Population per Acre.
Hampstead	2,252	5·32
Wandsworth	11,695	4·34
Lewisham	17,224	2·02

To propose dealing with the rain water which occasionally falls on these vast numbers of the whole acreage of the metropolis, in the same channels with the "sewage" of the few people who inhabit thereon appears to me erroneous in principle, and would entail a vast amount of unnecessary expenditure, not only without "benefit," but with a positive injury to the population, by the abstraction of so large an amount of waters that now flow into the Thames.

I would carry out my suggestion by one main line of intercepting sewer, commencing at Putney and terminating at Sea Reach, at any one of the five points indicated in a subsequent paragraph.

The starting depth must be below present requirement, because of the rapidly increasing population on both banks of the river west of Putney, and whose sewage must ultimately be kept from polluting the Thames.

Captain Burstal's sections of the Thames furnish the latest and most accurate information, as to the bed of the river from the Nore to Putney.

Starting this proposed sewer at Putney below the level of the bed of the river, it would proceed as close to the river as practicable to take in, in its progress, all existing sewer channels, until it arrived at a point to be selected between Lambeth Palace and Waterloo Bridge; from the point selected, then to proceed in the most practicable straight line to Sea Reach.

Captain Burstal has shown, that between Holehaven and Scar Elbow there is a depth of water at high water of 73 feet 6 inches, and 57 feet at low water of spring tides. Taking the average run of the tide there at three miles an hour, there would be 264 feet lineal of sea water passing, while the pumps were discharging each minute "sewage."

The

The following Table will show the sectional area of the River Thames, in square feet, at five points, for selection of discharge at Sea Reach:

PLACE.	Trinity High-water.	Mean Low-water.
Garrison point to Shoeburyness	1,173,600	659,400
London Stone to Crow Stone	705,450	295,140
Brick-yard point, Allhallows, to Canvey point, Hadleigh	499,660	250,900
St. Mary's Bay to Bay at Deadman's points	363,870	170,590
Egypt Bay, through Blythe, Beacon Buoy to Hole Havenpoint	309,300	161,600

The main intercepting sewer would immensely improve the means of removal of the Surrey and Kent "sewage," because it would require the channel to be at a considerably greater depth than has been proposed, when viewed only as the southern drainage line.

Further, it would have the advantage of improving the salubrity of many additional miles of the River Thames, by preventing any of the "sewage" of the population of 47,000 acres in Erith, Dartford, Greenhithe, Northfleet or Gravesend from passing into the river, and consequently would be a great additional "benefit," not only to the whole metropolis, but also to those inhabitants in Kent below the present metropolitan boundary line.

The great benefit to the northern side would be in the much greater depth at which the intercepting sewer would be made, than any of the existing outlets from Fulham eastward to the River Lea, and would abolish the whole of the tide-locked gates on either bank of the Thames.

All the northern drainage so collected would pass under the bed of the Thames to the southern main line already indicated. Three of such crossings, I believe, would suffice.

The first, between Fulham and Vauxhall Bridges.

The second, between Vauxhall and Blackfriars Bridges.

The third, in an iron-pipe through the Thames Tunnel.

The utilisation of the metropolitan sewage would be greatly facilitated, I may almost say rendered possible, by the single line I propose, because it would pass through the agricultural counties of Surrey and Kent, with ordinary road, railway and river communications close to it in its whole extent.

The great difficulty of this portion of the subject, the enormous admixture of water with fertilising matter, would be very much diminished by the separation of the rain water from the combined system which at present obtains; but my chief object is the sanitary improvement of the whole population, by removing existing and preventible causes of disease.

The only pumping station requisite to effect the continuous discharge of the metropolitan "sewage" may either be on the bank at the selected point at Sea Reach, or at a point somewhat nearer to Gravesend, according as borings would show the difficulties of executing the works through the marsh land to the outlet. I propose the discharge of the sewage to be at the bottom of the water, on the bed of the river, so as always to have a large vertical mass of water above the discharge.

The great engineering difficulties eastward of the River Lea, on the Essex side, have always appeared to me insurmountable, while by simply leading the "sewage" discharge of the eastern portion of the northern side of the metropolis to the indicated crossing through the Thames Tunnel, an enormous amount of expenditure will be saved, and the difficulties avoided.

Of course I do not comprehend in my view of the required legal expenditure high and middle-level intercepting sewers on the northern or southern side, to carry off the rain-water which falls on those respective localities; neither do I contemplate the disturbance of the streets, and of the great interruption to the trade and commerce of the metropolis which the combined system proposes as necessary to carry out that object; my collecting interception on the northern side would be as near to the river as possible, and at such a depth that all existing sewers could, by underpinning where necessary, have their falls so improved as to be self cleansing, (for example, the whole Belgravian District of St. George, Hanover-square, and from Scotland-yard, through Westminster), saving the immense expenditure which is now necessary in the disgusting and health-destroying operations under the head of cleansing sewers.

I have, as briefly as I can, shadowed out my ideas on the important subject submitted to your consideration; should you have resolved that, in your judgment, it is necessary to continue the combined system of sewage and rain-water channels, and to have a northern and a southern intercepting line of sewers, it would be a useless waste of your time, and of mine, to go further into detail of my views, which are diametrically opposed to any such plan.

I have felt it right, as one of the members of the Metropolitan Board of Works for the parish of St. George, Hanover-square, to respond to your public invitation. That parish will have to pay about one-twelfth of the whole taxation for the effectual improvement of the discharge of the metropolitan sewage; and, because the parish I represent requires a much deeper system of sewers than it at present possesses, or than it is likely to have under the plans which have been discussed and decided upon by the Metropolitan Board of Works.

I have, &c.
John Leslie,
59 and 60, Conduit-street, Hanover-square,
London.

28 February 1857.

Appendix X.

Plans of Drainage.

Text of Plans.

Messrs. *J. R. M'Clean & Stileman.*

(11.)—Messrs. J. R. M'Clean & Stileman.*

To Captain *D. Galton*, R.E., *James Simpson*, Esq., C.E., *T. E. Blackwell*, Esq., C.E.

Gentlemen, 17, Great George-street, Westminster, 28 February 1857.

In accordance with your notice I beg to submit, for your consideration, the accompanying plans, sections and documents.

1st. The plans and sections of an outfall sewer between West Ham and the German Ocean.

2d. An Ordnance map, showing the general direction of the outfall sewer, and the position of the land proposed to be reclaimed between the River Blackwater and Burnham Creek.

3d. Plans and sections of the sewers and other works required for connecting the sewage of the district south of the Thames, including Woolwich and Greenwich, with the proposed outfall sewer at West Ham, on the north side of the Thames.

4th. Description of proposed works.

5th. Estimate of proposed works.

You will observe that the estimate of discharging the sewage of the southern district of the Metropolis into the Thames at Erith, as described in the reports of the engineer of the Metropolitan Board of Works, is double the cost of discharging it by the system now proposed into the outfall sewer north of the Thames, at West Ham, through which it may either flow to the sea, or be used for agricultural or chemical purposes, without being a nuisance. In the former case the estimate is upwards of 900,000 *l.*, in the latter only 450,000 *l.*

I shall be happy to wait upon you on any day you may appoint, to offer any additional explanations you may require respecting the system I propose, and to state objections to that proposed by the engineer of the Metropolitan Board of Works.

I am, &c.

J. R. M'Clean.

Description of Outfall Sewer between *West Ham* and the *German Ocean*, as shown on the Engraved Plans and Sections, and Ordnance Map,† on Inch Scale, accompanying this Report.

The proposed outfall sewer to commence by a junction with the one proposed by the engineer of the Metropolitan Board of Works, near the pumping station at West Ham, at a point where the whole of the intercepted sewage and rainfall of the northern, western and southern districts of the Metropolis will flow through the same channel.

The level of the top water at the junction to be 17′ 8″ above Trinity datum. The conduit to pass over the North Woolwich Railway by means of an iron aqueduct, and under the Tilbury Railway, near its junction with the Eastern Counties Railway. The Railway to be raised 2′ 6″ for the purpose of allowing the water in the conduit to be maintained at that point at a level 14′ 8″ above Trinity datum, during the time of the maximum discharge; thence to proceed through Ilford, crossing Barking Creek above the navigable part of the river, and thence, without interfering with the level of any road, to the marsh land near Battle Bridge, in the Valley of the Crouch, to which place the tide at present flows; from that point to pass through the marsh lands, as far as the ridge between Burnham and Southminster, and thence in a tunnel into the Dengey Marshes, and through the marshes to the Swire Hole Channel of the German Ocean. The conduit to be a covered sewer, 20 feet diameter, as far as the marsh lands adjoining the River Crouch, from whence, with the exception of a length of about two miles covered, near Burnham, to be an open sewer until it reaches the German Ocean. The fall will not be less than eight inches between West Ham and Battle Bridge, and the mean velocity will vary between 2′ 6″ and 3′ 0″ per second.

Between Battle Bridge and the German Ocean the fall will be four inches per mile, and the mean velocity two feet per second.

The discharge from West Ham will be continuous at all times of tide.

The conduit will be capable of discharging 39,180 cubic feet per minute, which is the maximum quantity of sewerage and rainfall to be provided for, as given in the Tables referred to in the reports of the engineer of the Metropolitan Board of Works, including the Western District; viz.:

	Cubic feet.
Sewage and rainfall of south side	12,609
Ditto north side, high level	2,961
Ditto „ middle level	10,730
Ditto „ low level	12,880
Including Western District	
Maximum sewage and rainfall	39,180 per minute.
	653 per second.

The

* *See* Minutes of Mr. M'Clean's Evidence, page 448. † *See* Map to illustrate Mr. M'Clean's Plan, Plate 4.

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The sewage throughout may be used for agricultural purposes, and at a moderate cost may be distributed in a fluid state over a large district of country.

The estimate of the outfall sewer is 1,600,000 *l.*

Description of Intercepting Sewers to collect the Sewage and Rainfall of the South Side of the *Thames*, and of a Conduit along *Southwark* Bridge, and to the Outfall Sewer at *West Ham*, including the Cost of Stationary pumping Engines, &c. at *Southwark* Bridge.—*See* Ordnance Map on large Scale, and Sheet of Sections which accompany this Report.

No. 1 *on Plan and Section.*

The proposed sewer is to commence by a junction with the Earl sewer, where it now crosses the Walworth road. It will receive the sewerage and rainfall from the district drained by that sewer, and also brought down by the proposed sewer from Putney sewer, on Mr. Bazalgette's plan, and by dotted red lines on the Ordnance map accompanying this Report. It will pass along the Walworth-road and the Southwark Bridge-road as far as Union-street, where it will unite with the Southwark Bridge sewer. In its course it will relieve the Newington Causeway sewer and the Battle Bridge sewer; and if a few modifications are made in the present sewers it will receive the whole sewage and rainfall south and west of Camberwell. The diameter will be seven feet, the fall two feet per mile, and the velocity will vary between two and three feet per second. This sewer will be capable of discharging the one-half of the sewage and rainfall of the southern district; and if the sewage only of the valley of the Effra is intercepted, and the existing channel left for pure and storm water, there will not be any necessity for the high level sewer proposed by the engineer of the Metropolitan Board of Works.

No. 2 *on Plan and Section.*

This sewer will form a continuation of No. 1 sewer as far as Southwark Bridge, passing along the Bridge-road. It will be enlarged for the purpose of receiving the sewage of No. 3 sewer. It will be 12 feet diameter, and capable of collecting the entire sewage and rainfall of the south side at the pumping station adjoining the bridge.

No. 3 *and* 4 *on Plan and Section.*

This sewer will commence near the dockyard at Woolwich, and will provide an outlet for the whole sewage of the town. It will then proceed along the low road to Greenwich, and will intercept the sewage of that town; thence along the main road, as far as Deptford, where it will diverge to the north, having previously received the sewage of that place and of Lewisham. It will then pass through the garden lands along the Greenwich Railway, and will intercept in its course the Earl sewer near its present outfall, and the Duffield sewer and the other low sewers which at present flow into it. It will thence pass along Long-lane and join the Southwark Bridge sewer in the line shown on the Ordnance map, if a new street is formed; or if not, along one of the existing streets until it falls into the Southwark Bridge sewer, having intercepted in its course the Russell-street sewer, the Bermondsey sewer, and other low sewers which depend on tidal outfalls. This sewer will be three feet diameter at Woolwich, and will gradually increase to five feet until it receives the contents of the Earl sewer and the low level sewers already described. It will be seven feet diameter between the Earl sewer and Southwark Bridge sewer.

Between Woolwich and the Earl sewer the fall will be two feet per mile, and from the Earl sewer, for the remainder of its length, three feet per mile. The velocity will vary between two and 3½ feet per second. It will be capable of discharging more than one-half of the sewage and rainfall of the south side, and will not reverse any of the existing currents in the sewers. The present outfalls of the Duffield and Earl sewers may be used for storm-waters, and the storm overflows and the high level sewer proposed by the Engineer of the Metropolitan Board of Works will not be required.

Steam Engines at Southwark Bridge.

In connexion with the Southwark Bridge sewer, steam-engines and an engine-house will be erected on land at present occupied as a timber-yard adjoining the bridge.

The whole of the sewage will require to be lifted 60 feet, or to a level of 38 feet above Trinity datum. No nuisance will be caused by these works, as the engines will be sufficiently powerful to maintain a continuous flow at all times, and the shaft will be only a vertical instead of an inclined sewer, and will be as well enclosed as the latter.

The maximum engine power required will be 1,500 horse power, and the engine-house will be most conveniently situated for a supply of coal.

As all the engines will seldom be worked at one time, there will not be any necessity for duplicate engines. This is shown in Mr. Bazalgette's last report on the quantity of rainfall. According to it the ordinary working of the engines for three-fourths of the year will not require more than 250 horse power daily, or one-sixth of the engine power provided, and on only 28 days the full power will be required. This affords an additional argument against the expensive construction of a high level sewer, and also against having two pumping stations, as proposed by Mr. Bazalgette, as the maximum engine power must be provided at each station, being six times greater than required, and men constantly on the spot to clean and work the engines, and attend to the fires.

No. 5 *on Plan and Section.*

Three wrought iron aqueducts to be fixed between the girders of Southwark Bridge, for the purpose of conveying the sewage from the south to the north side of the Thames; the dimensions of each aqueduct will be 5′ 9″ × 2′ 6″; the space between the girders is adapted for this work, and each aqueduct will have two independent girders to support it; the only interference with the iron-work of the bridge will be the alteration of three connecting plates near the centre of each

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girder, the other bracing will not be interfered with. At each end of the bridge the three aqueducts will unite in one, and on the north end the aqueduct will terminate in a sewer near the crossing of Cannon-street.

The highest part of the bridge gives the limit of the height required for pumping on the south side, as the sewage will descend from that point by gravitation to West Ham, where it will fall into the outfall sewer. The total length of the aqueduct will be 660 yards.

No. 6 on Plan and Section.

Between Cannon-street and the City-road a sewer eight feet diameter, and having a fall of three feet per mile will be constructed, passing along Moorgate-street, Finsbury-square and Windmill-street, where it will unite with the middle level sewer proposed by the engineer of the Metropolitan Board of Works. From that point, although practically the works would be united, an independent sewer 9′ 6″ diameter is shown as far as the aqueduct across the Lea, for the purpose of making the comparative estimates. This sewer having a fall of two feet per mile will be capable of conveying the 12,000 cubic feet of sewage and rainfall on extraordinary occasions to the aqueduct across the Lea.

As some difficulty arises in ascertaining what quantity of sewage and rainfall the engineer of the Metropolitan Board of Works proposes to pass through the aqueduct across the Lea, a parallel aqueduct capable of conveying the whole of the sewage from the sewer No. 5 to the outfall sewer at West Ham has been estimated.

This aqueduct will complete the connexion between the southern and northern districts, and the whole sewage of the metropolis will flow uninterruptedly out to sea instead of into reservoirs at each side of the Thames, and afterwards into the river.

Estimate for the Construction of Intercepting Sewers to collect the Sewage and Rainfall of the South side of the Thames, and of a Conduit along *Southwark* Bridge, and to the Outfall Sewer at *West Ham*, including the Cost of Stationary Pumping Engines, &c., at *Southwark* Bridge.—*See* Ordnance Plan and Sections which accompany this Report.

Yards.	Lin.			£.	£.
10,560	Lin.	From Putney to Camberwell-road - - - -		7	73,920
2,860	„	Camberwell-road to Union-street -	Section No. 1	8	22,880
440	„	Union-street to Southwark Bridge pumping-station - - - -	„ No. 2	20	8,800
3,960	„	Union-street to Earl sewer, Rotherhithe - - - - - -	„ No. 3	8	31,680
8,932	„	Earl sewer to Woolwich - - -	„ No. 4	6	52,800
660	„	Southwark Bridge aqueduct - -	„ No. 5	60	39,600
1,584	„	Southwark Bridge aqueduct to City-road - - - - - -	„ No. 6	10	15,840
5,082	„	City-road to Dock Railway Junction, with high and middle level sewers -	„ No. 6	11	55,902
2,183	„	Additional cost of aqueduct across River Lea, from high level and middle level sewers, to pumping station at West Ham - - - - - - -		20	43,660
		Pumping engine (say 2,000 horse power) and station -		- -	70,000
		Contingencies - - - - - - - - -		- -	34,918
				£.	450,000

(12.)—Mr. J. J. Morewood.* †

Mr. *J. J. Morewood.*

Letter, with Plan, Sections, Drawings and Miscellaneous Papers relating to proposed mode of Draining London.

Gentlemen, 1, Barford Terrace, Islington, London, 28 February 1857.

I have the honour to introduce myself to you as the originator of the plan for draining the metropolis by means of two tunnel sewers, one on each side of the Thames, in the prosecution of which, I and those associated with me have expended upwards of 12,000 *l.*; and I can, with truth, affirm that the last 12 years of my life have been almost entirely devoted to the prosecution of this scheme. Under these circumstances, I feel pleasure in laying my claims before an impartial tribunal; and I beg also to transmit copies of my plan and sections, which were submitted to a Select Committee in Parliament, in 1853, and approved by them, after a full hearing, not only of my witnesses, but of witnesses brought and examined by counsel on behalf of the Metropolitan Commission of Sewers and the City Commission of Sewers; which Committee was presided over by Lord Seymour, now the Duke of Somerset.

The original outfall, as described in the plan deposited by me, was on the north side, at Barking creek, and on the south side, at Greenwich Marsh.

The Select Committee however, on examining into the question of deodorisation, suggested that if deodorising works were made, it would not be necessary to carry the outfall, on the north, beyond the River Lea.

All

* *See* Minutes of Mr. Morewood's Evidence, &c., page 450. † *See* Map to illustrate Mr. Morewood's Plan, Plate 5.

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Mr. *J. J. Morewood.*

All the plans which provide main lines of intercepting sewers are substantially founded upon mine, but the advantages of my original design over that adopted by the Metropolitan Board of Works, are shortly these:

The cost of its execution, as proved by the eminent contractor, Mr. Brassey, who offered to undertake the works at that sum, would not exceed 1,050,000 *l.* The works adopted by the Metropolitan Board, are estimated at about 3,000,000 *l.*

The tunnel sewer on the south side, is carried nearer to the River Thames than that projected by the Metropolitan Board of Works, and therefore better adapted to the drainage of that low district.

The cost of the works and the sufficiency of the capacity of the tunnel sewers formed subjects of minute examination on the part of the Select Committee, who took the evidence of the surveyors to the Metropolitan and City Commission of Sewers, and of eminent engineers upon the subject, and were satisfied of its sufficiency.

I beg also to transmit a history in detail of the origination of this scheme and of various other schemes, which have now, year by year, been adopted and abandoned by the successive Commissions of Sewers, who have been appointed for the metropolis.

This history will, I think, be found worthy of your perusal, as showing the gradual progress of scientific and public opinion towards the tunnel sewers, which I first suggested, and which upon their early announcement were met with an opposition as general as that almost universal approval which is now accorded to them.

I shall be happy to attend whenever you do me the honour to summon me, and to afford any further explanation or evidence that you may require.

I have, &c.
(signed) *J. J. Morewood.*

To Captain Douglas Galton, R. E.
James Simpson, Esq., C. E.
Thomas E. Blackwell, Esq., C. E.

List of Documents, February 28, 1857.

Letter addressed to Captain Galton, R.E., James Simpson, Esq., C.E., Thomas E. Blackwell, Esq., C.E.

Second Letter giving a history of tunnel sewers, &c.

Appendix, No. 1, Names of Metropolitan and City Commissioners of Sewers who have adopted the tunnels.

Appendix, No. 2, Parliamentary Paper, No. 376 (1854) } The Commissioners' scheme of 1853.
„ No. 3, „ „ No. 394 „ }
„ No. 4, „ „ No. 427 „ Mr. Morewood's reply.
„ No. 5, Extract from the words of the Chairman of the City Commission, the Chairman of the late Metropolitan Commission, and of the Chairman of the Metropolitan Board of Works.

Parliamentary Plan and Sections, Session 1848; Second Reading, standing, March 7, 1848.

Parliamentary Plan and Sections, Session 1853; Second Reading, March 9, 1853.

Parliamentary Plan and Sections, Session 1854; Second Reading, standing, March 2, 1854.

Plan and Sections as deposited with the late Metropolitan Commission of Sewers, in accordance with their resolution, and by them remitted to the Metropolitan Board of Works.

Letter giving a History of Tunnel Sewers.

Gentlemen, 1, Barford Terrace, Islington, February 28, 1857.

In addressing you further, in reference to the plan of two tunnel sewers, one on each side of the Thames, for the arterial drainage of the metropolis, and for intercepting and conveying the sewer refuse beyond the limits of the town, I may claim some indulgence, on the ground that I am the originator and the registered promoter of that system of drainage, and that I have devoted nearly 12 years to the perfecting of the plan, and more than 30 years to the general subjects connected with the pollution of the Thames and the inefficiency of the Metropolitan drainage arrangements.

Public attention had been drawn to the subject by myself and others, in 1826. The visitation of the Asiatic cholera in 1832, had awakened public alarm, and 13 years later, or nearly 20 years from the first public discussion of the question, we had got no further than the general admission of the great evils, but no comprehensive or efficient remedy had been suggested.

During this long interval of nearly 20 years, my mind had been steadily devoted to the question, and in June 1845, the idea of utilising the sewer refuse of the metropolis, and thus securing its efficient removal, presented itself to my mind.

In the ensuing autumn, I submitted to Her Majesty's Government, a plan of two tunnel sewers, one for each side of the metropolis, into which all the house drainage or sewer refuse should be discharged, even if increased to more than double the present volume, and should be conveyed to deodorising works at the terminal outfalls, being at that time satisfied that the sewer refuse admitted of economical utilisation. Deodorisation and utilisation, do not, however, affect my mode of dealing with the great evils to be overcome, and whether applied or not, leave my plan of two tunnel sewers for the main drainage of the metropolis, perfect and complete; nor is that plan affected by the sewer refuse being passed into the Thames immediately below London, or carried out to sea.

In the following year, 1846, the daily and weekly press, with scarcely an exception, either described or referred to this drainage plan, which was also illustrated by a weekly periodical, the Pictorial Times,—and which stated the objects which I have always had in view; viz.:

The

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The public, in preference to all private advantages.

The present sewers to be undisturbed, keeping them as tributaries to a great intercepting drain, or conduit to be constructed.

That the contents of the sewers should be conveyed away from the metropolis.

The abstraction of the greatest possible quantity of fertilising matter.

These were correctly described by the editor as "the main features of a plan which promises to relieve the public of an unhealthy nuisance, and to assist the agriculturist by a great reduction of cost in the cultivation of his land."

Deeming the plan to be of the utmost national importance, I addressed a letter to the Chairman of the General Quarter Sessions of every county, requesting him to bring it before the noblemen and gentlemen who should attend the January meeting of 1846. A full description of the plan was thus brought before the magistrates of every county, and a similar description was also sent to every private banker, and to every branch of all the Joint Stock Banks throughout the country.

Three distinct documents were also sent to every Member of Parliament, the last of which, being accompanied by a lithographed plan and sections, was delivered on the 19th May 1846. The government of the late Sir Robert Peel, which had spoken of the plan as "a comprehensive seheme which was under the consideration of the government," thereupon nominated a Parliamentary Committee to inquire into the subject. Before this committee, evidence was given in support of the works proposed by me; viz.: that the efficient removal and deodorisation of the sewer refuse of the metropolis, could be accomplished for a sum not exceeding 1,300,000 *l.*

This Committee reported to the House of Commons, after receiving evidence respecting various modes of utilisation:—"There will be found individuals, no doubt, in this country of enterprise, to give further development to each of these experiments; but it is only through the agency of a company that they may be all combined and applied to the important purposes of cleansing our towns, purifying our rivers, and enriching our soil."

In September 1847, a new Government, that of Lord John Russell, having been formed, a Royal Commission was appointed, having for its object, to provide for the evils arising from the condition of inefficient drainage. The results of their investigations and deliberations, which, together with the Health of Towns' inquiries, occupied a space of five years, resulted, as you are aware, in the devising of that plan called the "converging system," a scheme by which it was proposed to supersede all existing house and street arrangements, in so far as drainage is concerned, substituting in their stead entirely new ones—a scheme which, even if it had been effective, which it was not, would have put the Metropolis to an expense at least four times greater than my plan of tunnel sewers, which, be it observed, was at that very period before the Government and the public, and consequently before the Sanitary Commission, with whom, indeed, I had also several communications in reference to the efficiency of my plan. The Consolidated Commission of 1847, including among its members the Sanitary Commissioners, were, however, publicly stated to be "unanimous" as to the effectiveness of the "converging system," in relation to and in connexion with which the Government, in February 1848 and April 1849, informed Parliament that grand results would be secured to the Metropolis.

Notwithstanding this unanimity, in August 1849, the Chief Engineer to the Metropolitan Commission of Sewers brought forward another scheme, which consisted of a deep well, 160 feet in depth, to be sunk in Copenhagen Fields, where the sewer refuse from all the Metropolis was to be pumped up and passed by a single surface tunnel to the east of London.

The Chief Surveyor to the Commission, on the other hand, brought forward two schemes, one for diverting all the sewer refuse from Westminster, &c. to Duncannon-street, Strand, and there pumping it into the Thames; and the other a single tunnel scheme, passing frequently under the Thames, which involved, also, the superseding every existing house and street drainage arrangement.

Such, then, was the result of five years' extensive inquiry, prosecuted by four Royal Commissions, and of all the information and experience of the previous divided Commissions of Sewers—four schemes, each one of which is now absolutely exploded, though at the time highly esteemed by these Commissions and by the Government, and from which Parliament and the public were led to expect the greatest benefits.

Aware of the nature of the proceedings adopted by these commissions, and convinced that not one of the plans could ever be carried into operation, I devoted myself to exposing the errors into which they had fallen, and continued to prosecute my own design, nothing having in the meantime tended to shake my confidence in its practicability, but, on the contrary, to confirm my views. Accordingly, in the autumn of 1847, I occupied myself with the prosecution of a Bill for the succeeding Session of Parliament, in spite of the disastrous condition of the commercial world, failures to the extent of 30 millions having taken place; and in the following spring, in spite of chartist disturbances in this country, the alarming political state of Ireland, and the French revolution.

I pressed forward that Bill, so prepared, before Parliament. The "Votes" of the House of Commons, on the 28th February, and the "Breviate" of the Bill, as settled by the Speaker of the House, and sent to every member on the 6th March, shortly describing the works proposed by me, are my evidence on this part of the subject, the latter being the fifth document transmitted between September 1845 and March 1848.

The Engineer and the two Chief Surveyors of the Metropolitan Commission of Sewers presented reports against this plan, dated 6th March 1848, and the Commissioners themselves passed resolutions against the further progress of the Bill, in which they, however, admit its comprehensive character, and that all the sewer refuse would be removed by its adoption; while the City Commission of Sewers passed a resolution, on the 29th February, to the effect that they were not opposed to the principle of the Bill.

The Government refused its sanction to the Bill being further proceeded with, and recommended that the order for the second reading should be discharged, thereby allowing it to be resumed during the Session. This was assented to on the 7th March 1848, after it had been proposed by me that the competing schemes should be referred to practical men, which was opposed by the Sanitary Commission, and was declined by the Government.

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J. J. Morewood.

This important inquiry in which you are now engaged is, therefore, that very inquiry the necessity of which I urged on the attention of Lord Morpeth, Mr. Chadwick, Dr. Southwood Smith, and Mr. Henry Austin, on the 6th March 1848, the question at that time being between the converging (or sump) system and my plan of a tunnel sewer for each side of the Metropolis; whereas now, after an interval of nine years, during which nearly all have been converted to my views, the question, happily, is not between my plan and something totally distinct, but between that plan and certain alterations made in and additions made to it.

During the Session of 1848, several endeavours were made by me to be allowed to resume the further prosecution of the Bill, but this was always objected to by the Government, who considered it best to leave the matter in the hands of the two Royal Commissions who were occupied with the subject.

Paradoxical as it may appear, it is nevertheless a fact, that on the 22d July of the same year, 1848, the Sewers Bill was introduced, and on the 4th September it was passed by the House of Commons, the 39th and four following clauses of which provide for the construction of a tunnel sewer to pass through the City of London, which is nothing more or less than the adoption of that part of my plan, no such clauses being required for the south side. I say my plan, and I repeat it emphatically, because I had, as I have already stated, brought the design before the Government in 1845, before the public and the Parliament in 1846 and 1848; and so far from any Royal Commission, or any body of persons or private individuals having adopted the tunnel sewer system, both the former and the latter had been my opponents, almost all parties who took a public interest in the question having given in their adhesion to the converging or sump system. I will also add on this point, that the City Solicitor, in his speech before the Lord Mayor, on the 16th July 1855, publicly stated with reference to the Bill in question, that when it was passed, "Parliament had it in contemplation to enforce the construction of intercepting sewers. The right order of proceeding had been inverted; the intercepting sewers were not even yet commenced," &c.

Thus my plan, and no other, was that remedial measure which Parliament had in view in passing the Sewers Bill of 1848, and which has become the basis of all future legislation on the subject.

The time at length arrived when the principle of two tunnel sewers should be further acknowledged as the true remedy for the evils connected with the drainage of the Metropolis, and the dispollution of the Thames. In opposition to the single tunnel system of the Chief Surveyor's, the Chief Engineer to the Metropolitan Commission of Sewers first spoke of my design as "more practicable." This was on the 21st June 1849. It was next proposed, on the 5th July, by one of the Commissioners, "That all plans which had been designed should be brought before the Commission, at the special court to be held on Monday fortnight," there being at this time only three plans in existence, viz., the sump system, the single tunnel scheme, and my plan; and in September an arrangement was completed for the drainage of Westminster, which rejected the plans proposed by the officers of the Metropolitan Commission of Sewers, and adopted my plan of a tunnel sewer for the northern side of the Thames. It was thus in September 1849, that the Metropolitan Commission of Sewers adopted the principle of tunnel sewers, the enforcement of the construction of which was intended by the Sewers Act of 1848.

In October 1849, and therefore a month after the adoption of my plan, it was found that advertisements for plans, which had been issued by the Commission of Sewers, had resulted in a very general recommendation of two tunnel sewers, one on each side of the Metropolis, whereby the correctness of the principle advocated by me was fully supported, although no fresh information of any kind is to be found in the 150 suggestions sent in; nor was it to be expected, seeing that the officers of the Commission had themselves prosecuted four abortive schemes, and seeing also that the time afforded to the competitors altogether precluded a satisfactory result.

The course of proceeding which had been adopted by the Commission in the summer of 1849, gave rise to an arrangement for securing that authoritative opinion in favour of two tunnel sewers, which, it was considered, would finally decide the question, and give assurance of the fullest support of the Government and Parliament. After I had furnished very important data bearing upon the subject, a new Commission consisting of royal and civil engineers was appointed in October 1849.

This Commission publicly adopted one tunnel sewer for the south side of the Metropolis, in August 1850, and pumping up the whole of the sewer refuse of the district was justified by one of the leading civil engineers; and in January 1851, the Metropolitan and City Commission of Sewers adopted a similar tunnel sewer for the north side, with pumping power, and sufficient capacity to remove all the sewer refuse from the northern bank of the Thames. This plan of two tunnel sewers was laid before the Government, and before Parliament, by a Return printed on the 24th February 1851, in which the area to be drained, the extent of the interception and the site for the terminal outfalls, were all identically the same as those proposed by me since 1845.

Some serious errors in detail were, however, committed, and on these being discovered, and the Commissioners further ascertaining their inability to borrow the funds which were required for the construction of the tunnel sewers, they publicly stated to the House of Commons, on the 23d June 1852, that the works were of the utmost urgency, and that they would cost 1,000,000 *l.*; a sum which represents two tunnel sewers.

The Commissioners, unable to carry their plan into execution, resigned, and were succeeded by others, who instructed Mr. Simpson, one of the present referees, to report respecting the "temporary outfall of the Westminster drainage, and the extension to the main drainage towards the east." In that gentleman's report, no allusion is to be found to the latter subject. His reason for abstaining from pronouncing an opinion upon it, I have always attributed to the fact that, at that time, the question was before a Parliamentary Committee in connexion with my plan. The officers of the two Commissions, in a report dated in May 1853, and before a Parliamentary Committee in the following June, admitted the superiority of the northern line of tunnel proposed by me, and the sufficiency of the southern tunnel for the removal of the sewer refuse of the district.

Thus every one of the Metropolitan Commissions of Sewers, from September 1849 to May 1853, is identified with the construction of two tunnel sewers; one on each side of the Metropolis. A list, containing the names of the gentlemen who composed these Commissions during the four years in question, is given in Appendix, No. 1.

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The inability of the Commissioners to raise the requisite funds led me to propose to the Government and to the Commission, to bring forward capitalists to construct the works, if three per cent. interest were secured to them, only in the event, and to the extent of the profits from the sale of the manure falling short of a dividend to that amount.

The subject having been referred "to Parliament," a Bill was duly prosecuted in the Session of 1853, and a full examination of witnesses took place before a Committee of the House of Commons, of which the present Duke of Somerset was chairman. And here I have to complain that the Metropolitan and City Commission of Sewers came before the Committee, appearing by counsel, day by day, harassing me by captious opposition; whereas I conceive that they ought rather to have assisted me in carrying out a plan which they themselves in substance copied, although, as I can show, they have trebled the expense of the works by additions totally unnecessary, and suggested by a mistaken notion that the rain-fall on the metropolitan area is much greater than it really is.* In spite of these obstacles, I, however, persevered, at a cost of several thousand pounds, and although my Bill was rejected, in consequence of the opposition of these public bodies, the chairman subsequently stated to the House of Commons:—

"That the plan which proposed that there should be two tunnels—one on each side of the Thames—to receive the drainage of the Metropolis, had been fully approved by the Select Committee." *Hansard*, March 2, 1854.

But I am not left without some commendation for my labours during this Session of Parliament; for Mr. Thwaites, the present Chairman of the Metropolitan Board of Works, in a pamphlet published by him on the 1st December 1855, at page 10. states:

"The first day on which evidence was heard before the Select Committee of the House of Commons, on the Great London Drainage Bill, was 6th June 1853. This scheme, which originated with Mr. J. J. Morewood, was brought before Parliament in the years 1845-6-7-8, 1851-2-3; it provided for the construction of two tunnel sewers, one on the north side of the Thames, the other on the south; and guaranteed the company 30,000 *l.* per annum, or 3 *l.* per cent. on a fixed capital, out of the Metropolitan Sewers Rates; while on the other hand, the ratepayers were to share any profits which should be realised over and above the 3 *l.* per cent. It was on this portion of the plan that the preamble was declared not proven, the Committee considered it inadvisable to report rating clauses without the sanction of the Government, and a vote of the House of Commons. The Metropolitan Commissioners were among the petitioners against the Bill, appeared by counsel in Committee, and their engineer and consulting engineers were among the opposing witnesses. The expenses incurred amounted to 1,333 *l.* 15 *s.* 11 *d.*, of which 969 *l.* 9 *s.* 5 *d.* were for legal and parliamentary costs, and the remainder for engineering evidence. The consulting engineers received 175 *l.* each, as apportioned by the accountant, from the gross amount of 500 guineas each. The preamble of the Bill was ultimately declared by the Committee not proven; so the Bill was lost,—nevertheless, the information obtained during the examination of witnesses, had considerably enlightened Parliament, as well as the metropolitan constituencies, on the subject."

And here I may observe, that the officers of the Metropolitan and City Commission of Sewers admitted before this Parliamentary Committee, in June 1853, that they possessed no intercepting drainage scheme, and they were, on the 2d June, desired to consider and report upon the subject. In the ensuing August, Mr. Bazalgette, who had declared before this Committee in 1853, that my plan would not improve the drainage of the Metropolis, and that the benefits of the present course of discharging the contents of the sewers into the Thames, were far greater than the injury, brought before the Government, and the Metropolitan Members of Parliament, an opposing scheme of high level sewers, which was published in the October following, and then fully approved by the Metropolitan Commission, who urged its immediate execution upon the Government and Parliament in 1854, by Sessional Papers, No. 376 and No. 394. To this proposal, I objected in a letter addressed to the Government, which was printed by the House of Commons, and forms No. 427. These three documents form Nos. 2, 3 and 4 in the Appendix.

Meanwhile, on the 27 July 1854, the Metropolitan Commission of Sewers obtained from Parliament sanction to borrow 300,000 *l.*, with the distinct understanding that it should be spent in commencing the construction of "two great outfall drains."† Of this sum 150,000 *l.* was accordingly borrowed; but in spite of a motion discussed by the Commission on the 16th January 1855, for adopting my plan for the south side of the metropolis, and an admission that thereby the district would be saved no less a sum than 300,000 *l.*, the motion being supported by a resolution passed by the chairmen, &c. of different local boards of the six parishes in Southwark, the money so borrowed was never applied for the purpose for which Parliamentary sanction was obtained, but remained in the hands of the Commissioners till the Metropolitan Board of Works was established, when the large sum referred to was handed to them, and by them has been applied to the defraying of their ordinary expenses. Had it been applied for the object for which it was obtained, it would have been devoted to the commencement of the two tunnel sewers, or "great outfall drains, one for the north and the other for the south side of the river," for which the Government and Parliament intended it.

The history of the period between the last-mentioned date, July 1854, and the present time, may be summed up in a few words.

With the 150,000 *l.* in hand the Metropolitan Commission of Sewers began to discuss their legal position, and discovered that they possessed no power to purchase land at the places fixed on for the terminal outfalls. The certainty that the Bill to constitute the Metropolitan Board of Works would

* Mr. Bazalgette, in answer to Question, No. 2557, actually stated, on the authority of Mr. Glazier, of the Greenwich Observatory, "that it is not an unfrequent occurrence that two inches of rain should fall in an hour in the metropolis."

† Hansard, July 27, 1854.

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would become the law of the land during the Session of 1855, to which Board the construction of the outfall drains was to be specially committed, no doubt had its share in preventing the Metropolitan Commission of Sewers from applying to Parliament for the required powers, and so the year 1855 slipped away; not, however, without a note of warning and alarm, in the delay in dealing with the pollution of the Thames, from men whose voice, on such a subject, is perhaps the most potential that could have been raised. I allude to a memorial signed by the bankers of London, the members of those powerful bodies, the Baltic Coffee House, the Stock Exchange, Lloyd's, the Dock Companies, and numerous other merchants and professional men, complaining of the condition of the Thames, and suggesting that immediate measures should be adopted to secure the construction of the two tunnel sewers, for which the Commissioners were authorised to borrow 300,000 *l.* These memorials were presented to the Lord Mayor by Mr. Frederick Smith, on the 18th September 1855, and were brought under the notice of the Common Council on the 20th; but the pressure arising from the war, and the legislation then in progress for the constitution of the Metropolitan Board of Works paralyzed the Lord Mayor's efforts, as it had already done those of the Metropolitan Commission of Sewers, and so nothing was done.

At length in January 1856 the Metropolitan Board of Works commenced operations, and in February held its first discussion on the Thames question; since which date a very considerable number of discussions have taken place on this very subject, during which it has given its consideration, not only to the plans of its own engineer, but also to the plans of several other individuals.

It may naturally be supposed that a plan submitted to the Metropolitan Board of Works by the originator of that system, which is acknowledged to be the only remedy for the evils under review, supported by an approval at once so unimpeachable and so unbiassed as that of the Parliamentary Committee, accorded to one who had no personal influence to command so much as a hearing from members of that distinguished assembly; nothing in short to recommend him to their consideration except the merit of his plan—would have been listened to, not merely with the respect and attention vouchsafed to it by the highest tribunal provided for such investigations by our free constitution, but would have been welcomed with no common interest by a body, which was mainly instituted for carrying into effect the best plan of intercepting sewerage. How far a course so natural, so necessary to the establishment of a character for impartiality, containing so simple a measure of justice, and so important to the public interest, has been observed, will be seen, when I state that the subject of granting me a hearing has been before the Metropolitan Board of Works on four different occasions, and on each has been refused. My first application was to be allowed to justify the approval of my plan by the Parliamentary Committee. It came before the Board on the 21st May, and was treated as if only fit for the waste paper basket. My second application was negatived on the 22d October. An endeavour to revoke this refusal could not be carried on the 9th December; and a second endeavour, for this end, was negatived on the 2d January last. Such is a simple account of the reception I met with at the hands of the Metropolitan Board of Works. The question interests the rate-payers to the extent of about 2,000,000 *l.*

And now, by way of clearing the subject of all possible misconception, suffer me to say, that the Metropolitan Commission of Sewers having been the first public body to bring forward a plan of tunnel sewers (which was in 1850), the name of their engineer, Mr. Forster, has sometimes been associated with the origination of tunnels by those who are unacquainted with the facts of the case. How far that gentleman was entitled to any such merit you will be able to form an opinion, when you call to mind that I laid my plan before the Government in 1845; that I brought the subject before the public and Parliament in 1846; that a Parliamentary Committee was the same year appointed to investigate my plan; that in March 1848 it was before Parliament, prosecuted by the same private enterprise which had originated it; and that in July following it was embodied in the Sewers Bill; that in 1853 I claimed before a Parliamentary Committee the honour of the origination, a claim which never was, as it never could be, challenged, resting on such evidence as I have already brought forward. But this is not all; I have the statements of men acquainted with the whole subject from the earliest date to the present time. I allude to the testimony of the chairman of the City Commission of Sewers, the chairman of the late Metropolitan Commission of Sewers, and of the present chairman of the Metropolitan Board of Works, whose united testimony concedes incontestably to me the authorship of the two tunnel sewers and works, known as the Great London Drainage Plan; and I beg to be allowed to submit to you a copy of their words in the Appendix, No. 5.

But it has been said, "What is there in the origination of such a plan? it is the simplest thing in the world. Every one can see that it is the remedy for the evils in question." This is precisely the same kind of argument that was addressed to Columbus, after he had crossed the Atlantic. And as he then replied, "Did any one ever think of such a continent till I returned?" so may I now say, "Did any one ever bring forward such a practical efficient plan as mine, previous to 1845?"

Although every endeavour has been made to oppose and to suppress my plan, and to obstruct my prosecution of that plan, which first solved the vexed question of metropolitan drainage, yet I can not only appeal to the words of the three chairmen just referred to, and to the various decisions which have been accorded to it since 1845, but also to statements made on the part of the Government, and to proceedings of the House of Commons thereupon:

Thus, for example, the House of Commons refused to delay, for four weeks, the Bill authorising the construction of the works proposed by me, by a majority of 111 to 16. This was on the 9th March 1853.

The proposal to raise the capital, and construct the works, if three per cent. interest were guaranteed, having led to the loss of the Bill in June 1853, the Government obtained powers, on the 9th August following, for the Commissioners of Sewers to raise a large sum of money, 200,000 *l.* of which was to be devoted to the commencement of the arterial drainage of the metropolis;* and during

* Hansard, August 9, 1853.

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during the following Session the Government again stated to Parliament that it was necessary to grant the Commissioners powers to raise 300,000 *l.*, to "enable them to commence the construction of the two great outfall drains, one for the north and the other for the south side of the river, works which were of great necessity."—*Hansard*, 27 July 1854.

These powers Parliament granted; but the Metropolitan Commission not having proceeded with the works for which Parliament granted them powers in September 1848, in August 1853, and July 1854, the proposed works were placed in the hands of the Metropolitan Board of Works; and the Government accordingly informed a deputation, on the 21st July 1855, "That one of the first acts the Metropolitan Board of Works would be called upon to perform, would be to carry out two main intercepting sewers, one on each side of the river Thames."

These words, as well as those which induced Parliament to grant borrowing powers in 1854, are identically the same as the words used to describe my plan, when the present Duke of Somerset stated that the Committee had fully approved the two tunnel sewers; and it is submitted that they are entirely at variance with a scheme of six tunnels, three on each side of the metropolis; and that the additional four tunnels rest upon the very evidence which the Parliamentary Committee ignored in 1853; and which the Government and Metropolitan Members of Parliament, on the 14th July 1854, admitted to be erroneous.

And now after all the inquiry instituted by the Health of Towns Commission, by the Sanitary Commission, the Consolidated, and the Metropolitan Commission of Sewers, from 1844 to September 1849, notwithstanding all the inquiries instituted, and the decision arrived at by the eminent Royal and Civil Engineers from 1849 to 1852; notwithstanding the investigations carried on, and the decision arrived at by the Parliamentary Committee of 1853, and by the Government and Metropolitan Members of Parliament in 1853, 1854 and 1855; notwithstanding all the past submission of plans to the Metropolitan Commission of Sewers, who publicly solicited them to be sent in up to October 1849, and up to the 3d April 1855; and to the Metropolitan Board of Works, who had various plans before them during last summer; notwithstanding the repeated rejection of schemes propounded by those who being the salaried officers of the various Boards, are naturally considered to be the most able authorities,—such rejections of their schemes dating 1848, 1849, 1852, 1854 and 1855, and notwithstanding the repeated expression in favour of my plan,—fresh advertisements have been issued for plans to be sent in to you up to the present day; and you have yourselves been informed that should you be able to devise any other scheme, it will be laid before the Metropolitan Board of Works for its adoption.

Thus all the engineering skill of the civilised world is brought into competition with my own on the details of a plan that has had several distinct verdicts in its favour, pronounced during the 12 years of its prosecution by myself.

Whatever your decision may be in reference to these details, there can be none in reference to the origination, and to the unwearied prosecution of those tunnel sewers, and works properly designated the "Great London Drainage Plan," which is virtually embodied in the Board's plan; but it is in my plan, entirely independent, and divested of its additions and alterations, that the financial, the physical, and the moral well being of millions of human beings is bound up. When I say financial, I refer to the thousands of acres of land which will become available for building purposes; and whereon will be located many a labouring family in that comfort, the want of which is so sorely felt in this luxurious metropolis. I also refer to the pecuniary advantages which will unquestionably be derived from securing a deeper drainage outfall for the populated districts, from preventing the present stagnation of sewer water, and consequent formation of foul deposit in the existing sewers; from the greater purity of the Thames; and from bringing the sewer refuse within reach of chemical science and agriculturists, thus securing a cheap substitute for guano, and giving also additional employment. When I say physical, I refer to the health of the metropolis; and when I say moral, I refer to the acknowledged fact of the intimate connexion between the physical and moral well-being of the population.

All these advantages which will unquestionably be conferred by the execution of the works proposed by me, have combined to induce that long perseverance on my part to which I have referred.

I have, &c.
(signed) *J. J. Morewood.*

To Captain Douglas Galton, R. E.
James Simpson, Esq., C. E.
Thomas E. Blackwell, Esq., C. E.

(13.)—Mr. J. Murray and Mr. R. W. Mylne, Civil Engineers.*

Mr. *J. Murray*, C. E., and Mr. *R. W. Mylne*, C. E.

The following suggestions, regarding the drainage of the metropolis, are submitted in consequence of the invitation from the Engineers appointed by Government to report on this important subject.

The question of outfall beyond the limits of the metropolis has now become a prominent feature, and many schemes previously devised, on a limited scale, have on that account been abandoned, and more comprehensive views entertained.

From a general knowledge of London and its vicinity, the contours of its surface, and the position of the principal sewers, we have been induced to submit the accompanying plan† for the effectual drainage of the southern districts, and a large portion of the low western districts north of the Thames. By this plan it is proposed to intercept the upland waters at a high level, and carry them to a distance beyond the Metropolis, where they could be discharged into the River Thames without inundating the low lands.

Instead of taking the catch-water sewer along the main roads through the populated districts of Greenwich and Woolwich, which lie exceedingly low (and if adopted would necessitate a great quantity

* *See* Minutes of Mr. Murray's and Mr. Mylne's Evidence, page 460.

† *See* Map to illustrate this Plan, Plate 6. The colours alluded to in this paper have reference to the original drawings, and not to the reduced printed copy of the map.

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quantity of the upland waters to descend and be lifted by engine-power at the outfall), the high ground has been selected south of Blackheath for the course of the proposed main sewer.

The upland sewage and ordinary rainfall would, by this scheme, be discharged without pumping power into the Thames, at the mouth of the Darent, 18¼ miles below London Bridge, immediately after high water, and into a sectional area of the Thames of great capacity. The sewage thereby diluted would be carried down the River for a considerable distance before meeting with the returning flood, and by placing gates at the outfall any further discharge would be prevented from entering the Thames during flood until the commencement of the ebb tide.

The southern districts of the metropolis, between Richmond and Woolwich, and the low districts between Kew and Chelsea on the north side of the Thames, are proposed to be drained by collecting the sewage and the ordinary rainfall into one main course, and through it allowing the combined waters to be discharged into the river, below Erith, at six miles beyond the metropolitan boundary.

The sewer would be covered for its whole length, having sluice gates on its entrance into the Erith marshes, to be closed on the rising of the tide; and between the sluice gates and the river two or more covered channels, to be formed for a mile in length, for the purpose of storing the sewage and rainfall during the period of flood-tide. At the lower end of these channels half-tide gates, pointing outwardly, having the sill at 19 feet below Trinity, would prevent the ingress of the tide; and by means of lower orifices the sewage would at all times enter the river below the water surface. After the period of high water the discharge would commence and be carried by the ebb tide for several miles down the river.

The sewer at its entrance into the marshes below Erith is proposed to be 14 feet in diameter, having its invert 11 feet below Trinity.

Its course upwards would be in open cutting through the outskirts of Erith, along the line of the North Kent Railway to Abbey Wood, and from thence to a ravine near Plumstead Church, where it would receive the Woolwich branch at the point E. on the map.

The sewer, 12½ feet in diameter, is proposed to be tunnelled from the ravine for a length of four miles through the high ground of Shooter's Hill, crossing under the public road between Eltham and Lee Green, in open cutting (with a branch to Blackheath Park), and from thence to the Ravensbourne Valley, by a short tunnel through the intervening ridge, with a branch upwards to Catsford.

The public road from Lewisham to Southend is proposed to be raised seven feet to permit the sewer to pass underneath it.

It is proposed to cross the Ravensbourne with the invert at the level of 24 feet above Trinity, for which purpose it will be requisite to deepen the bed of that river at the point of intersection, and to lower the water surface; thus improving the drainage of the valley, but not affecting the head of the mill below, which is 21·8 feet above Trinity.

To allow the sewer to pass under the Beckenham Railway, it will be necessary to raise the present embankment and rails eight feet. This alteration will cause the railroad between the point of intersection and Catsford Bridge to be made level, and between it and the public road at Lady Well, on an incline of 1 in 100, which is the gradient now in use in other parts of that line of railway.

After taking the sewage and drainage from the valley of the Ravensbourne at the point C. on the map, the sewer, 12 feet in diameter, is proposed to be tunnelled through the high ground to near Nunhead Cemetery, at the point B., where it is proposed to receive the sewage and drainage from the low level district, No. 1, coloured blue.

The catch-water sewer, 10 feet in diameter, is then proposed to be continued westward, through Peckham Rye Common and East Dulwich (receiving a branch sewer from Champion Hill), and passing by a tunnel south of Herne Hill, and along Half Moon-lane, and by a tunnel between Brixton Church and the reservoirs of the Lambeth Waterworks (with a branch sewer to Balham Hill) through Clapham Common, and across the Falcon Brook to Wandsworth Common, where the sewer is proposed to terminate, 8½ feet in diameter, with its invert 39 feet above Trinity.

From Nunhead Cemetery to Wandsworth Common the catch-water sewer would pass through public roads with little traffic upon them, and through open commons, interfering to a small extent with private property. The line from Plumstead to the Ravensbourne passes entirely through private ground of an agricultural character, free from houses, and a considerable portion is Crown land.

The inclination of the sewer from Wandsworth to Nunhead and the Ravensbourne, is proposed to be uniform throughout, at two feet per mile, and from the Ravensbourne for three miles, at three feet per mile, and thence to the junction of the Woolwich Branch, at 3½ feet per mile, and from thence to its termination at Erith Marshes, at three feet per mile. The total length being 18¾ miles.

The works from the outfall to Plumstead Church would be in dry sand, and some of its length founded on solid chalk. Under such favourable circumstances, and above the level of high water, the sewer could be executed at a moderate cost. The four-mile tunnel, for more than two-thirds, if not its entire length, would be executed through a ridge of chalk, rising in parts to nearly 100 feet above the level of the tunnel; and the chalk, from its great elevation, would be but little charged with water. The works at Mottingham-lane and Eltham Green would be the most troublesome; but as the greatest part of the tunnel sewer could be executed in short lengths, at a moderate depth, the cost will be reduced accordingly.

The tunnel between the Ravensbourne and Nunhead Cemetery would be on the basement beds of the London clay; and the catch-water sewer upwards would be throughout in solid London clay.

No. 1. *Low Level District.*

The low level districts south of the Thames, between Battersea and Greenwich, tinted blue * on the map, are proposed to be drained to a pumping station situated near New Cross. The area amounts to 13·56 square miles, exclusive of docks and canals, and a large portion of it is several feet under the level of high water.

The

* Yellow, in Plate 6.

The present inhabited district comprises 10·56 square miles, and the present maximum daily water supply amounts to about 255,000 cubic feet per square mile. Taking the inhabited area at this quantity, and the uninhabited area at three-fourths, it gives a total maximum on the collective areas of 3,266,500 cubic feet per diem.

This supply is only given for a few days during the year, and during extreme drought, when much is absorbed into the soil, and when street watering, with other extraordinary sources of consumption occurs. It is assumed that one-fourth may be due to these causes, and therefore the remaining quantity of 2,449,913 cubic feet per diem, or 1,700 cubic feet per minute over 24 hours, will require to be pumped. As a large proportion of the discharge of sewage takes place in the early part of the day, the maximum may be taken at 3,400 cubic feet per minute.

The fall of rain forms a very prominent element in the question of drainage.

It is proposed to construct the sewers capable of receiving one quarter of an inch in depth per diem; which, upon the area of 13·56 square miles, will amount to 5,468 cubic feet per minute. A larger quantity occasionally falls, but the streets and sewers being well washed and scoured by ordinary rains will allow the storm waters to be discharged into the Thames by the Falcon Brook, and through a new sewer, 10 feet in diameter, to be used for rain-water only, proposed to be connected with the Effra sewer at Camberwell-lane, and made to intercept the rain-waters passing from the uplands through the Earl sewer to, and continued to Deptford Creek.

For the drainage of this low level district it is proposed to construct,—

1. A main sewer from Battersea Fields to the pumping station along the line of streets adopted by the Metropolitan Board.

2. A branch from the Duffield sewer along St. James's Road, forming a junction with the former at the Grand Surrey Canal.

3. A main sewer from High-street, Greenwich, along the Greenwich Road, under the Ravensbourne at Deptford Bridge, and along a portion of High-street, Deptford, and the Greenwich Railway, and across market gardens to the pumping station.

4. A branch from Rotherhithe along Deptford Lower-road, forming a junction with the last sewer at the Greenwich Railway.

The invert of the sewer at the pumping station being the lowest part of the district is proposed to be placed at 22 feet 9 inches under Trinity, and the invert of the proposed catch-water sewer into which the water is to be pumped being 27 feet 3 inches above the same standard, the total quantity of sewage and rain-fall of 8,868 cubic feet per minute will have to be lifted to a height of 50 feet, and be conveyed in iron pipes to the catch-water sewer near Nunhead cemetery, at the point B. on the map.

To raise the quantity, engines of 840 horse-power will be required, or a mean power of 678 horses exerted over 24 hours.

No. 2. *Low Level District.*

The low districts on the south side of the Thames, tinted light green on the map, between Richmond and Battersea, including Wandsworth, and rising southward to the 50 feet contour line, are proposed to be drained to a pumping station situated to the eastward of the mouth of the River Wandle.

The total area amounts to 10·85 square miles, of which about 1·75 is now only inhabited.

The present and prospective suburban sewage arising from the entire area may be taken at 100,000 cubic feet per diem per square mile, or 753 cubic feet per minute, for 24 hours; and during the early part of the day, at a maximum of 1,506 cubic feet per minute.

The rainfall taken at one-eighth of an inch per diem will give 2,188 feet per minute, or a total maximum sewage and rainfall of 3,694 cubic feet per minute.

For the drainage of this district, it is proposed to construct sewers on the lines adopted by the Metropolitan Board.

1. A main sewer from Putney to the pumping station.

2. Another from the Heath Wall sewer to the same point.

Engines are proposed to be erected to lift and convey the foregoing quantity in iron pipes to the upper end of the catch-water sewer at Wandsworth Common, at the point marked A. on the map.

The difference of level between the inverts of the low and high level sewers being 51 feet, will require engines of 357 horses power, or a mean power of 284 horses exerted over 24 hours.

No. 3. *Low Level District.*

The low districts on the north side of the Thames, tinted green on the map, between Brentford, Fulham and Chelsea, including Kensington, and rising northwards to a little above the 50 feet contour line, are proposed to be drained to a pumping station situated to the westward of the mouth of the Kensington Canal.

The total area amounts to 14·58 square miles, and may be subdivided into two districts.

First Division.—The one coloured dark green on the map, bounded on the west by the Counters Creek sewer, and extending to the uplands of Wormwood Scrubs and Acton, has an inhabited and uninhabited area of 2·56 and 4·26 square miles respectively.

As regards the quantity of sewage; it has been ascertained that the maximum daily water supply on the inhabited area is at the high rate of 400,000 cubic feet per square mile; but, from the peculiarly dense population of Chelsea and Westminster, it is reasonable to assume a rate of one half of the prospective increase on 2·38 square miles uninhabited, and one-fourth for the Acton district of 1·88 square miles. Thus, for sewage, a maximum quantity of 1,688,000 cubic feet per diem is obtained; and, deducting therefrom one-fourth for absorption and other causes, leaves 1,266,000 cubic feet per diem, or 879 cubic feet per minute; and, over the early part of the day, a maximum of 1,758 cubic feet per minute.

Second

Second Division.—In the other less inhabited district of 7·76 square miles, tinted light green of the map, the prospective consumption may be taken at 100,000 cubic feet per diem per square mile, or 539 cubic feet per minute for 24 hours, and during the early part of the day a maximum on 1,078 cubic feet per minute, making collectively for the entire districts north of the Thames, a total sewage of 2,836 cubic feet per minute.

For the drainage of this district it is proposed to construct sewers along the lines adopted by the Metropolitan Board.

1. A main sewer from Chiswick (capable of extension hereafter to Brentford) to the pumping station.

2. A branch from Fulham, forming a junction with the former at Sands End Lane.

3. A main sewer from the Ranelagh at Chelsea Hospital to the pumping station, intercepting the Counters' Creek and other sewers which now discharge into the Thames.

4. A continuation of the Counters' Creek sewer towards Acton.

The invert of the sewer at the pumping station being 24 feet under Trinity, it is proposed to lift the sewage and rainfall by steam engines near the mouth of the Kensington Canal, and convey it in iron pipes across the Thames, in conjunction with the bridge proposed to be constructed by the West End Railway Extension; or, if that project should be abandoned, across the Thames in iron pipes under the bed of the river, and be connected with the upper end of the catch-water sewer at Wandsworth Common, marked A. on the map. The difference of level between the inverts of the low and high level sewers being 63 feet, engines of 689 horses power will be required, or a mean power of 520 horses exerted over 24 hours.

Catch-water Upland District.—The uplands between Peckham and Wandsworth Common, tinted red * on the map, comprise an area of 13½ square miles, of which about 2 square miles are at present inhabited. Considering that a great part is rural, it is assumed that on the whole area the prospective sewage may be taken at 75,000 cubic feet per diem per square mile, or 703 cubic feet per minute, and the maximum at 1,406 cubic feet per minute.

It is proposed to construct the sewer capable of receiving from the entire area of 13½ square miles, rainfall to the extent of one eighth of an inch in depth per diem, amounting to 2,722 cubic feet per minute, which with the sewage, will make 4,128 cubic feet per minute, and inclusive of the quantity pumped into its upper, and will make collectively a maximum quantity of 13,598 cubic feet per minute to be discharged through the catch-water sewer near Nunhead Cemetery, at the point marked B on the map.

The Ravensbourne district, tinted light red,* comprises an area of 4·89 square miles, of which half a square mile is at present inhabited. From its irregular surface it is assumed that the prospective sewage will not exceed 50,000 cubic feet per diem per square mile, or 243 cubic feet per minute for 24 hours, giving a maximum of 486 cubic feet per minute for the early part of the day.

If the rainfall be assumed at one-eighth of an inch per diem, it would give from the area of 4·89 square miles, 987 cubic feet per minute, which with the sewage, give collectively a maximum quantity of 1,473 cubic feet per minute to be discharged into the catch-water sewer at the point C on the map.

The Lea district, tinted red,* comprises 1·47 square miles, of which 0·47 is at present inhabited.

Assuming that the prospective sewage and rain-fall be taken in the same proportion as in the last district, they will make collectively a maximum quantity of 398 cubic feet per minute to be discharged into the catch-water sewer, at the point marked D on the map.

The Charlton district, tinted orange,* comprises an area of 4·78 square miles, of which 0·9 of a square mile is at present inhabited. The park and commons occupy about one-fourth of the remaining area, and on this reduced surface the prospective sewage is assumed at 100,000 cubic feet per diem, or 486 cubic feet per minute for 24 hours, and therefore yielding a maximum sewage of 972 cubic feet per minute during the early part of the day.

As the surface is composed of sands and pebble beds overlying the chalk, the rain-fall is almost entirely absorbed, and is therefore calculated at one-sixteenth part of an inch per diem, giving a total maximum sewage and rainfall of 1,454 cubic feet per minute to be discharged into the catch-water sewer at the point E on the map.

The sewer for the drainage of this district is proposed to commence at Greenwich Park at the level of 17¾ feet above Trinity, and to pass through private grounds as far as the North-Kent Railway, and continued underneath and along its south side, in iron pipes, by Charlton to Woolwich, and thence by a sewer five feet in diameter, along the Plumstead-road to its junction with the main sewer, having the invert at 7 feet above Trinity.

In regard to a very small portion of the inhabited east end of Greenwich and western portions of Woolwich, no sewage scheme has been provided, as it is at present of so small an area, and may be drained into the Thames, and hereafter can be pumped up into the catch-water sewer in conjunction also with the drainage of the Isle of Dogs, by a pipe under the river.

By the collection of the sewage and rain-fall at the two pumping stations at Chelsea and Wandsworth, it of course relieves the densely populated districts through the heart of the city on the one side, and the districts of Camberwell and Peckham on the other, from the waters derivable from the collective area of 25½ square miles, draining to the pumping stations. Not only will the public thoroughfares be less interfered with, but the sewers will be of a reduced diameter, and can be placed at a less depth.

The several districts hereinbefore described comprise a total drainage area of 63½ square miles of which the low level districts amount to 39 square miles.

The

*Blue, in Plate 6.

The following table shows the maximum engine power, amounting to 1,886 horses, for the low level districts, as well as the proportion for the present requirements.

The next table indicates the maximum quantity of sewage and rain-fall, amounting to 25,791 cubic feet per minute, as well as the proportion for the present sewage.

	Inhabited. Square Miles.	Uninhabited. Square Mile.	Maximum Horse-power required: for present Sewage and Rainfall.	Maximum Horse-power required: for prospective Sewage.	Lift in Feet.
Low Level District, south side - No. 1	10·56	3·00	784	56	50
Ditto - - - 2	1·75	9·10	235	122	51
Low Level District, north side - 3	4·36	10·22	461	228	63
	16·67	22·32	1,480	406	
	38·99 Total pumping area.		1,886, or about 48 H. P. per square mile.		

Upland - - - - -	13·50
C. Ravensbourne - - - -	4·89
D. Lea Green - - - -	1·47
E. Woolwich and Charlton - -	4.78
63·63 - -	Total square miles to be drained.

Present and Prospective Sewage and Rainfall.

	Maximum Quantity in the early part of the Day. Sewage.	Maximum Quantity in the early part of the Day. Rainfall.	Total. Cubic Feet per Minute.	Minimum Quantity. Sewage.	Minimum Quantity. Rainfall.	Total. Cubic Feet per Minute.
A. No. 2 - - -	1,506	2,188	3,694	753	2,188	2,941
A. No. 3 - - -	2,836	2,940	5,776	1,418	2,940	4,358
B. Upland district -	1,406	2,722	4,128	703	2,722	3,425
B. No. 1 - - -	3,400	5,468	8,868	1,700	5,468	7,168
C. Ravensbourne - -	486	987	1,473	243	987	1,230
D. Lea Green - -	102	296	398	51	296	347
E. Woolwich and Charlton - -	972	482	1,454	486	482	968
	10,708 +	15,083 =	25,791	5,354 +	15,083 =	20,437

If at any time hereafter it be found advisable to collect water for flushing the catch-water sewer, reservoirs may with facility be formed in the flat lands of the Ravensbourne Valley, and in the ravine through which the Falcon Brook passes.

If the latter be considered to interfere with private property, a reservoir of an ornamental character could be formed on Wandsworth-common, and the spare power at the pumping station applied to fill it with water from the Thames.

It has been deemed unnecessary for present purposes to give any estimate of the probable cost of the works, more particularly considering that many schemes have already been promulgated and calculated in great detail which may be relied on, and give sufficient data to form a general opinion on the subject, of more value than any estimate made within a limited time on so comprehensive a project as the drainage of the most difficult portion of the Metropolis.

Finally,

Finally, it should be observed, that the present sewage of London is discharged into the Thames through about 60 main outlets, chiefly at a period considerably after high water, and passes down the river channel at Blackwall Reach, through a sectional area, which even at high water does not exceed 38,600 superficial feet, and this discharge takes place at a time when a large amount of the back tidal waters, extending 25 miles upwards, have already ebbed out, thus leaving the dilution of the sewage in a great measure dependent on the drainage area of 4,070 square miles due to the River Thames at that point, whereas at the proposed point of outfall the discharge of two-thirds of the entire sewerage of London would commence at the period of high water, discharging into a sectional area of 92,500 superficial feet, with the full run of 37 miles of back tidal waters, and a drainage area of 5,028 square miles due at that point of the river.

On the line of the main sewer means can be afforded for distributing sewage manure for agricultural purposes, and to the Plumstead and Erith Marshes, if required, as also to the Dartford Marshes, by laying pipes at the point of outfall under the bed of the river Darent.

Northern Drainage.

In regard to the northern areas of London, which are not included in the southern scheme, it was intended to have submitted similar detailed suggestions for their drainage, but as time has not permitted of doing so, it is proposed merely to give a general outline, that which is conceived could be worked out in detail.

The area in question comprises 35½ square miles, which may be divided into three portions.

The upper or high level district includes 7·11 square miles, which is accurately defined by the summit contours of the high lands surrounding, having the Hackney Brook as its natural drainage outfall.

The middle level area may be varied according to the manner of drainage proposed, and although a deep tunnel under the principal thoroughfares of London is feasible, yet it is conceived that if a tunnel sewer of moderate depth was carried along the northern portion of London, closely following the line of the Regent's Canal, little or no interference with the public traffic would take place, and the canal would be a valuable means for removing the excavations from the tunnels to a distance by barges, and in the transit of materials to the works during their execution. The invert of the tunnel also, it is considered, could be placed at such a level that by branch lines of surface sewers along its course, large areas to the south could be included, and the whole be carried to a junction with the high level sewers (which collectively would form a drainage area of 21·9 square miles), and being conveyed across the Lea Valley at a level that would not interfere with public works, by gravitation be discharged at a distance from the Metropolis.

The description of the suggested line of sewers for the middle level district, tinted red, would be as follows:—

A tunnel sewer, to commence at the level of the Ranelagh sewer, at the point where it passes under the Paddington canal, into which a surface branch sewer from Porchester-terrace would enter, and from thence pass along the St. John's Wood road, at some depth through the centre of Regent's Park, along Park and Hamilton-streets, passing on its course under the Paddington and Regent's Canals in three places, and under the River Fleet (the sewage of which it would divert), and thence along the north bank of the canal, to a point marked F on plan, between St. Pancras Lock and the Great Northern Railway, having the invert at about the level of 30 feet above Trinity. From this point a branch sewer would pass under the Regent's Canal, and traverse Brewer and Judd-streets, the line of the existing Guilford-street sewer, and along Oxford-street, terminating at the intersection of the Eastern Ranelagh sewer, at the level of about 38 feet above Trinity; also a short branch sewer into the same from Portland-crescent by the New-road.

From the point F the main sewer would follow the line of the Regent's Canal, and be tunnelled under Islington, and enter into open cutting from the City Basin Lock along Arlington-street, and across private grounds to and along the Downham-road, Albion-road, and through the centre of the London Fields, receiving at this point a branch from Old-street through Hackney-road and Margaret-place.

From the London Fields the main sewer would go directly north under the West India Dock Railway, over the Hackney Brook, and enter the rising ground at Pembury-road, to the south-east corner of Hackney Downs, arriving at a level of about 22 feet above Trinity.

By a branch sewer across the Hackney Downs the high level district would be intercepted, and the collective drainage conveyed in a short tunnel under the Orphan Asylum grounds, and crossing the Lea Valley by an embankment, with aqueduct openings, and over the Eastern Counties Railway, at the junction of the Loughton line, at the level of about 18 feet above Trinity, from thence it could be carried along rising ground towards Ilford, Barking, &c.

The low level district tinted blue * must necessarily have a deep sewer, and no alteration in the lines of sewers is suggested from those approved by the Metropolitan Board, but from the diversion of the western low level drainage to the south side, the sizes of the sewers will be of reduced capacity.

11, Great Queen-street, Westminster. *John Murray*, M. Inst. C.E.

Carlton Chambers, 8, Regent-street, 28 February 1857. *Robert Wm. Mylne*, F.G.S.

* Yellow, in Plate 6.

Appendix X.

Plans of Drainage.

Text of Plans.

Messrs. *Richardson* and *Clark.*

(14.)—Messrs. Richardson and Clark.

(i.) Text of Plan.

Gentlemen,

In submitting to your notice the inclosed description and plans of our system of "above-ground high level" drainage, we have, in the first place, to state that is not our object to propose any plan of works for the arterial and intercepting drainage of the metropolis.

Our attention has been directed to the disposal of the drainage matters after their delivery at the metropolitan outfall, on a plan calculated to prevent any pollution of the Thames, and render the sewage easily available, in a liquid or a solid state, for agricultural purposes.

As a mode of attaining these objects in the most efficient way, we offer for your consideration a plan for disposing of the metropolitan drainage by means of an aqueduct, or above-ground discharging main, from the metropolitan points of outfall to the sea.

Referring to the enclosed description of the plan referred to, we will not here enlarge upon its character and advantages, but at once proceed to state our views with reference to its application to the metropolitan drainage.

The plans for the arterial and intercepting drainage works of the metropolis, with the extension recommended by the Government engineer, as approved by the Metropolitan Board, and the Chief Commissioner of the Board of Works, have been so maturely considered, and are so dependent on natural causes; many of those plans have been so extensively executed, and the whole system so indispensably connects itself with stupendous works already constructed, that any modifications that might result from the investigation about to be instituted, under the authority of Government, would probably be limited to minor details; unless the necessity, which appears now to be admitted, of discharging the sewage at a great distance from London, should become a disturbing cause, interfering with the levels of existing sewers, and of others in progress, or to be constructed.

Any disturbing cause of that nature would create an enormous amount of wasteful expenditure, loss of time, and public inconvenience.

To obviate these evils is our aim, and we therefore propose so to adapt our system to the drainage plans of the Board, whatever they may be, when further improved and finally completed, that it shall be ancillary to those plans, and conducive to their better execution, by affording the means of taking up the drainage matters at the points of the metropolitan outfall, and discharging them at any distant points that may be fixed upon.

With that object in view, we conceive that the adoption of the proposal we have the honour to submit, would not only obviate any difficulty that might exist in carrying out the plans of the Board, but would afford remarkable facilities for rendering them more perfect, and their execution more easy.

Should this proposal be adopted in principle, the restoration and maintenance of the purity of the Thames water would cease to be a question for consideration. That point would be settled in the most satisfactory way, for no part of the London drainage would be discharged into the river.

In that case the original Plan of the Metropolitan Board, with the point of outfall at B, might be reverted to with much advantage. In reviewing that plan, as connected with the intention of discharging the sewage from the outfall reservoirs into the Thames, it was found that to comply with the Act of Parliament regulating the metropolitan drainage, it would be requisite to remove the points of outfall lower down the river to B*. But if the sewage should be carried away to the sea by an above-ground main, the objection which suggested the removal of the points of outfall from B, would cease altogether.

It would be premature at the present time to propose the precise mode of applying our system to the metropolitan drainage. Its chief merit is its applicability to any circumstances; and we are now mainly desirous to draw attention to the subject, that it may be understood and appreciated.

When called upon, we shall be ready to submit a comprehensive scheme for disposing of the drainage of the districts on both sides of the Thames, with plans and estimates of cost. In the meantime we are able to state that, for the construction and maintenance of the works on the above-ground plan, considering all the advantages connected with it, the expense will be less than for a subterraneous sewer, whilst the revenue to be derived from the distribution and sale of sewage manure will be much greater.

As an illustration of the mode in which our system may be applied to the metropolitan drainage, after a careful survey of the ground lying between Erith Marshes and the Medway, we are enabled to present a plan for taking up the sewage of the south side of the Thames, at the point of outfall B*, and discharging it into the sea at Yantlet Creek.

The projected line of discharging main would commence at the outfall at B*, at an elevation of 45 to 55 feet above the level of the reservoir. After crossing Erith Marshes, it would pass the town of Erith along the bank of the Thames, and from that point it would take a direct course to Greenhithe, passing over the River Davent at an elevation which would not obstruct the navigation. It would be carried in front of Greenhithe along the bank of the river. From thence it would take a direction parallel to, and on the north side of the North Kent Railway to Northfleet, passing inland behind that town, and under the high road, through a cutting, along which the sewer would be carried under the railway at a point near the Windmill, and pass round the town of Gravesend on the south side, still proceeding along a cutting, which would follow the direction of the high road passing near the cemetery and south of Windmill Hill. Emerging from this cutting, the aqueduct would reach the railway a little to the east of Milton, at a point where it would cross the railway and the canal at the required elevation. From this point the sewer would be carried over the marshes, as indicated on the plan, until it approached within half a mile of Dagnam,

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Dagnam, passing from thence through a short cutting to the outfall reservoir near Slough, from which the discharging branch would be carried to the shore on the west side of Yantlet Creek, and continued on a jetty to the outer edge of the sand, bringing the outlet of the sewer to deep water at 2 to 3 feet above Trinity high-water mark. The total length of the aqueduct would be about 23 miles. The fall would be continuous, averaging 2½ feet per mile; but for the first 5 miles from the head at B*, the incline would be 4 to 5 feet per mile. By this arrangement, when the body of liquid was much increased by rainfall, the upper part of the sewer being full, the stream, impelled by hydraulic pressure, would flow with great rapidity.

For a general notion of this line of above-ground discharging sewer, and of the manner of executing the work, we refer to the inclosed description, and to the annexed sheet of plans and drawings* exhibiting,

1st. The line laid down on an Ordnance Map.
2d. An elevation showing the arrangement at the pumping station at the head of the sewer.
3d. Plan and elevation of a section of the line at the outfall to the sea; and
4th. A view of the sewer above ground supported on columns.

We offer this project as a specimen of what may be done with the above-ground drainage plan, and for the purpose of rendering it more intelligible. But before leaving the subject we have to point out that, by removing the metropolitan outfall to a point near Deptford or Woolwich, nearly three miles of sewer might be saved, and a better natural fall obtained.

As to the north side of the Thames, by the application of our plan, a discharging main could be carried to the sea in a more direct line than would be possible with a brick sewer, and the distance would be shortened.

For our views on the question whether it be preferable to adopt two discharging mains, one for each side of the river, or one only for both sides, and for more ample details on the subject generally, we beg to refer to the statement, and to the plans and drawings which accompany this letter.

We have, &c.
(signed) *William Richardson.*
Geo. Clark.

5, Ranelagh-grove, Pimlico, London,
28 February 1857.

(ii.) Letter in reply to a request for Estimates.

Gentlemen, 5, Ranelagh Grove, Pimlico, London, 30 May 1857.

In compliance with your request, we have the honour to lay before you a statement relative to the expense of conveying the London sewage, from the north to the south side of the Thames, and a detailed account of the estimated expense of our above-ground main sewer.

In comparing the economy of our plan for conveying the London drainage under the river with that of other plans for effecting the same object, it is to be understood that the circumstances in the two cases are assumed to be similar, that is to say, the point at which the Thames is to be crossed being determined, the question is the construction of a main sewer under the bed of the river, the work to be of a solid and durable character, and adequate to the requirements of the case.

In this comparison we dismiss from consideration the operation of tunnelling through the ground under the river, as one which, if attempted, would be attended with so much difficulty, and so much uncertainty, both of expense and success, as to be in a practical as well as an economical point of view, entirely out of the question.

We consider that the only safe mode of constructing a main sewer under the Thames, is to carry on the work in an open cutting through its bed, by forming coffer-dams in small sections, removable successively as the work proceeds, and not occupying more than 30 to 40 yards across the stream, at any one time during the progress of the works, offering therefore no serious obstruction to the navigation.

That mode of working being adopted, our proposition would be to lay down a tube of cast-iron segments, bolted together on the system described in our statement of 28th February last, cased outside and lined inside, with a brick cylinder.

Commencing at either bank of the river, a coffer-dam would be made in which a section of the work would be executed, and so on by successive sections the sewer would be completed.

The annexed transverse section, Fig. 6, shows the details of construction of a sewer on our plan 14 feet internal diameter, which probably is a capacity sufficient to convey the northern drainage to the south side. (*a*) is a bed of concrete 2 feet under the outer brick cylinder; (*b*) is a foundation of beech planks also encircling the outer brick cylinder; (*c*) is the external brick cylinder; (*d*) is the cast-iron tube formed of segments bolted together; (*e*) is the asphalte lining to the iron tube; (*f*) is the inner cylinder of blue vitrified bricks; (*g*) is the inside of the sewer, 14 feet diameter; (*h*) represents a group of piles in four or five tiers, tied together, forming bearings to the sewer at determined distances.

The iron tube being laid inside the outer brick cylinder, and lined by the inner one, the flanges of some inside and some outside of the plates, will be built into the masonry of the outer and inner cylinders respectively, binding the iron with both. The upper half of the outer circle might, for greater security, be in granite dressed smooth, which affording no hold to ships' anchors, would more effectually protect the work from damage. This arrangement, and the solid nature of the combined structure, obviate the necessity of sinking the sewer much below the bed of the river. Five feet of clay puddle above the crown of the arch is allowed as a sufficient protection. Indeed, if the top of the sewer were bare, it could suffer no injury from anchors dragging over it.

The work, when completed, will form an unbroken continuity of cohesion, the whole length of the structure, the iron tube constituting an inflexible core to the outer cylinder, and a protective shell or shield to the inner cylinder which forms the sewer.

An important advantage obviously of this continuity of cohesive strength, is the equal bearing of the structure on the foundation, and the capability of considerable lengths being supported on bearings at their extremities. Thus any partial defect or sinking in the foundation, which might be

* *See* Maps, &c. to illustrate this Plan, Plate 7.

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be fatal to a sewer of masonry by causing fracture, for want of sufficient cohesive strength in the materials and parts, would not be a like cause of danger to the iron-cased and iron-bound tunnel, to which, moreover, additional security might be given by driving sets of piles into the foundation 50 to 60 feet apart, in the manner shown in the plan; these forming bearings on which such lengths might be supported, even without any intermediate foundation, would be a guarantee against damage from the settlement of the ground. We do not consider this precaution necessary, but it might be desirable to apply it in a case where the work being of so important a nature, and an accident might be attended with serious consequences, no source of security ought to be disregarded.

According to the estimates we have framed, we find the expense of a main sewer under the Thames on our system would be 360 *l.* per yard forward, of which 280 *l.* would be for the coffer dams, and 80 *l.* for the construction of the sewer and its foundation. The total expense of the work complete will depend upon the depth and width of the river at the point where the sewer is to be constructed.

Your inquiry having directed our attention more particularly to the question of conveying the sewage from the north to the south of the Thames, we have, in preparing an estimate, had to fix upon a supposed point of crossing in accordance with that view of the subject. This also brought us to consider the modifications the general plan of drainage might have to undergo in the event of the above-ground system being adopted, on the basis of the proposition of the whole of the metropolitan drainage being discharged into the sea by means of a main sewer on the south side.

To explain our view of the subject we annex an Ordnance map, on which the blue lines indicate the extensions and branches suggested to connect the drainage system of the north of London with the above-ground sewer from Erith to Yantlett Creek, proposed in our letter of the 28th February last.

The outlet of the extension of the high level sewer at Four Mills, West Ham Marsh, proposed by the engineer of the Metropolitan Board, appears to be the most eligible point of outfall for discharging the northern drainage into the above-ground connecting branch, which, as shown on the map, might be carried from that point to the Thames, and thence to the discharging main on the south side, in the direction of one or the other of the following lines:—

1. Between the river Lea and the Woolwich Railway, or crossing the latter to the upper part of Bugsby's Reach, a little below Bow Creek.

2. Across Plaistow level to Woolwich Reach, and thence to Woolwich or Charlton.

3. Across the Plaistow of East Ham levels to Galleon's Reach, and thence in a direct line over Plumstead and Erith Marshes to the south point of outfall of the Metropolitan Board at B*.

4. In a direction nearly due east over Barking Creek to Barking Reach, and thence to B* on the south side.

At or near to the lines of intersection shown on the map, the width of the river at Trinity high water level, and the depths at low water, 17′ 10″ below Trinity mark, are as follows, commencing from the Kent side:

BUGSBY'S REACH.

		′	″
150 feet		0	0
100 „		15	0
200 „		11	0
100 „		15	0
100 „		17	0
180 „		16	0
50 „		15	0
400 „		9	0
150 „		0	0
14,30 feet.			

GALLEON'S REACH.

		′	″
250 feet		0	0
100 „		7	6
100 „		16	6
100 „		23	0
100 „		21	0
200 „		18	0
210 „		23	0
100 „		18	0
500 „		9	0
150 „		0	0
1,810 feet.			

WOOLWICH REACH.

		′	″
150 feet		0	0
250 „		15	0
300 „		13	0
300 „		12	0
450 „		9	0
370 „		0	0
1,820 feet.			

BARKING REACH.

		′	″
280 feet		0	0
220 „		5	6
200 „		12	0
400 „		15	0
600 „		10	0
420 „		9	0
150 „		0	0
2,270 feet.			

For the construction of a sewer under the Thames, the nature of the soil of the bed of the river, and the soundings and currents, for which a special survey is required, might in some measure determine the choice of the precise spot; but we do not consider there would be any absolute obstruction to the execution of our plan at any point within the limits marked on the map. The question would be one of expense.

The same cannot be said of a brick sewer, for which the nature of the foundation and the depth to which the work could be carried, are more serious considerations.

So

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So far as we are able to judge from the general plan of the Metropolitan Board of Works, the second line intersecting the river a little above Charlton Pier, would be preferable to the others, the width of the stream and the depths in deep water being there the least; but for a connecting branch on the north side, the Victoria Docks interpose an obstruction, which can only be overcome by a syphon sewer under the docks, and the river exceeding a mile in length.

The first line, therefore, crossing the north-west end of Bugsby's Reach, is suggested as that where the sub-fluvial sewer may be constructed. To this point, the northern connecting branch might be brought from the outfall sewer at Four Mills, and extended to Greenwich Marsh, which would afford an excellent site for the central station of the above-ground drainage system, where the head of the main discharging sewer, the reservoirs and pumping engines would be established.

The length of the line intersecting the stream at Bugsby's Reach at high water is stated to be 1,430 feet, or 443 yards; but as that is an average width, and we are unable to fix the exact point which might be selected, we calculate the dam and tunnel work under the river as for a maximum length of 550 yards, which at our estimated price before stated of 360 *l.* per yard forward, will amount to - - - - - - - - - - - - - £. 198,000

We allow 100 yards on each side of the river, for the approaches to connect the tunnel with the above-ground sewer; and we estimate this expense at* - - - 20,000

TOTAL estimated Expense of the Sewer under the Thames - - £. 218,000

The use of granite for the upper half of the outer cylinder is not included in the Estimate.

The northern sewage delivered from the high level outfall sewer at Four Mills, at a level 9′ 6″ above Trinity high-water mark, might if the proposed sewer under the Thames were used as a syphon, be discharged into the reservoir at Greenwich Marsh at about high water level, without pumping.

If the syphon system should be adopted, and indeed under any circumstances, it might be advisable to construct two smaller tunnels (10 feet diameter), containing together the same area as the larger one (14 feet) already proposed. As a rule, the two sewers would be worked simultaneously, but occasionally, and at periods when one would be sufficient for the service, they might be alternately examined and cleansed. By this arrangement, the sound state of the structure could be at any time ascertained, and obstruction of the channels effectually guarded against. The construction of a double sewer on our system, would add comparatively little to the expense, and tend to give greater strength to the work. The same cannot be said on either of these points with regard to a brick sewer.

The total length moreover of the above-ground sewer, taking this direction, would be the shortest. From Four Mills to the central station in Greenwich Marsh, the distance would not exceed three miles, and the distance from the station following the course indicated on the map to Greenhithe and Yantlett Creek, would be 29 miles, making the total length 32 miles.

The estimated expense of an above-ground sewer of 12 feet diameter, is 85,000 *l.* per mile, at which rate, 32 miles would amount to - - - - - - - - - £. 2,720,000
to which, adding the estimated expense of the sub-fluvial sewer already stated at - 218,000

The total expense would be - - - - - - - - - - - £. 2,938,000

In these estimates, reservoirs, engines and station buildings are not included.

Until the advantages of the above-ground system for the purposes of irrigation with liquid manure, and drainage of marsh land developed themselves, the terminus of the line might be fixed a few miles below Gravesend, with an outfall into Long Hope. By this arrangement, about ten miles of sewer would be saved, and the total expense reduced below 2,000,000 *l.*

No doubt adopting the same line in an opposite direction for a sewer under the Thames at Bugsby's Reach, the sewage of the south might be conveyed to the north side, where a convenient site for the central station may be found in Plaistow level, from which point the metropolitan drainage might be discharged into the sea by an above-ground main sewer. But the length of the line would be increased 10 or 12 miles, and the country to be traversed would not offer the same facilities as the south line for the execution of the works; whilst on the other hand the drainage of Gravesend and other places south of the river, would not be diverted from the Thames.

It only remains for us to institute a comparison between the expense of an iron and a brick tunnel under the Thames. In order to do this with precision, we have divided our estimate of the former into two parts, the coffer dam and the tunnel works; the one being 280 *l.*, the other 80 *l.* per yard forward. With reference to the first price, provision is made in the estimate for constructing coffer-dams of great strength, 50 feet long and 33 feet wide inside. The external diameter of the sewer regulates the width of the dam, and the number and length of the piles; as well as the dimensions of the strutts, waling, ties and bolts, and all the arrangements necessary to give strength to this important part of the preparatory works, on the proper construction of which the solidity and durability of the sewer to be built within the dam mainly depends.

The external diameter of our 14 feet iron sewer, including a bed of concrete, is 22 feet. That of a 14 feet brick sewer allowing for sufficient strength, with a bed of concrete, cannot be less than 28 feet to 30 feet. The number and length of the piles therefore, and all the timber and iron work, and the labour and expenses of constructing the dam, must be increased in the ratio of its increased dimensions.

The total amount of this increase in the expense of the coffer dams, we consider will not be less than one-third the estimate for our work.

With reference to the sewer, without entering into the details of an estimate of a brick sewer, when we take into account the quantity of earth-work, which will be nearly double, the great increase of strength required for the foundation, and the large amount and superior quality of the brick-work

* Adopting the pile foundation, this sum would be increased about 10,000 *l.*

brick-work required to ensure the solidity of the structure, we have no hesitation in expressing our opinion, that the expense will be one-half more than that of an iron tunnel on our plan.

We have previously referred to the probability and fatal results of accidents in a ponderous structure of this kind under the bed of a river.

The necessity of building it in short sections, adds to the danger by increasing the liability of unequal settlement of the foundation, an inconvenience from which the iron tube is protected by the peculiar rigidity and cohesive strength of its structure.

There is no doubt that a brick tunnel might be made under the Thames, combining the requisite conditions of strength and durability. But to obtain perfect security, it would be necessary to adopt extraordinary precautions in the foundation, and descend a great depth below the bed of the river, which precisely would be causes of an immense increase of expense.

In compliance with your request, we enclose a detailed account of the estimated expense of an above-ground main sewer.

I have, &c.
(signed) *William Richardson.*
George Clark.

(iii.) LETTER suggesting the Erection of a piece of Sewer, on their plan, by way of Experiment.

Gentlemen, 5, Ranelagh-grove, Pimlico, London, 6 June 1857.

THE novelty of the plan of an above-ground iron sewer on our system might raise a doubt whether it will, in practice, realise all the required conditions.

The undertaking to which the plan is proposed to be applied is of such vast importance, that, before it could be adopted, we are sensible that its efficiency in every respect—the strength and stability of its structure, the expense and facility of its construction, and its imperviousness to frost, require to be tested by experience.

We beg, therefore, to suggest for consideration, that a given length of sewer on our plan, say 120 feet, might be erected as a specimen of the work.

This might be done in the present season, so that the effect of frost might be ascertained during the ensuing winter.

In the event of this suggestion being approved, we would beg to be allowed to lay before you working drawings of the proposed specimen of an above-ground sewer.

We have, &c.
(signed) *Wm. Richardson,*
Geo. Clark.

(iv.) LETTER on the subject of Drainage generally.

Gentlemen, 5, Ranelagh-grove, Pimlico, London, 4 July 1857.

IN the communications we have had the honour of addressing to you, we gave a plan and estimate of our above-ground main sewer, calculated to convey the whole of the London drainage to the sea.

The estimated expense, including a tunnel under the Thames, was about 3,000,000 *l.*, with an outfall at Yantlett Creek, and about 2,000,000 *l.* with an outfall three miles below Gravesend, the discharge level in both cases to be 2 feet above Trinity high-water mark.

These estimates refer to the hypothesis of one line of sewer being adopted for the drainage of both sides of the river; but we stated that "the above-ground system, in its full development, would comprise a main on each side of the river," and we expressed our opinion that "the owners and occupiers of land on either side of the Thames, would not allow the manuring wealth of one side to be diverted from its natural channels to fertilise the lands on the other side."

Having since directed our attention particularly to the applicatton of liquid sewage to agricultural purposes, impressed with the conviction that that mode of disposing of the London sewage is a question of far greater importance for national and private interests than the cheapest mode of discharging it into the sea, we beg to offer the following considerations to your notice.

The dimensions of a sewer calculated to carry off the metropolitan drainage of both sides of the Thames, must be in proportion to the quantity of sewage to be discharged. From data supplied by various reports, we assumed that, on our system, a circular tube of 12 feet diameter afforded the required area; and we framed our estimate of the expense, amounting to 85,000 *l.* per mile, on the basis of that diameter.

But if separate above-ground sewers be constructed for the two metropolitan districts, north and south of the Thames, and provision be made for the overflow of the occasional excess of storm waters, from a collecting reservoir into the river (which offers no difficulty), the area required for these sewers would be considerably less.

The diameter, considering the continuous and rapid flow with a sufficient incline, obtainable by the above-ground plan, might be, instead of 12 feet, only 8 feet, or even less, and the expense reduced about one-third. The whole expense of a tunnel under the Thames, and of the north and south connecting branch, would be saved.

Taking these reductions into account, the expense of an above-ground sewer on the north side, from West Ham Marsh to Sea Reach, being a distance of 20 miles, may be estimated at - - - - - - - - - - - - - - - - - - £. 1,200,000,
and on the south side, from Greenwich Marsh to a point three miles below Gravesend, being a distance of 22 miles, at - - - - - - - - - - - 1,300,000,

Together - - - £. 2,500,000.

Thus, with an expenditure of two millions and a half, which might be taken as a maximum estimate, north and south London would be provided each with a perfect system of drainage, with outfalls

outfalls below Gravesend, at a level above high-water mark; and every facility would be afforded for using the sewage to enrich the lands on both sides the river.

The London drainage question would be disposed of in a way to satisfy all parties interested; and the advantages to be derived from applying the sewage of towns to agricultural districts would be fairly tested. If the results corresponded to the success already obtained in some parts of England and Scotland, and in other countries, of which there can be no reasonable doubt, such would be the increase of the value of the lands in Essex and Kent, irrigated with liquid sewage, that the lines of sewer on each side of the Thames, respectively, would be soon extended to the German Ocean and Yantlett Creek, at the expense of the districts over which those extensions would pass, for the landowners and occupiers would be only too glad to contribute their quota of the capital required.

Under the arrangement now suggested, there would be some advantages in establishing the heads of the above-ground discharging sewers at points B* of the Metropolitan Board of Works, (at Rainham Creek and Erith Marsh). The overflow of storm waters into the Thames, at these points, would be free from objection, as the portion of sewage they might contain during a few hours of rainfall would be so diluted as to afford no reasonable ground of complaint to the inhabitants of the districts up or down the river.

An efficient and self-acting plan for carrying the excess of rainfall being adopted, the capacity of the above-ground sewers for the discharge of sewage waters, properly so called, might be reduced, probably, to 6 feet diameter, with a corresponding reduction of the expense. Supposing the points of outfall, as above suggested, to be at or near to Sea Reach, the united length of the two above-ground discharging sewers, north and south, commencing at points B*, would be about 26 miles, and the total expense would not exceed 1,300,000 *l.*

In a remunerative point of view, moreover, this arrangement is worthy of attention. The expense of these sewers would be under 50,000 *l.* per mile, and the revenue from the sale of liquid manure may be estimated at from 4,000 *l.* to 5,000 *l.* per mile, leaving a margin, after allowing working expenses and repairs, for a fair return on the capital expended.

We have, &c.
(signed) *Wm. Richardson.*
Geo. Clark.

To Captain Douglas Galton, R.E.,
James Simpson, Esq., C.E.,
Thomas E. Blackwell, Esq., C.E,
&c. &c. &c.

(15.)—MR. J. W. ROGERS.*†

Gentlemen, 5, King William-street, Charing Cross, London, 28 February 1857.

Mr. *J. W. Rogers.*

IN presenting my propositions for remedying the existing evils of the sewerage system, I feel it unnecessary to enlarge, *to you*, upon the following facts:

1. That the sewers of London are more or less filled with excretory matter, and, to use the words of the Registrar-general, "that the long retention of some hundreds of thousands of tons of excrement in the sewers and under the houses, produces those physical impurities of the atmosphere which greatly exaggerate the ravages of disease."

2. That such matter deposits itself in all sewers which it reaches, gradually but certainly leaving a portion of itself wherever it touches.

3. That from the moment of deposit in the sewers decomposition commences, and that the gases yielded to the atmosphere are, in fact, poisonous to mankind; whilst, if not evolved, they would be of the highest nutritive value to vegetation.

Lastly, That there is no known mode by which excretory matter can be discharged through a sewer by the action of water only, and that the greater the length of the sewer, the greater must be the certainty of deposit.

Believing such facts to be incontrovertible, I beg leave to submit to your consideration my propositions for their remedy.

Taking into view the large amount of money expended upon the sewers of London, with the hope, no doubt, of carrying off the excretory matter, which I conceive should never have been permitted to enter them; and which, in fact, the general law of the land forbids, although repealed in London; and being aware that the prejudice in favour of water-closets is perhaps ungovernable, and that the many "vested interests" in the system are wide-spreading and powerful, I feel that we must bow to prejudice and self-interest, and adopt the water-closet system; although I believe it to be perfectly unjustifiable, *if the matter be discharged into a public sewer or water-course*; and that, by so doing, I, the inhabitant of a house in London, or the director of an hospital, (where infection exists in almost all ejecta,) send it, with the seeds of disease which it in every instance holds, to be disseminated midst millions, and to produce deaths, whilst its originators escape from the consequences.

To obviate that special evil, I propose the arrangements pointed out in the Sketches annexed,‡ or those presented to the late Metropolitan Commissioners, which are herewith submitted, and to which I beg your obliging attention; the principle of all being the same, namely, *the total exclusion of excretory matter from the general sewers.*

The first sketch shows a pipe or metal main varying from nine inches diameter to two feet, or greater, if found necessary, according to the locality and lengths, to be laid through the existing sewers, about one third from the bottom, supported on bearers attached to the sides, and not interfering with the flow of the surface or culinary water from houses.

Into this pipe I would discharge all matter from water-closets, *but nothing else;* connecting the water-closet pipe directly with the metal main in the sewer; each to be joined in the same manner as water-pipes adapted for *high service.* Nothing should pass into these pipes but that which is now usually discharged into water-closets, namely, *night soil and chamber refuse,* together with the usual closet-water. And I need scarcely name to you that the quantities of liquid, as compared with solids, must, in such event, be at least ten-fold; in many instances much more: consequently, stoppage in the pipes would be very unlikely; first, because of the greater quantity of water; next, because of the very slight tendency to decomposition of the matter, from the absence of atmospheric action.

If But, if stoppage were to occur, it would be capable of remedy in *two ways.* First, the seat of the evil

* Mr. Rogers' paper has, by mistake, been printed in smaller type than those of other gentlemen.
† *See* Minutes of Mr. Rogers' Evidence, page 461.
‡ *See* Plate 8.

evil could be at once discovered by the sound given from the pipe when struck by a hammer, and that part might be immediately unconnected and cleansed, the joints being simple flanges, bolted together. And the inconvenience of such an operation would, in fact, be *nothing* as compared with the removal of stoppages in the sewers at present, when the sewer has to be broken into, and the foulest matter bucketed up into the open streets, and carried off in carts. My second, or indeed I should say my first, for I believe it to be the best arrangement, is that which the second Sketch points out.

It will be seen that the "excretory matter pipe" discharges itself into the "filtering chamber," which I propose to be placed at the mouth of each of the general sewers, or at such intervals of position *inland*, as might be found convenient, where the levels prove adverse; and for which latter purpose, I submit the arrangement of *the underground chamber*, shown in the Diagram marked (A.), separate from this paper, and which is the original plan placed before the Metropolitan Commissioners in 1849.

The solid matter passing into the Filtering Chamber No. 2, naturally falls, and deposits itself at the bottom, which declines towards the centre. The water rises as the chamber fills, and passes away horizontally through a bed of peat charcoal, which perfectly absorbs all impurities, leaving the solid matter beneath, which is lifted by the "Archimedean screw," and discharged into the "intermixing machine," where it is, at once, converted into a manure, such as the sample presented herewith.

This operation would be continuous, the screw being driven by the engine shown in the Sketch. The matter passing up is discharged at the mouth in a semi-solid state, and at once divested of odour by the process of intermixture with the peat charcoal in the intermixing machines. But it may be discharged into covered barges or carts direct from the screw, and *without the application of peat charcoal* or intermixture; a ready market will be had for it amongst the many manure manufacturers of London, whilst it will be found that, inasmuch as the solids have not been exposed to the atmospheric action, as in a sewer, decomposition will have but slightly taken place; and therefore, that there will be but slight odour, and all the original elements of nutrition for plants will be preserved.

Assuming now that stoppage has taken place in any of the pipes connected with the filtering chamber, it may be removed effectually and at once by the following operation: The stop-valve of the pipe entering the chamber is closed; the exit valves, also, and the manholes; and the whole matter within is pumped out by the engine. Next, the air-pump, shown, is put to work; and as soon as a perfect vacuum is produced in the chamber, the stop or entrance valve is opened, and instantly whatever matter is in the pipes *must rush into the vacuum in the chamber;* which it would be desirable to regulate in size proportioned to the area of the pipes discharging into it; but, even if not so, a repetition of the operation would draw the matter, first, from the nearest, and next, from the farthest points, to the chamber.

Stoppages therefore could not take place; and by such means, I believe the excretory matter from the whole of London might be continuously drawn off, without at any time giving out its poisons as at present.

It is scarcely necessary to add, that the vacuum chambers should be capable of resisting the atmospheric pressure, when the vacuum is produced. Their construction is very simple, being of cast-iron plates flanged together, and in compartments of about 6 feet square.

Such is the principal plan which my judgment urges me to place before you; at the same time I would beg your consideration of the second and third propositions, shown by the Diagrams Nos. 1, 2, and 3, which are also the original drawings submitted by me to the Metropolitan Commissioners of Sewers in 1849; and fully described in the paper laid before that body, and subsequently published in a pamphlet from which I extract the following:—

Diagram No. 1, shows a tank to be placed under the flag-way, or in any convenient position, *between* the house and the main sewer, into which the soil-pipe of each house can be made to discharge. Its position can be varied according to circumstances, and it will be seen that the size, 2 feet 6 inches square, will enable it to be placed, without any difficulty, so as to intercept the excretory matter in its passage to the main drain. It will also be seen by the Diagrams, which show the tanks in structure, position, section, &c., that although the water from the closets will be driven into the tanks, the excretory matter alone will be retained. By this arrangement the overplus water will filter away almost in a pure state, through the charcoal deposited at the bottom of the tank, leaving almost all its nutritive properties behind. Thus *water only* will reach the main sewers, whilst that which now fills them with poisoned vapour will be not only retained in the tank and rendered harmless, but will produce a most profitable manure.

If the tank be sunk under the pathway, a receptacle for it can be very simply constructed of brickwork or metal; and a trap-door, of three feet square, composed of a frame of iron filled with asphalte, will prevent the objection to a metal surface in a footway. The removal of the tank can be accomplished without any communication with the house.

It may be objected that in several instances the position of the soil-pipe, &c., would present obstacles to this exact operation; but no engineer will doubt that such modifications can be suggested as will meet all variety of position. The *principle* is the question for consideration, namely, *that of intercepting all excretiæ before it reaches the public sewer.*

I propose that these tanks shall be removed, say, *once a quarter*, as I believe the capacity will be sufficient to retain the average solid discharge from each house for that period; but if at two months, or even one month apart, the question is of minor consequence. I have little doubt it will be found that four or five times a year will be sufficient for each removal; when another tank should be substituted, partly filled with charcoal.

The Diagram No. 3, shows the description of waggon proposed for removing the tanks. By means of the crane attached they can be lifted from any depth, and deposited in the waggon. Each journey will remove and deposit three tanks; and as the average weight may be taken at one ton each, it will be seen that the charge for carriage in the estimates submitted is, in fact, much over the reality.

When thus removed they should be conveyed to a district station, where the final intermixture with the remaining quantity of charcoal will take place. The contents should be immediately thrown into an *intermixing mill*. As quickly as intermixed, the mass will run from the mill in an apparently dry state, and may be transmitted throughout the country in bags by any conveyance. The mill can be worked by hand or other power, and its effectiveness has been fully proved.

An objection may possibly be raised as to the arrangement for a separate tank to each house, on the score of cost and frequency of removal; but analysis of facts will show this is no real difficulty. Say each tank be removed five times per year, the total number for 200,000 houses will be 1,000,000 removals. Assume the working days to be 300, and that each waggon make only four journeys per day (much under what may be done), there will be required to accomplish the whole work—

Waggons	278
Horses	556
Men	556

It will be seen therefore that the daily operation is comparatively trifling, and in London can be accomplished by contract at much less cost than I have estimated; perhaps without the purchase of a single additional horse, as it is well known that the horses of the general carriers now rest many hours of the day unemployed. It is to be borne in mind that the operation will produce no inconvenience whatever to the inhabitants of the houses; no odour can be given out, nor, in fact, exist—the quantum of charcoal in the tank being sufficient to prevent this, even were the vessel open; but it would be of course removed without the cover being unclosed. The moment the contents be thrown into the intermixing mill, with the required quantity of charcoal, all odour must be destroyed.

But if the number of tanks be objectionable, they can be made to receive the matter from two or several houses. The *principle of intercepting from the main sewer, and at once killing those gases, which kill us*, being what I respectfully but strenuously urge. Many modifications, however, of my proposition may be found advantageous. The matter from the houses of one or several streets may be driven into *a stationary tank*, constructed on the same principle as the portable ones which I propose—the water being allowed to filter away through the charcoal, the tank retaining the excretiæ. This can be very simply accomplished in many localities by close pipes being used to convey the matter to a vaulted chamber under the street, and below the level of the house drains.

Finally,

Finally, I would ask attention to the Diagram marked (B.), which is also an original, submitted to the present Metropolitan Board, and which is briefly described in the following extract from lectures delivered by me at the Royal Dublin Society; copies of which I had the honour to present to you some time since:—

The lecturer now drew the attention of the meeting to an admirably executed diagram of his special plan for the sewerage and sanitary arrangement of all towns. He said, "This section shows what I term a dry tunnel, which I propose to run through the centre of every street; the side walls being made water-tight to the height which tide water may rise. It is about six feet high and four feet wide, built partly of dry rubble stone, arched with brick; and beneath is formed a brick sewer, half a circle, about two feet in diameter, covered with flags, two inches apart. This sewer is to carry off the surface-water from the streets, and also that which will filter through the dry masonry of the walls, and thus effectually drain not only the street thoroughfares, but the foundations of the houses (hear, hear)—especially as a small dry rubble stone shaft, of about two feet square, will run laterally from the main dry tunnel to each house, through which to carry the connecting pipes. The result, so far, must be the thorough drainage of the whole surrounding soil. (Loud applause.)

Through this main tunnel I would run all the water and gas mains, electric wires, &c., charging the Companies for their use. I doubt not it would be found that a considerable revenue would arise to Corporations from that source, whilst a saving would accrue to Companies from the easy access obtained both for laying and repairing; and inasmuch as the surface of the streets would not ever have to be disturbed, the thoroughfares would by degrees be rolled into almost solid masses; and repairs would, as I really believe, diminish at least one-half. (Hear, hear, and applause.)

In addition to the water and gas mains, I would also run through this tunnel a metal main to receive all matter and water from each house. (Hear, hear.) This main I would discharge at any convenient point into a peat charcoal filter, such as I have already described; which filter would retain the foul matter, and permit the water to pass away pure, and it might then discharge into the surface-water drain at the bottom of the dry tunnel. But in addition, I would so construct the filtering-chamber, that periodically, after its being emptied of the matter collected, which can be simply done, as may be seen by the plans, I would exhaust that chamber by means of an air-pump; first having closed the valve of the house main-pipe discharging into it, and, on producing a vacuum in the chamber, I would open the valve, and the result, of necessity, would be that the whole contents of the pipes, resting anywhere, solids as well as gases, if at all existing, would rush into the filtering-chamber, and by this means noxious gases, from the emanations of the refuse of cities, would no longer exist. (Hear, hear, and loud applause.)

Permit me to add, that I had hoped to be able to present, with this, a publication now in the press, entitled "*Facts and Fallacies of the Sewerage System of London,*" recently prepared by me, and detailing facts, which, I believe, will be of interest in the question; the first three copies of which, I shall have the honour of transmitting; I shall then trespass further by seeking the favour of a personal communication, with the hope of rendering personal explanation of points on which I may, perhaps, not be understood; and should you think proper to grant it, I will feel much obliged.

In conclusion, I beg to point out that the merits or demerits of my propositions could be readily tested; a single street leading to the Thames, or a small district might be acted upon, and the question set at rest, for a comparatively trifling outlay; whilst the proposed "intercepting sewer" would cost *several millions;* and, as I believe, would, when too late, be discovered to be ineffective.

I have, &c.
(signed) *Jasper W. Rogers.*

To Captain Douglas Galton, R.E.,
James Simpson, Esq. C.E.,
Thomas E. Blackwell, Esq., C.E.
&c. &c. &c.
29, Great George-street, Westminster.

(16.)—Mr. C. A. Smith.*

Mr. *C. A. Smith.*

Gentlemen, Crooms Hill, Greenwich, 28 February 1857.

Entertaining a very strong impression of the impracticability of the several schemes for the removal of the London sewage, which involve deep tunnels at some little distance from the river, for the conveyance of the sewage matter to some distant point of outfall into the Thames, I venture to suggest that London should arrange for the removal and disposal of its refuse nearer home, and upon a system less experimental, and less exposed to the alarming contingencies connected with miles of excavation through unknown strata, intercepting springs, draining streams and wells, open to vicissitudes of storm floods, and other objectionable interferences which the proposed subterranean rivers may give rise to. I would suggest that the present system of sewers should remain untouched, that as much of the surface drainage as possible should flow direct into the Thames. That the present sewer outfalls should terminate in very capacious tunnels, one on each side of the river, constructed in the bed of the river, by way of embankment, between Battersea Bridge and Limehouse, and capable of extension both ways, according to the increased exigencies of the population. That at certain intervals there shall be works established on the banks of the river, provided with proper stink-shafts of considerable height, with furnaces at the top of each to draw up and consume the offensive gases and products, and with proper machinery and appliances for deodorising and disinfecting the sewage matters. That the solid results should be, from time to time, removed in barges from these depôts for the purpose of manure; or at all events to raise the level of the marsh lands bordering on the Thames, and the innocuous fluids thence arising might be allowed to pass into the Thames, thus keeping up the mass of water, and providing, by proper safety-valves, for the overflow, if an excess be occasioned by storms or other contingencies.

The expense of such embankment would be great, but there would be something gained in return by the addition to the banks, the beauty of the river, and the avoidance of expense in the otherwise necessary alteration of the inland sewers.

Not being an engineer, I do not profess to give any details, but the above appears to me to be a more desirable mode of disposing of this difficult question than any that I have yet seen suggested.

I am, &c.
(signed) *Chas. Aug. Smith.*

The Government Referees
on Metropolitan Drainage.

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* *See* Letter from, and Minutes of Evidence given by Mr. Smith, &c., Appendix IX., page 319.

Appendix X.

Plans of Drainage.

Text of Plans.

Messrs. *Thornton* and *Jackson.*

(17).—Messrs. Thornton & Jackson.*

Gentlemen, 25, Queen's-road, Regent's Park, 26 February 1857.

We have been much gratified at receiving from you an official notice to submit for consideration those plans and designs for the main drainage of London, which, in June last, we had the honour to present to the Metropolitan Board of Works.

We now beg with much deference to lay these plans and designs before you, having the satisfactory feeling that the same will receive from you an impartial examination, and that a scientific and practical judgment will be pronounced upon them.

During the last two years much of our time and attention have been bestowed upon the subject of the main drainage of the Metropolis and the purification of the Thames; first, in deciding on the simplest and most comprehensive method of effecting the two above-named objects; and second, in collecting data on which to base our calculations, in forming the necessary plans and designs, and in estimating the cost of forming the same into execution.

The effectual Main Drainage of London is a subject demanding the deepest reflection, and the scientific or practical man, before he can come to any satisfactory conclusion, must first inquire whether it is more advisable to accept the existing system of sewers, and confine his attention solely to the construction of a main arterial sewer to intercept the whole of the sewage now flowing from them into the Thames, and thus prevent the further pollution of the stream, or whether, along with the formation of this main sewer, some modifications should not be made in the arrangements of the existing system.

There can be no doubt that if the sewers of London had to be reconstructed on some common principle, instead of being what they are, the piece-meal growth of many years, vast improvements might be introduced, so as to render them in every way more suitable for their intended purpose. But as such re-organisation is hardly within the reach of probability, it appears the more practical way to assume that the sewage will continue to flow through its present channels.

The existing system may, as we have already observed, have grown up in a disjointed and piece-meal way, and yet it may well excite wonder and admiration, when we reflect that by means of it some 60,000,000 gallons, or 270,000 tons of sewage are, according to our estimate, daily carried through the various sewers into the Thames.

It were out of place to consider at any length in the present report what effect has been produced upon the health of London by the discharge into the river of such an enormous mass of offensive matter; it is enough that public opinion and feeling, based on the results of many scientific and sanitary inquiries, have arrived at the conclusion, now confirmed by the voice of the Legislature, that such pollution of the Thames shall no longer continue.

It is true that, in comparison with other capitals of Europe, and even with the large cities of our own island, London enjoys a very favourable degree of public health, as the Registrar-general's Report for 1856 shows the average mortality to be only 22 per 1,000; but to whatever causes this may be owing, it is certainly not due to any improvement that has taken place in the disposal of the sewage, for that still continues to poison the river, and to fester on its banks. We may, however, reasonably conclude, that when once the Thames has been effectually purified, and the sewage conveyed to some point beyond the metropolitan limits, the public health of London will assume a still more favourable character, and its present comparatively low rate of mortality be yet further reduced.

It is certainly in the hope of such a result that the voice of public opinion has been so loudly expressed in favour of some thorough and effectual system of drainage, amply sufficient, not only for the present time, but also for the probable future requirements of a largely increasing population.

With these prefatory remarks, we now beg to submit for your consideration the means by which we are of opinion that the above results can be the most readily attained.

In order to make our explanation as clear as possible, it may perhaps be well here to state, that in the following report the main drainage of the north and south sides of the Metropolis is treated as two distinct works, consisting of one deep main sewer on each side of the Thames,† as far as point C (Drawings Nos. 1 & 2), in Plumstead Marshes, where it is proposed that the two sewers should unite.

From this point to Erith Reach, the nearest spot permitted by the First Commissioner of Her Majesty's Works for the discharge of the sewage, our design for the main drainage will be considered as one work, in which will be included the collective steam power for pumping the sewage, the reservoirs for containing it during high water, the requisite arrangements and appliances for its deodorisation, should that process be considered necessary, and lastly, the means for its discharge in either a purified or natural condition.

Having explained our plans and designs for the conveyance of the sewage to the point required by the First Commissioner of Her Majesty's Works, we shall next proceed to discuss the propriety of continuing the deep main under the Thames at point B (Drawings Nos. 1 and 2) to the Essex side, and passing the sewage along a main drain extending to point F (Drawings Nos. 1 and 2) at Sea Reach.

We further propose to consider the state of those rivers and streams, such, for example, as the Lea and others, which are at present made the recipients of sewage, and to describe the mode by which it is contemplated to divert the same, and to purify these streams in the same manner as the Thames.

We

* *See* Minutes of Messrs. Thornton & Jackson's Evidence, page 466.
† *See* Map to illustrate Messrs. Thornton & Jackson's Plan, Plate 9.

Appendix X.

Plans of Drainage.

Text of Plans.

Messrs. *Thornton* and *Jackson.*

We beg also to append a few suggestions for the purification of the last-named river beyond the metropolitan area, and for the sanitary improvement of the towns and villages on the banks of the Thames, or its tributaries beyond London.

Lastly, we shall submit for your consideration an estimate of the cost of the whole works, and a schedule of the prices at which we are willing to execute the same.

Main Drainage of the North Side of the Thames.

Taking the north side of the Thames first, we beg to call your attention to the red line traced along the north bank of the river (*see* Drawing No. 1), which represents the course of a proposed deep main or tunnel sewer, commencing at point A at Kensingon Canal, and terminating at point B in Erith Reach. Between these two points it passes Chelsea Hospital, under the approaches of Vauxhall Bridge, the Penitentiary, the Houses of Parliament, the approaches to Waterloo Bridge, Somerset House, Blackfriars, Southwark and London Bridges, the Tower, the London, and the West and East India Docks, Bow Creek, to the north of the Victoria Docks, thence under the Thames at G at Gallion's Reach, and from thence to C in Plumstead Marshes. Here it will be joined by the deep main from the south side of the river (*see* Drawing No. 2, figure 7), at which point, to facilitate the union of the deep mains, and serve also as an entrance thereto, for any purposes required, a shaft will be carried up to the surface, and from this point to the reservoirs at Erith Reach, the main sewer will be enlarged, so as to be equal to the united areas of the two deep mains on each side of the river.

In the first instance, with the view of saving the expense of about three miles of tunnelling, we had proposed to pass the deep main under the Thames from H at Limehouse, to I at the iron tramway near Woolwich, (as shown by the dotted line between these two points), and there to unite it with the south main as far as B at Erith Reach. But on reflection, it became apparent that though this saving might be desirable at the present moment, we should not in such case, be making any provision for the increase of the streets and population, which is certain to take place in a few years, in consequence of the opening of the New Victoria Docks, and of the unceasing extension of London generally. We have therefore decided to carry our proposed deep main sewer to the north of the Victoria Docks, as shown upon the plan, and to pass it under the Thames at G, as described.

It is proposed that the depth of the deep main at A at Kensington Canal, shall be 40 feet beneath Trinity high-water mark, (Section Drawing No. 2, figure 1), or about 43 feet beneath the surface, and that it shall fall with one regular gradient to point B at Erith Reach, where the depth will be 70 feet. The deep main will thus have an uniform fall of 30 feet in its whole length of about 17 miles, or 20·11 inches per mile; consequently when the deep main is filled with sewage to the crown of the arch at C in Plumstead Marsh, the bottom of the first portion from A to Blackfriars Bridge, will be bare as question of level, and as shown by the dotted blue line (*see* Longitudinal Section Drawing No. 2).

The depths of the main sewer may be something more or less than those given, according to the more accurate information that may be hereafter obtained as to the depths of the foundations of the various buildings under which the main passes, and as the depth of the Thames at G. and B. may determine. Our object is so to construct the main sewer that it may pass freely, and without any damage, real or supposed, under all houses, streets, public buildings, warehouses, quays, shipping basins; the various docks with the passages to them, beneath Bow Creek; and finally, under the Thames at G, and thence to B in Erith Reach.

Should any difficulty arise in passing under the river at G, where the width is about 2,000 feet, it is proposed to resort to the use of coffer dams (*see* Drawing No. 2, figure No. 4.) These will be inserted in a series of successive short lengths, in order not to interrupt the free navigation of the river. As soon as one of the lengths is completed, the water will be pumped out, and the excavation open out in short lengths, to keep defended the foot of the piles, down to the necessary depth, the brick work of the tunnelling inserted, and the earth work carefully replaced and punned over the tunnel, flush with the original bed of the river. This length of coffer dam will then be removed, and a new one proceeded with, until the entire distance across the river is accomplished, when the deep main will be carried on in the usual way to B at Erith Reach.

We may here briefly explain the objects we have had in view in making the deep main follow the course of the river. First by carrying the deep main sewer along the immediate margin of the Thames, and by bringing up shafts from it to the sewers at present in use, provision is made for the effectual exclusion of the contents of any existing and all future sewers or open drains from the river between Kensington Canal and Gallion's Reach, a distance of about 13 miles measured along the red line on drawing No. 1. Second—by constructing the deep main at the depth from the surface already named, we avoid the disturbance of any thoroughfare throughout its entire length, and we cause no nuisance to detailed business, and no interference with general traffic in any of the streets. It is intended in the construction of the proposed tunnel sewer, that all the materials shall be brought by the river, and that all the earth and other matter mined from it, shall be conveyed by barges to any place between A and B at Erith Reach, where such matter may be found serviceable, or to form the quays behind the river walls of the Thames embankment, if that important work be carried into effect at the same time as the main sewer.

By this means we shall save the carriage of a necessarily enormous quantity of bricks, earth, lime, sand, timber, &c., through the already too crowded thoroughfares, and prevent all danger of damage to the foundations of houses and entire streets, by avoiding the sinking of those deep shored up excavations which must be resorted to, if ordinary arterial sewers are to be constructed. Third—the construction of the deep tunnel sewer will place all the low and swampy districts to the north of the Thames, on a comparative hill, 40 to 60 feet above their drainage level, and it will therefore thoroughly drain all the low lying parts of Chelsea, Brompton, Belgravia, &c., and the future populated district of Plaistow Marshes and that tract of country.

 Hitherto,

Hitherto, all the sewers in these localities have been flushed more or less full by every tide, and their fœtid contents thus backed up, have been in consequence, the fruitful sources of fever and disease.

The proposed deep main will effectually put a stop to all such tidal gorging and overflowing in any and every sewer in the above districts, whilst it will make the latter as dry and as wholesome as the higher parts of London, and thus render the property thereon more valuable.

We are aware that it has been recommended to divide London, north of the Thames, into three distinct areas, and to construct as many main sewers to carry off the drainage from each, the areas being named respectively the north high level, the middle level, and the low level area.

With great deference we would state, that we do not approve of the diversion from the sewers of any natural stream from the higher levels in the country, nor of springs or rain, or storm waters, nor of any of the water supply pumped into London. On the contrary, we would suggest that wherever available, such waters should be carefully guided through the sewers of the Metropolis, on the principle that they will tend to liquefy and flush out into the deep main the otherwise torpid and intractable contents of the existing sewers.

Having thus briefly mentioned the advantages to be gained from the proposed main sewer, we shall now proceed to describe the intended mode for its construction.

Mode of constructing the Deep Main Sewer on the North Side of the Thames.

1st. The deep main sewer will be all tunnel work, to be executed (as shown by drawing, No. 4) in about 6 feet lengths, or less, where greater care is required. To effect this, a series of shafts will be sunk in positions isolated from the streets and traffic, down to a connexion with the main sewer below. These shafts will also be made as near as may be found necessary to all existing sewers, the contents of which are now discharged into the Thames; but where this cannot be effected, express shafts will be carried from every existing sewer or polluted stream, to the deep main, so that all sewage and surface water will pass down these shafts into the main, at a point immediately before that at which the sewers and streams now enter the Thames. Any sewers to be hereafter made, can also have shafts sunk so as to carry their contents also into the deep main.

2d. Provision will be made for the sewage of any drainage areas formed by the necessary divergencies at the Houses of Parliament, Somerset House, the Tower, and the St. Katherine and London Docks, the Isle of Dogs (including the East and West India Docks), and Plaistow Marshes, of the deep main from the banks of the river by the reversal of the fall of all sewers, existing in such areas, from the River to the deep main, so that their contents will pass into the latter instead of the former.

3d. When the deep main sewer is completed, it is proposed that all the existing sewers and open drains and watercourses at present discharging into the Thames, shall be simultaneously stopped short off from it, and the sewage made to fall, by means of the shafts already described, into the deep main, instead of into the River.

Estimated Quantity of Sewage to be carried off from the North Side of the Thames.

There is great difference of opinion in estimating the quantity of sewage that has to be conveyed from the Metropolis, though this, as Captain Burstall has very properly suggested, is a problem which must be solved with sufficient accuracy, before the size of the main sewer can be decided upon. It is certain, however, that it is being on the safe side to err rather in excess of size than the contrary, when estimating for the requirements, even of the present population of London and its suburbs.

But if we look to the enormous increase of its inhabitants, and the extension of the streets and environs of the Metropolis during the last half century, in which the houses and the population have nearly doubled, it becomes evident that we ought to make provision for the future requirements of a population on which there is every likelihood to be a corresponding rate of increase during the next 50 years at least.

If the increase of the population of London be calculated from 1851 to the end of 1857, in the same ratio of increase as that presented by the Census Tables between 1841 and 1851, the inhabitants on the north side of the Thames will be found to amount to 1,073,934, and of the south side to 704,290; but to be on the safe side, we accept two millions as the number of the population for which main drainage has to be provided on the north side of the Thames in the year 1857.

We are aware that in dealing with the sewage of any town or district, it has hitherto been usual to compute a certain number of gallons as due from every head of the population, or from every house in the locality; and such mode of reckoning may perhaps be the best, where there is no certain information as to the quantity of water artificially supplied, or as to the amount of the natural rain-fall; but where these data can be accurately obtained, we consider that they form much the best basis for an estimate, because it is to these two sources that the quantity of sewage in every inhabited district must be chiefly due.

Now in the case of the Metropolis, accurate information respecting both the artificial water supply and the natural rain-fall can be obtained, and our estimate of the sewage to be carried off from the population of the north side of London has consequently been based upon these two precise and reliable data.

The information as to the water supply has been procured from "a Return made to the President of the General Board of Health by the Metropolitan Water Companies, showing the quantity of Water pumped into London in 1856;" and that as to the natural rain-fall, from the Tables of the recorded results of the average annual rain-fall in and near London during eight years.

To

To these must be added the water received from wells and springs, the quantity of which can however, be only roughly estimated. On the other hand, and in reduction of the above, must be estimated the loss by evaporation (derived from the same tables as the records of the rainfall), and this, together with all other water consumed, evaporated, or otherwise dissipated, must necessarily be reckoned, and the quantity deducted from the total amount of water supplied; the difference being considered as the quantity of the sewage which has to be conveyed away from the north side of the Thames.

Estimates of Water Supply.

Daily Supply of Water pumped into *London* by the several Metropolitan Water Companies in 1856.

	Gallons daily.	Gallons.
New River Company	25,000,000	
East London	16,000,000	
West Middlesex	6,895,368	
Grand Junction	6,714,292	
Chelsea	5,323,000	
Hampstead	603,000	
		60,535,660
Rain-fall (as shown by the part coloured blue on Map No. 1) over an area of 30* square miles, extending from Kensington Canal to Gallion's Reach, a distance of about 13 miles, measured, along the course of the main sewer, and stretching from the river for about three miles to the west, north and east, beginning at A, taking the course of the Kensington Canal, thence to Shepherd's Bush, Kentish Town, Stoke Newington, Lower Clapton, Stratford, West Ham, Plaistow, and thence to G on the Thames, at Gallion's Reach, at 27 inches annually over the above area, as shown by the Tables		32,130,069
Storm-water, 5·77 inches over the above area, such fall having occurred in November 1843, and being the largest recorded in the Tables, less 2·25 inches, the average monthly rainfall, and, therefore, 3·52 over an area of 30 miles		4,188,825
Private wells, springs, &c., roughly estimated at two gallons per head of the whole population of two millions		4,000,000
Total Gallons		100,854,554

Estimated Deductions for Water which will never reach the Deep Main.

	Gallons.	
For the domestic and household uses of 2,000,000 of persons, for cattle, the watering of streets, squares and gardens, for fire and steam-engines, the cleansing of stables, cow-houses, &c., say one-third of the whole quantity (60,535,660) gallons pumped into London	20,178,553	
Deduct one-third of the supply from private wells and springs	1,333,333	
Deduct for evaporation, shown to be 15 gallons out of every 26 gallons that fall in rain, and therefore over an area of 30 square miles	18,536,578	
Deduct a similar proportion for the storm-water, over a similar area	2,418,185	
		42,466,649
Gallons		58,387,905

From the above returns it will be seen that the water pumped into London by the several companies, together with the supply obtained from private wells (64,535,660 gallons in all), gives, for a population of 2,000,000, about 32 gallons of water per head, as supplied for consumption, irrespective of rain and storm-water.

Thus there are, according to our estimate, 58,387,905 gallons of sewage to be collected and conveyed from A, at Kensington Canal, to G, at Gallion's Reach, at the present time. But it has been already shown how rapidly the population of London is likely to increase, and we may therefore fairly presume that, before the expiration of a century, another million will be added to the two

* *Note by Referees.*—The boundary on the Plan gives an area of 45 square miles.

Appendix X. Plans of Drainage. Text of Plans. Messrs. *Thornton* and *Jackson*.

two already calculated on. In such case the estimated quantity of sewage to be conveyed from the north side of London in 1956, will be as follows:

	Gallons.
Pumped into London in 1856	60,535,660
For increased population, say one-third	20,178,550
Wells and springs in 1856	4,000,000
For increased population, say one-third	1,333,333
Rainfall for 1957, same as 1857	32,130,069
Storm-water in the same proportion	4,188,825
	122,366,437

Estimated Deductions in the same Ratio as in 1856.	Gallons.	
By consumption and waste on 80,714,210 gallons, say one-third	26,904,736	
Ditto from private wells and springs	1,777,777	
Evaporation from rainfall	18,536,578	
Ditto - from storm-water	2,418,185	
		49,637,276
Gallons		72,729,161

If this result of 72,729,161 gallons be accepted as being as nearly as true an estimate as such a difficult subject will allow us to arrive at, we have then to provide a main sewer, whose inside area, with a fall of 14·54 inches per mile, shall be capable of collecting and conveying this ultimate quantity, say of 73,000,000 gallons of sewage from A to C, at Plumstead Marshes, and thence to B at Erith Reach, a distance of about 17 miles, every 24 hours.

It will be conceded that sewage, containing, as it does, large quantity of organic and other matter, both in suspension and solution, will not flow with the activity due to pure and limpid water; and if so, the deep main-sewer must be increased in size to accommodate this lethargic condition, in order that it may pass such an enormous amount as 73,000,000 gallons of sewage, with the necessary speed, through the 17 miles of deep main to B at Erith Reach.

We are aware that the area we have considered it necessary to provide for the deep main is greater than strict theoretical calculation would show to be due to pure water. Yet, as it is a question of making provision for the sluggish torpid flow of 60,000,000 gallons of viscous sewage, with occasional storm-water, through a pipe of brick-work with all its retarding friction, for a distance of 17 miles every 24 hours, we are of opinion that the deep main should not be of less than the following dimensions:

The sectional form to be elliptical, and its interior size at A, at Kensington Canal, to be of 16 feet vertical, and 12 feet horizontal diameters, forming an area of 150·79 superficial feet (*see* Drawing No. 2, figure No. 1) at C, (Drawing, No. 2, figure No. 2), in Plumstead Marshes, the vertical diameter to be 20 feet, and the horizontal 16 feet, forming an area of 251·32 feet, the area of the sewer increasing uniformly from A to C.

The united deep main from C to B., at Erith Reach, will be of 26 feet vertical, and 20 feet horizontal diameter (Drawing No. 2, figure 3), forming an area of 408·40 feet, being about 6½ feet more than the united areas of the deep mains on the north and south sides of the Thames.

Thickness of Brickwork.

The thickness of the brickwork, forming the entire ring of the deep main sewer, at A at Kensington Canal, will be five concentric rings, or practically, 2 ft. 1 in., to terminate at C in Plumstead Marshes, with six rings, or 2 ft. 6 in. from C to B at Erith Reach, with seven rings, or 3 feet, all in cement (*see* Drawing No. 2, figures 1, 2 and 3).

These thicknesses may, at first sight, be considered somewhat large, but from our intimacy with railway tunnels, and bearing in mind the many failures that have occurred from want of strength, we feel practically justified in adopting these dimensions. The proposed deep main will be subject to expansion from within, as well as to pressure from without, in the former instance from its being filled with sewage, and in the latter from its being empty, and both these conditions ought to be carefully provided for.

The inside of the deep main, throughout its entire length, will be lined and close bedded, 4½ and 9 inches deep alternately, with the hardest Staffordshire blue bricks, glazed on the sides, forming the inside face of the sewer. By this means, the durability of the sewer will be preserved, and the passage of the sewage will be aided by the diminution of the friction, whilst the growth of stalactitic substances will be checked, and the coarser portions of the sewage prevented from attaching themselves to the sides of the sewer, a common occurrence when the granulated faces of ordinary bricks are presented to the slow torpid movement of a viscous substance such as sewage.

To construct the deep main, and to facilitate its completion, shafts will be sunk, at distances of about 400 yards from each other, and mining operations carried on simultaneously in opposite directions, so that in the 17 miles there will be 66 shafts and 132 headings, advancing forward at the same time.

Railway tunnels of a much larger area are usually advanced by 12 feet lengths, and one of these is generally completed per week.

But (as shown by drawing No. 4), and as a matter of safety to the buildings above, the deep main sewer will be advanced in six feet lengths, and from one to two of these lengths at each heading, or about six yards on the average, will be completed per week at each shaft. At this rate, with 66 shafts, the deep main from A to B would be finished in 76 weeks. But this assumes an uninterrupted rate of progress, and at least one-third more time must be added for stoppages from

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from water, irregularities of workmen, delays in the supply of bricks, and for the unforeseen difficulties that may be met with in the ground to be mined. We see, however, no reason to doubt that with six months for making the necessary preparations, and for sinking the shafts, in two years further time, the whole of the deep main might be finished and in operation.

When the deep main is completed, and all the existing sewers connected with it, it is proposed that the shafts be covered with six-inch Yorkshire flags, so as hermetically to seal up the deep main, and thus prevent all smells and exhalations arising therefrom.

At first it may seem reasonable that ventilators should be left open down to the deep main to give freedom to the current of the sewage, and that to prevent noxious smells, ventilating shafts should be carried to a considerable height, in order that all exhalations might pass off innocuously.

We are of opinion, however, that ventilators would tend to encourage the escape of the gases into the atmosphere, whereas by the sealing of the deep main from end to end, all the air exhausted by the pumps at B will be constantly re-supplied down the shafts, and drawn from the street sewers, whilst the noxious gases escaping from them through the gratings will thus be to some extent diminished.

Deep Main Sewer along the South Side of the Thames.

All the arguments that may be used in favour of a deep main sewer along the margin of the river on its north side, apply with equal force to the south side, and we may therefore at once proceed to describe the main sewer we propose to construct for this portion of London. The red line drawn along the south bank of the Thames, and shown on drawing No. 1, indicates the course of the proposed main sewer, which commences at D near Battersea Church, and then passes eastward under the approaches of Battersea Bridge to the front of Battersea Park, and under the approaches of the Chelsea, New, and Vauxhall Bridges. From this point, it continues in front of Lambeth Palace, and under the approaches of Westminster, Hungerford, Waterloo, Blackfriars, Southwark and London Bridges to St. Saviour's Dock, soon after which the main turns to the right to avoid the deep foundations of the Commercial and other docks. The main sewer resumes the course of the river at Stonehouse Buildings, passing under Deptford Creek, in front of Greenwich Hospital, and then again leaving the river, it takes a straight line through Greenwich Marshes to Charlton Wharf, where it again joins the river, passing under the Royal Arsenal at Woolwich, to Plumstead Marshes, where it is joined by the deep main from the north side at C. From this point the two deep mains, now united in one, are carried on to B in Erith Reach. It is intended to make the main sewer on the south of the same depth from the surface, as that on the north side of the Thames, viz.; at Battersea 40 feet, and at Erith Reach 79 feet, beneath Trinity high-water mark. (*See* Drawing No. 2, figure 5.)

Estimated Amount of Sewage to be conveyed from the South Side.

Before determining the size of the main for the south side, it is necessary to consider the probable amount of sewage from this portion of the metropolis.

The population at the present time, taking the increase since 1851, to be in the same ratio as between 1841 and 51, is in round numbers 705,000, and the quantity of water supplied for domestic consumption would seem to be about 30 gallons per head per diem, as appears by the following—

"Return made to the General Board of Health of the Water pumped into that part of London South of the Thames, by the Metropolitan Water Companies in 1856."

	Gallons Daily.	Gallons.
Southwark and Vauxhall Company	10,331,122	
Lambeth	6,109,000	
Kent	3,500,000	
Plumstead and Woolwich	550,000	
		20,490,122
Add, for water supply from private wells and springs, say two gallons per head of a population of 700,000		1,400,000
		21,890,122

As to the rainfall, the proportionate amount will be the same on both sides of the river, though, from the more scattered nature of the population, the water is in a less polluted state on the south than on the north side; and it is difficult to estimate how much of the rain-fall passes into the sewers, and how much is collected by the River Wandle on the west, and by the Ravensbourne on the east, and so carried into the Thames.

It may, however, be assumed, that if the population and area of the north side be considered as 2,000,000 and 30 square miles respectively, the population and area of the south side may, in round numbers, be taken at 1,000,000 and 15* square miles.

Indeed, this will be found nearly accurate, for taking the area coloured blue on drawing No. 1, which comprises a district extending from Wandsworth, through Clapham and Stockwell, by the north of Champion Hill to Peckham Rye, the south of Hatcham and the back of Greenwich, to the south-eastern corner of Greenwich Park, it will be found to be about 16 square miles in extent. The

* *Note by Referees.*—The boundary on the Plan shews an area of 19 square miles.

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The rainfall from this area may be taken as sufficient, considering the amount that is diverted in the Ravensbourne by the Grand Surrey Canal, from Ravensbourne to Deptford.

	Gallons.
Taking, therefore, the water pumped into London, and that derived from wells, &c., as already specified at	21,890,122
The rain-fall over the above-named area of the 16 square miles, at 26 inches per annum, as shown by the Tables	17,136,036
The storm-water over the same area at 5·77 inches, the largest recorded monthly fall, less 2·25 inches, the average fall for a similar period, leaving 3·52 inches as the storm-water, to be computed over an area of 16 square miles	2,234,040
TOTAL	41,260,198

DEDUCTIONS as for the South Side of the *Thames*.	Gallons.	Gallons.
By one-third of the water used for domestic, household and public purposes	7,296,107	
By evaporation, shown to be equal to 15 out of every 26 gallons that fall in rain	9,886,174	
By evaporation of storm-water in a similar proportion	1,288,869	
		18,471,750
		22,788,448

This quantity of 22,788,448 gallons being accepted as the amount of sewage that has to be conveyed each day from the south side of the Thames, the next step will be to estimate for the probable increase of the population during the ensuing hundred years.

We have shown that at the present date the population of South London is about 704,290; and having regard to the increase during the last few years, we may reasonably assume that in 1957 the inhabitants will not be less than 1,000,000 in number.

	Gallons.	Gallons.
Therefore, water pumped into London and obtained from wells in 1857	21,890,122	
Add one-third for increase of the population in 1957	7,296,707	
		29,186,829
Rain-fall and storm-water same as 1857		19,370,076
TOTAL		48,556,905
Deduct one-third of the domestic and household supply	9,728,943	
Deduct for evaporation of rain and storm-water	11,175,043	
		20,903,986
TOTAL		27,652,919

Making allowance, as on the north side for the torpid flow of the sewage, and adopting the above results as our data, we have estimated 28,000,000 gallons, as the quantity for the daily conveyance of which provision must be made, the deep main having to extend from D at Battersea Church to C in Plumstead Marsh, a distance of about 15 miles; the fall being, as on the north side, 30 feet.

At the commencement of the sewer at Battersea Church, the deep main will be 12 feet vertical by 9 feet horizontal, and the thickness of the brickwork composing the ring 20 inches, or 4 consecutive rings of 5 inches each when set. (*See* Drawing No. 2, figures No. 5). At C in Plumstead Marshes the deep main will be 16 feet by 12 feet, and the thickness of brickwork 2 feet 1 inch, or 5 consecutive rings of 5 inches each. (*See* Drawing No. 2, figure 6.) As on the north side, the deep main on the south side will be lined throughout its course with glazed Staffordshire blue bricks, and the work set in cement throughout.

All the details of construction, such as the carrying of the shafts up to the existing sewers, the reversal of their fall, when the deep main may leave the course of the river, and the like, will be carried out on the same principle as that intended to be adopted on the north side.

United Deep Main from C *in Plumstead Marshes to* B *at Erith Reach.*

The united areas of the two deep main sewers at their point of junction at Plumstead Marshes are 402·11 superficial feet. The united deep main to Erith Reach must therefore be of corresponding dimensions, and we accordingly propose to construct it 26 feet by 20, making an area of 408·4 superficial feet. The thickness of the brick-work will be 3 feet, in 7 consecutive rings, making practically 5 inches in each course, the whole to be laid in cement, and the interior of the main to be lined with 4½ and 9 inch blue Staffordshire bricks with glazed faces, the same as in the mains on the north and south side of the river (*see* Drawing No. 2, figure 3).

Auxiliary

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Auxiliary Sewers.

Wherever the deep mains leave the course of the river, either on the north or south side, it will be necessary, as has been already stated, to reverse the course of the existing sewers, or otherwise to intercept the sewage of all districts lying between the river and the proposed mains. The sewers in these districts, whether on the north or south sides of the river, are indicated by blue lines. It will also be requisite to run sewers along each side of Deptford Creek, the Ravensbourne, and such other streams as are at present made the recipients of the sewage, in order that the latter may be divided into the deep main, and prevented from passing into the Thames. The proposed course of such drains is indicated by the red lines drawn along the margin of these rivers and streams on drawing, No. 1.

At present, our information does not place us in a position to judge either of the sizes or the lengths of such auxiliary sewers, and we can therefore only submit our general views of the way in which the pollution of the Thames may, in the instances above named, be the most effectually prevented.

The Reservoirs at B *at Erith Reach.*

Drawing, No. 3 shows the plan of two reservoirs proposed to be constructed in brick-work in mortar, except that part which, as hereafter described, is intended to be laid in cement, brick and half brick, that is 4½ inches and 9 inches alternately.

Each reservoir will be 6 acres in area, 24 feet in depth, and of a capacity to hold 40,000,000 gallons of sewage. The bottoms or floors of the reservoirs will be inserted in brick and half brick-work (14 inches thick), laid upon concrete as shown (Sections figures 1 and 2).

Upon these inverts, a series of pillars (marked *b, b, b,* &c. &c. &c.) will be erected, laid in mortar, but cased with brick and half brick, as above-mentioned, laid in cement. Upon these pillars a covering of arches, also of brick and half brick, in mortar, will be carried over the tops of the reservoirs, so as to completely close them up, and prevent the escape of all unpleasant smells.

All the walls of the reservoirs that may be exposed to contact with the sewage, as well as the sewers in the walls, the pump well, the passages leading into and out of the same, and the passages into and out of the reservoirs, will be faced with Staffordshire blue bricks, 4½ inches and nine inches deep alternately, laid in cement, and glazed on their external faces, the same as in the two deep main sewers.

A large amount of deposit will no doubt take place in the bottom of these reservoirs, and provision has therefore been made for the removal of the same by the construction, in the bottom of the walls, of sewers and outlets with stop-doors (as shown at *a, a, a,* &c.)

These sewers are in connexion both with the reservoirs and the receiver from the pumps, and are intended to flush out into the river, in the manner practised at the Liverpool Docks, any accumulation of mud there may be. But as we anticipate that the sewage will be of too objectionable a nature, and perhaps of too much value as a manure, to allow of its being passed into the river, gates B B have been provided in the passages A A to permit either reservoir to be filled independently from the pumps, or emptied separately into the river.

Thus, reservoir No. 1, by means of closing gates L will be cut off from receiving any more sewage, as soon as the deposit has become so large as to render its removal necessary. Mud-boats will then be brought in by the tide from the river, and when it falls, they will be kept berthed in the mud; gates C C are then, if necessary, closed against the flow of the next tide, and until the boats are loaded with the mud deposited from the sewage. It is intended that this operation shall go on from day to day till reservoir, No. 1 is cleared of mud, by which time it is presumed that reservoir No. 2 will require cleansing, and this operation will go on in it, whilst No. 1 is being used for the reception of the sewage.

In addition to this mode of removing the deposits, other means have been provided by a railway and waggons, as hereafter described.

This alternate working and cleansing of the reservoirs will be equally necessary, whether the system of deodorising be adopted, or the sewage allowed to pass into the river in its impure condition.

On reference to the section (Drawing No. 2 at B), and again to the enlarged section of the same (Drawing No. 2, figure 1, from E to F), it will be seen that the bottoms of the reservoirs are placed at the level of half ebb, or about 9 ft. 3 in. above low-water mark, and the top surface of the sewage when the reservoirs are filled, will be 24 feet above that level, or 14·9 feet above Trinity high-water mark, the average rise of spring tides being about 18½ feet.

By this arrangement, the reservoirs will be empty at 9 ft. 3 in. above low water, and the last of the sewage, leaving the passages A A, will be about 5 miles down the river, or near Greenhithe before the flood-tide begins to make.

Each reservoir has been calculated of size and depth sufficient to contain 40,000,000 gallons, or something more than the sewage raised in 12 hours' pumping; although, in ordinary practice, the gates will only be closed about 8½ hours, that is, from half ebb to high water. At high water, the gates or sluices will be opened, and the sewage will then pass into the river, but the engines will continue pumping till the tide leaves the level of the bottom of the reservoirs, when the gates B B will be closed, and no more sewage be permitted to enter the river till the next high water.

The gates B B are constructed so as to correspond in height with the depth of the sewage in the reservoirs; that is, 20 feet above the sill, and the upper sides of the top bars are framed at the level of the springing of the covering arches, so that should the reservoirs become so full as to endanger the safety of the covering arches, the surplus sewage may flow over the gates into the river. But such a condition will rarely arise, and can never happen except at about high water; so that in any case, the sewage will only ascend the river a short distance, before the turn of the tide brings it down again.

Gates C C are intended to be used, as occasion may require, to prevent the tide entering the reservoirs. The latter will be made of sufficient capacity, and the gates so adapted as to contain any storm-water that may fall over and above the ordinary daily supply of the sewage.

We have proceeded thus far on the understanding that it is not intended to allow the sewage, discharged

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discharged into the river, to return again by the flood-tide to above the same point B, at which it has entered.

If, however, the First Commissioner of Public Works, by fixing B as the point of discharge, intends, or will be contented that the outflow of the sewage shall continue from high to low water, and then stop and be retained in the reservoirs, in such case the bottoms of the reservoirs can be placed at the level of low water, and their tops at a correspondingly lower depth, or 9 ft. 3 in. lower than that now shown by the accompanying drawings. By this means, a considerable annual saving will be effected, owing to the reduction of 9 ft. 3 in. in the lift of the pumps.

Or if, by fixing the point of discharge at B, it is understood that the sewage may be passed into the river at any or all times of the tide, then the reservoirs (except for the problem of the deodorising and utilising of the sewage), will not be required at all, and a large amount will be consequently saved by their non-construction.

River Wall at B *at Erith Reach.*

A river wall will be built (as shown in Drawing No. 1 at B), and again more fully (in No. 3 at B and section figure 1 at A). The mouths of the passages at A A will also be provided with aprons, fenced with street piling at G G. (*See* Section figure 1 at G.)

By these means no mischief can be caused either to the sides or bed of the river by the discharge of the sewage from the reservoirs.

Drawing No. 3, figure 3, also shows a safety overflow from the deep main into the river.

A pair of gates at J. will be placed in the passage, and these will be closed by the rising tide, and so seal up the mouth of the overflow, and thus prevent the entrance of any water from the river, opening again at low water, by any pressure from the inside, acting as the difference of levels of the water may govern the action of the gates.

Steam Power.

We have already stated that our estimate of the greatest daily supply of sewage is from the

north side of the Thames - - - - - - - -	58,000,000	gallons.
From the south side - - - - - - - -	22,000,000	„
	80,000,000	„

We have, therefore, the above as the maximum quantity to be lifted 60 feet from the deep main into the reservoirs at Erith Reach, the average quantity being however less by the amount of storm waters.

The above figures form the data for calculating the steam-power required, and we find that 1,010 horse power is the exact amount needed; but we prefer to make our estimate for 1,250 horse power, so as to meet the chance of an extensive fall of storm water, leaving a surplus of 240 horse power for contingencies.

Engines, Wells and Pumps.

The deep main sewer being made to terminate at a general receiver D (Drawing No. 3) to supply the pumps five wells will also be provided, each containing two pumps worked by an engine of 250 horse power.

The five sets of pumps, with an aggregate of 1,250 horse power, can be worked either separately or in combination, or any portion of the five can be worked together, as may be found necessary.

We have preferred dividing the steam-power as above, because should one engine fail, there will be four left to do the required duty. Whereas if two engines, each of 625 horse power were used, and one got out of order, the other would not be competent to pump off the daily quantity of sewage; besides which, if five engines be employed, three or four can be in daily use, whilst the remaining one or two can be kept efficient, and in reserve, to supply the place of any one that may fail in its work, or to meet any extra supply of sewage occasioned by storm water.

Each pair of pumps, and also the well in which they are inserted, can be isolated from the rest, by closing the receiving and discharging doors of the well at c. c. c., &c. and using the other adjoining engines to pump the water of the disused well through a connecting sewer d. d. d., &c. and any repairs that may be necessary can thus be proceeded with.

We further propose, and have made provision for the same in our estimate, to extend the general receiver D., and to build two other wells, with boiler and engine-houses to correspond, up to the surface only, as shown by dotted lines.

Our object in so doing is, that as London increases, such extension will be required, and as the cost will be so much less, it is better that the foundations should be laid at the same time as those of the other five wells.

Safety Overflow.

In the construction of a great work like the main drainage of London, every care should be taken to make the various works of such strength in all their parts, that failure in any one instance may be rendered almost an impossibility, whilst every portion should be so arranged that the whole may harmonise and work on one grand and comprehensive system. Yet, whilst using the greatest possible care in construction, it is at the same time right to be provided against, and to be ready to ward off any catastrophe that may arise to the drainage as a whole, and to guard against any interruption that may be occasioned to the perfect working of any of its parts. It is, therefore, necessary to make such arrangements as shall for the time required meet any casualties in the shape of ordinary repairs to the engines, pumps, wells or reservoirs. In any such case, or should it be at any time necessary to stop all the pumps, or should there occur an extraordinary flood of storm water so sudden and heavy as to overpower the pumps, a general overflow is provided.

For the nature of the arrangements made to provide against such a contingency, we beg to refer you to drawing No. 1, which shows a diversion of the deep main from K. to J. into the river, round

round to the north of the reservoirs, and also to longitudinal Section (Drawing No. 2), which shows the mouth of the overflow to be placed at low water level at H.

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Drawing No. 3, from H. to J., shows, on a natural scale, the plan of the same diversion, whilst the longitudinal section, on the same drawing at H., shows the level of the mouth of the overflow at low water, and its continuance on the same level to the point of discharge at J. in the river.

Under any emergency arising in the reservoirs or pumps, the gates at H. are opened, and those at K. closed, when the sewage will take the course of the diversion, and be discharged at J. by its own natural gravity, due to 3·53 inches of fall per mile, that being understood to be the inclination of the river between Kensington Canal and Erith Reach.

The gates at H. are provided with sluice-doors, which can be kept open at such a level above water as shall enable them to act as an ever prepared overflow, should the sewage ever chance by accident or neglect to rise to that elevation in the shafts. By this arrangement, no undue pressure from within can ever lead to the "blowing," in common parlance, or the bursting of the deep main under the river.

Old Sewers maintained as Safety Overflows.

Should, contrary to the best calculations, or owing to any cause beyond the reach of human foresight, any catastrophe arise to the deep main, or to any of its parts, or to the pumps or reservoirs, or should any repairs at any time be required, so as to render it necessary to keep the deep main temporarily, a provision for the same will be made in every sense (*see* Drawing No. 3, figure 3), by means of a sluice or stop gate being let down at a., and that at b. being opened, when the sewage is turned down in its old course into the river at c. The necessary repairs being made, or the mischief corrected, a. is raised, b. closed, all communication with the river cut off, and the sewage allowed to fall down shaft a. as before, into the deep main. These overflows into the river will also be another means of safety in case of very extraordinary rain or snow storms.

The mouths, as at c., of all these old sewer outlets, will be adapted for, and provided with self-acting hanging doors, closing by the action of the tide, and opening when any pressure of the sewage from within requires an egress into the river.

By the above arrangement of the overflow of the great main at B., the sewers of London with the advantage of the fall of the river at Erith could never be flushed back, and overcharged by the tide as is at present the case.

In point of fact, the deep main sewer, as suggested by us, would appear to be sufficient of itself to carry off the sewage of London, and to discharge the same at Erith, without the assistance of either engines or pumps. But to such an arrangement there are three chief objections: First, The sewage, if discharged at low water, would return with the flood tide about as far as Woolwich. Second, The fall in the river between Kensington Canal and Erith Reach being only about 5 feet, or 3·64 inches per mile, much deposit of sewage would take place in the deep main; and, Third, The sewage would be retained in London twice a day during high water as at present, except for the advantage gained by the natural fall in the river between Kensington Canal and Erith Reach.

But, as the contents of the sewers of London could only flow from them when the tide receded from Erith Reach, or for about 14 hours out of the 24, the time thus allowed, say seven hours every ebb, would not be sufficient (looking to the fall of 5 feet, or 2·85 inches per mile, in 21 miles, the distance by the river), to carry off the sewage from London. We must, therefore, have recourse to pumps to raise the sewage, and to reservoirs to store it up during high water, under the same conditions as those we have already described.

The Deodorising and Utilisation of the Sewage.

In describing the reservoirs, we have stated that they would be so arranged as to allow of the sewage being deodorised or not, as circumstances might hereafter decide.

We have given the subject all the attention its great importance demands, but without being able to come to any positive decision as to which, or whether any effectual plan, for the deodorising and purifying of sewage water, has yet been discovered.

We are aware that there is much evidence of a very positive kind, chiefly, however, from those who are interested in the success of their respective schemes and patents, that sewage water can be thoroughly purified, and that the solid contents obtained from it, form a valuable manure, saleable on highly advantageous terms.

But when we come to look closely into the matter, we find that though, in some cases, the sewage appears to be thoroughly deodorised and purified, yet that the manure is so little esteemed as to be unsaleable, except at a price quite disproportionate to the cost of its production. In another instance brought under our notice, an attempt has been made to overcome this difficulty, by mixing with the solid matter obtained from the sewage large quantities of ammonia. Again, in a third case, we have seen water, apparently quite pure and limpid, after being bottled and corked up for a few days, give, on its being opened again, very plain and unpleasant evidence of the source from which it was originally procured.

In no one instance, that we are aware of, has sewage water been submitted to any process by which all its noxious elements are destroyed, and all its fertilising elements retained; on the contrary, the weight of scientific testimony is in favour of the use of sewage manure in a liquid form, as being the only one in which the most valuable fertilisers can be retained until applied to the ground, itself the only effectual absorbent of such fertilisers.

But again these, however valuable, bear a very small proportion to the enormous bulk of the liquid sewage itself; and science has hitherto failed to point out any feasible means for conveying the sewage of large towns, much less that of London, to the requisite distances, or for applying it to sufficiently large areas of agricultural land.

The fact of a Government Commission being at this moment engaged in the investigation of the subject, is the strongest proof of the want of any accurate or reliable information respecting it. And we conceive that, till the inquiries of this Commission are completed, any definite conclusions as to the treatment of town sewage, in either its liquid or solid form, ought to be deferred.

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We are aware that, amongst other processes, mechanical means, such as filtration, have been recommended. But we are at a loss to discover the advantage of even the most perfect filtration, when, of the offensive portions of town sewage, there is at least as much in solution as in suspension; and though such a process may not seem difficult of application on a small scale, it becomes a very different matter when it is a question of dealing every day with perhaps 80,000,000 of gallons of liquid sewage. We can hardly imagine the extent of filtering space that would be needed in such a case; but it would certainly require to be so large that the construction of the same would be a very serious objection, either in London or the suburbs, as a matter both of extent and offensiveness.

Nor is it easy to see how such an enormous quantity of sewage could be effectually filtered without the semi-fluid deposits soon choking up the filtering-beds, or at least very seriously impairing their efficient action.

In the plan we propose to adopt, there is, first, the alternative of the sewage being allowed to pass into the Thames in its natural state, a mode of treatment for which the First Commissioner of Her Majesty's Works would seem to have been prepared when he fixed on Erith Reach as the highest point at which he would suffer the sewage of the Metropolis to be discharged. Secondly, we beg to submit for your consideration an easy and simple plan of deodorisation, by which the sewage, if not wholly, will be in at least some measure purified, whilst the solid deposits will be to some extent of value.

In the preceding description of the reservoirs it has been shown, that whilst the sewage is being pumped into one, the other, not being needed, will be cleared of its accumulations; and we have already pointed out the method by which we propose to blow into the river, at any state of the tide after half ebb, such deposits as may have collected, should the same be found to be of too little value to make it worth while to store them up for manure.

It will be gathered from the foregoing remarks, that in our plan for the main drainage of the Metropolis, the question of preventing the future pollution of the Thames has been treated as by far the more important one, and that of the conversion of the sewage into a manure, as quite a secondary consideration.

We are ready to acknowledge the importance of the question, and that if a really valuable solid residue could be obtained from the sewage, we should be neglecting our duty in not showing some plan by which works for the removal and discharge of the sewage could be combined with others for its conversion into a solid manure.

But when we find, from the reports and investigation of those who have examined the question both scientifically and practically, that the manure hitherto obtained from sewage is and must be comparatively worthless, we are forced into the conclusion, that it is better to discharge the sewage in its natural state, provided this can be done at some point where it will not be prejudicial to health, rather than to design works for the manufacture of a manure of small value, and for which, therefore, there will be but little demand.

Still, however, it may be considered necessary to resort to some method for the deodorising and purification of the sewage, without regard to any pecuniary advantages to be obtained from the solid results of the sewage so treated.

In such case, we would propose the simple use of lime, so well known for its efficacy in separating and precipitating the solid particles in suspension in the sewage.

We are aware that, of the matter thus precipitated, all is not due to the sewage alone; but that a good deal of the solid matter is composed of carbonate of lime, obtained by the action of lime upon all water that contains carbonic acid, which exists, we need hardly say, in all London water, besides being generated by the fermentation of the sewage. Our object in suggesting the use of lime, however, is to secure, as far as may be, the purification of the sewage, rather than to endeavour to obtain a valuable solid residue from it.

We have accordingly provided a receiver near the reservoir at point B. (*see* Section Drawing No. 2, and Plan Drawing, No. 3), down which the lime can be thrown in any quantities that experience may show to be necessary to produce the largest amount of deposits, and, consequently, to effect the greatest possible purification of the sewage. The lime, on being thrown down, would be immediately received by the sewage, the purification of which would begin as it passed to the wells. Here the action of the pumps would thoroughly amalgamate the lime with the sewage, and in this condition the latter would be thrown into the reservoir, where, for 8 ½ hours, that is, from half-ebb to next high water, it would be confined in a state of rest; during the whole of this period the lime would be actively doing its work, and the solid contents of the sewage being rapidly deposited. At high water the gates B B of the reservoir would be opened, and the sewage, in its purified state, allowed to pass into the river.

It will be noticed that the carrying out of this plan of deodorising requires no additional expense, except that of the construction of the lime receiver; and if at any future time it appeared advisable to abandon it, the same could be done by simply closing over the shaft.

With respect to the removal of the solid deposits from the reservoirs, it has been already shown that mud barges can enter them from the river, berth on the mud deposits, and be loaded with the same, tide after tide, till the reservoir is emptied.

As a further provision for the removal of the deposits, and the conveyance of the same, either to the hop grounds of Kent or to any other locality, for agricultural purposes (should a demand for such deposits arise), it will be seen that passages with gates, N N, are inserted (*see* Drawing No. 3) to keep the sewage in the reservoirs; but when either of them require to be emptied of their deposits, gates C C being closed to exclude the tide, gates N N are opened, and, a railroad being laid into the reservoirs, waggons are introduced. These will then be filled with the mud deposits, and the latter removed and "tipped" (in railway phraseology) on to store ground provided on the marsh, where they will be allowed to consolidate, and then removed by water or land carriage.

We do not profess by the above process to be able to produce the complete deodorising or purification of the sewage, though there is, in our opinion, no doubt that, by the action of the lime and the amount of the deposits, both of these results will in some measure be obtained; neither do we pretend to attach any great importance to the value of these deposits, though they must to some extent possess fertilising qualities.

The simplicity and economy of the plan proposed are the reasons for our submitting it to your consideration, believing, as we do, that any deodorising processes at present in use are at best costly

costly and doubtful experiments, and that the purification of town sewage must be effected by some means of a more active and simple character than that of spreading it over our immense and undetermined area of artificial gravel and sand beds.

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Extension of the Main Sewerage Works from B, on the west side of Erith Reach, to F at Sea Reach.

We have hitherto confined our remarks and explanations to those portions of the proposed works lying between Kensington canal and Battersea church, on the west, and point B at Erith Reach, the latter having been the spot selected by the First Commissioner of Her Majesty's Works, as the nearest to London at which it is advisable to allow the sewage to pass into the river.

At the same time, we cannot but express how strongly we feel the importance of extending the sewage to some point still more distant than Erith.

Looking at the more than doubtful success that has hitherto attended the application of deodorising or purifying processes to sewage, we must confess to feeling some apprehension that the discharge of the sewage from more than two millions and a half of people into the Thames, at Erith Reach, may very seriously affect the health of the population living on or near the banks of this portion of the Thames; and if so, it seems to be a very partial and one-sided application of right sanitary principles, to remove the possible or probable causes of unhealthiness from the heart of London merely to transfer them to the towns and villages lower down the river; and, under such circumstances, the inhabitants of these places would have very fair grounds for objecting to have the whole collected sewage of London thus brought to their very doors.

The main drainage of London involves the necessity for works of a stupendous and very costly character, though it is fortunate that the wealth and resources of the community for whose benefit these works will be carried out are so enormous as to render the question of expense quite secondary to that of efficiency. The main drainage of the Metropolis, if done at all, must be done thoroughly and efficiently, and on a scale commensurate with the advantages to be obtained.

Under such circumstances, the additional expense demanded for a further extension of the point of outfall is of very slight consequence, if by such extension there is a positive certainty of avoiding the possible evils that may arise from the discharge of the sewage in Erith Reach.

Feeling this, and entertaining, as we do, very serious doubts of the complete efficacy of any of the yet existing means for the purification of sewage water, we have come to the conclusion that it is the wisest course to carry the outfall lower than Erith, and to extend the main sewer to Sea Reach.

On reference to Drawing No. 1, and Section Drawing No. 2, it will be seen that we propose to discharge the sewage through Mucking Flats into Sea Reach, at point F; our reason for fixing on this spot being, that the river is here a mile wide at low and a mile and three-quarters wide at high-water, so that the effects of the discharge of the sewage into such an expanse of water will be almost imperceptible, whilst the water at Sea Reach possesses probably as much saltness as the sea itself, so that the noxious qualities of the sewage will be immediately neutralised.

Instead of making the reservoirs with the accompanying steam power, pumps, &c. at B, we propose to pass the deep main direct from under the Thames to E, on the opposite side, and then construct the wells, reservoirs, steam power and pumps, as shown by Drawing No. 3, but unaccompanied by reservoirs.

The proposed extension, which will be 12 miles in length, is shown by the red line on drawing No. 1, from E to F, running across Winnington Marsh, and passing Aveley Stifford, and thence to point F at the sea wall or bank at Mucking Flats.

From this point we propose to excavate an open drain, sufficiently large to carry the sewage directly across the flats into Sea Reach at low-water point.

The steam-power, pumps, wells, &c. to be constructed at point E, will be precisely the same as those designed to be made at B, but instead of continuing the deep main of the same depth as to the west of Erith Reach, it is intended to raise the main drain at E, so that at this point its inside bottom shall be level with Trinity high-water mark (*see* Longitudinal Section Drawing No. 2, and Cross Section, figure 8), and with that of low-water mark at its termination at F. The extended deep main will thus have a fall equal to an average spring tide of 18 ft. 6 in., or of 18·50 inches per mile, the distance from E to F being, as has been already stated, 12 miles.

In order to secure sufficient area for the passage of the sewage, and at the same time to avoid the unnecessary height to which it would be requisite to carry a single sewer above the surface of the marsh, we have made our design to consist of two sewers—(*see* Drawing No. 2, Section figure 8),—having an united sectional area of 480 feet, whilst that of the single deep main from C to E is only 408 feet. Our reasons for this enlargement are two-fold:

First, it is necessary to provide for the increased friction caused by the sewage coming in contact with the four sides, and the increased width of bottom of two, instead of a single drain; and, second, it is of importance to give the sewage a free passage through the 12 miles of extension, so as to avoid the possibility of the pumps getting choked.

Section figure 8 shows the form of these two proposed sewers, and the thickness of the brickwork, the whole of which from B to F will be laid in cement, and lined with Staffordshire blue bricks, glazed on their outside faces, in a similar manner to those of the deep mains west of Erith Reach.

Drawing No. 2, figure 9, shows the plan of these sewers at the discharging point F, provided with tidal gates H H as shown. The latter will be closed by the action of the tide, when it rises above the level of the sewage in the inside, but as soon as the tide falls, the gates will be again immediately forced open by the pressure of the sewage from within.

The two extended sewers are represented as taking a straight course from B to F, because we are not in possession of the necessary levels to enable us to lay down their direction, in accordance with the actual profile of the country; but, as in a long gradient on a railway, a slight diversion to the right or left will easily accommodate the course of the sewers to obtain an uniform fall between the points named.

With the exception of, perhaps, one or two roads on Winnington Marsh, which will be carried under the main drains, all the roads from E to F will, as a rule, applying also to public and farm

roads, whenever necessary, be raised and passed over the sewers. The streams and rivulets on the other hand will most probably be all carried under the sewers by means of culverts or other arched ways.

Whenever the surface of the natural ground is below the necessary foundations of the sewers, as is the case in Winnington Marsh, the foundations will be laid on pinned clay or concrete, and embanked over (as shown in Cross Section Drawing No. 2, figure 8). In other cases, the ground for the reception of the two main drains will be cut open, the brickwork inserted, and covered over or embanked with earth-work of sufficient weight to insure their strength and security.

There can be no doubt, wherever its application is practicable, of the great value of liquid sewage as a manure, and as the two main sewers above described will be to some extent above the surface of the country, it will be easy to draw the sewage from them, and apply it in its natural state and by means of its own gravity.

The process of application would be very similar to that from the warping drains leading out of the Ouse, in Yorkshire, where the tidal water, charged with rich alluvial matter, is allowed to flow over and fertilise the adjacent country. In the same way the land lying near the proposed extension sewers, throughout their proposed course of 12 miles, might be enriched with liquid sewage.

It may, at first sight, appear a somewhat startling idea to propose to pass the deep main in the form of a tunnel under the Thames at Erith Reach. But we have given much attention to the subject, and the experience we have gained during the last 20 years on the railroads of England, has taught us that the construction of a tunnel under the Thames at Erith, will be a much less difficult work than was that of the Thames Tunnel at Rotherhithe, though that was a wonderful undertaking at the time at which it was constructed, considering how much less knowledge was then possessed on the subject than that which has since been obtained.

We have already stated that we propose to execute the deep main under the river at Galleon's Reach by a series of coffer dams, and we should follow the same principle with the tunnel at Erith Reach, in illustration of which we beg to refer you to Drawing No. 2, figure 4.

On this plan we feel no hesitation in undertaking the construction of the deep mains under the Thames, either at Galleon's Reach or at Erith.

The Purification of the Thames and the Continuation of the Deep Mains beyond Kensington Canal and Battersea.

Although the proposed deep mains commence at Kensington Canal and Battersea respectively, there can be no doubt that if they were both carried further to the west, much noxious matter would thereby be prevented from entering the Thames.

Our reason for commencing the north deep main at Kensington Canal, and that for the south at Battersea, is, because at these two points it becomes necessary to have the mains at a sufficient depth to enable them to pass freely and securely under all streets, public buildings, docks, &c. which may be met with between the two above named places and the eastern extremities of London.

As, however, both to the west of Battersea and Kensington Canal, there is a general absence of dense masses of buildings, and a large extent of open ground, great facilities are thereby offered for the continuation of the proposed main drains at a much less depth from the surface, the construction of which can all be done in open work.

We have not considered these continuations westward as a necessary part of our proposed plan of main drainage, but we have inserted in our estimate a schedule of prices at which we are prepared to execute this work should its construction be decided on.

The next question for consideration is that of the best means of preventing the future pollution of the Thames beyond the limits of the Metropolis, because, in reference to this subject it is not sufficient to regard the area of London alone; due attention must also be paid to the condition of the towns and villages situated on the banks of the Thames or its tributaries beyond the Metropolis; the inhabitants of these places, on the Thames alone, being, in round numbers, about a quarter of a million, and those on its tributaries being probably as many more.

It is true that from imperfect sewerage arrangements and other causes, but a comparatively small amount of the refuse and excreta of this population reaches the Thames in the form of liquid sewage, yet, when every allowance has been made, it must still be admitted that a serious amount of offensive matter is poured into the river before it approaches London.

If this be so, we conceive that means must be adopted for the deodorising of the sewage of the smaller towns on some separate and distinct principle.

We are aware of the difficulties that lie in the way, and that the question of a proper drainage outfall is the chief obstacle to the execution of efficient sewerage works in many provincial towns at the present moment.

But, if the Thames is to be thoroughly purified, the process of deodorising must be applied to more than the sewage of London. If, for example, we take one of the first tributaries of the Thames beyond the point where the proposed south deep drain commences,—we refer to the river Wandle at Wandsworth,—it will be found that that stream is in a very polluted condition from its being the receptacle for the sewage of Croydon and the adjacent villages.

The volume of water poured into the Thames by the Wandle is a sufficient reason why the latter should not be taken into the deep main, and the only way therefore to prevent its continuing to be a source of pollution, is to apply means for the purification of all sewage matter before the same enters the Wandle.

We believe that, to some extent, the sewage of Croydon is so treated; the drainage works carried out there within the last few years having polluted the Wandle to such an extent as seriously to affect the interests of persons owning property along its banks. But though some improvement may have been effected, the Wandle is still very far from being a pure stream.

Any remarks respecting the Wandle apply equally to all tributaries of the Thames that are made receptacles for town sewage.

And it certainly appears to us a matter of the highest importance that whenever and whatever means

means are finally adopted to cut off the sewage of London from the Thames, care should be taken also to provide against its pollution by the more scattered but still very large population living on or near its banks, but beyond the metropolitan area.

The readiest means of accomplishing this end would seem to be, by the passing of an Act of Parliament requiring all places where thorough drainage has been or may be hereafter carried out to collect the sewage in reservoirs of their own, where the same may be subjected to some process of purification and deodorising, before it is allowed to pass into the Thames or any of its tributaries; and the solid contents, if possible, made available as a manure for the use of the adjacent farm lands, or, it may be, that means may be devised for the application of the sewage to these lands in the form of liquid manure.

If some general plan of purification could be thus carried out, the Thames would be free from all sources of pollution, except from such slight causes as the natural drainage flowing from cultivated lands, or the house drainage from small scattered populations; and its waters would be once more restored to their original purity.

Estimated Cost.

Having now completed the explanation of our plans and designs for the main drainage of London, we beg to submit to you our estimate of the cost of executing the same.

	£.
Deep main on the north of the Thames, from A at Kensington Canal to C in Plumstead Marshes	1,569,975
Deep main on the south of the Thames, from D at Battersea to C in Plumstead Marshes	1,071,324
United deep main from C in Plumstead Marshes to the pumping station near B at Erith Reach	305,721
Overflow from H to J at B at Erith Reach	38,258
Engine-house, engines, boilers, receiver-wells, reservoirs und passages into the Thames	507,022
River wall at B at Erith Reach	28,042
£.	3,520,342

The above is the estimated cost of the main drainage works, on the supposition that B at Erith Reach will be the point selected for the discharge of the sewage into the Thames.

The following is our estimate if the outfall be extended to Sea Reach, in the manner already suggested by us.

	£.
Deep main on the north of the Thames, from A at Kensington Canal to C in Plumstead Marshes	1,569,975
Deep main on the south of the Thames, from D at Battersea to C in Plumstead Marshes	1,071,324
United deep main from C in Plumstead Marshes to the engine wells at the reservoir at B in Erith Reach	305,721
Overflow from H to J at B at Erith Reach	38,258
River wall at the mouth of the overflow	3,520
Extension of the united deep main from the engine-wells on the Kent side of the River, to the pump-wells on the Essex side at E	310,093
Engine and boiler-houses, wells and receivers	134,042
Steam engines	82,500
Extension of deep main from E at Erith Reach to F at Sea Reach	1,658,761
Open cutting from F to low water	6,292
£.	5,180,486

In the preparation of the foregoing estimates, those of the quantities have been gone into in great detail and with much care, whilst the prices charged have been calculated at the current rates obtained for tunnels or railroads, the requisite allowance being of course made for the greater contingencies of water, the deep main following the course of the Thames so closely.

Throughout the whole of our plans and designs, we have carefully observed the strictest economy in outlay that is consistent with a due regard to the requisite area, strength and thickness of the proposed deep mains, for we hold it to be equally false and culpable to underrate either the cost or the strength of any work, either public or private.

And certainly, if this principle be applicable in any case, it is in that of the main drainage of London, involving as it does the health of more than two millions and a half of people, and where failure in any one of its parts may occasion vast mischief, and require much outlay for its rectification.

Keeping this consideration carefully before us, we have designed our works with the view of combining strength and capacity with security and thorough efficiency.

The estimates are based on the experience we have acquired upon railroads and public works for more than 30 years, and we believe that our design can be carried out for the sum above-named.

We are therefore willing to enter into a contract to execute the whole of the works in accordance with the plans and designs, and for the amount named in our estimate. Further, in case of our design being accepted, we shall be willing, for the sum of 96,000 *l.* to uphold the works, and pump the sewage from both sides of the Thames for 12 months after their completion; and at the expiration of that period, we shall be prepared to maintain the works, and pump the sewage into the Thames for any further period that may be agreed upon.

We beg in conclusion to leave our plans in your hands, feeling as we do, perfectly satisfied that they will receive the fullest attention and consideration, that any merits they may possess will be fairly

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Text of Plans.
Messrs. *Thornton* and *Jackson*.

fairly judged, and that whether successful or not, we shall have the benefit of a practical and scientific investigation, and of a fair and impartial decision.

We have, &c.
G. Thornton, Engr.
Thos. Jackson.

To Captain Galton, R. E.,
James Simpson, Esq., C. E.,
Thomas Blackwell, Esq., C. E.,
29, Great George-street, Westminster.

(18.) Sir William Worsley, Bart.*

(i.) Letter forwarding Pamphlet† containing Plan of Drainage.

Sir *W. Worsley*, Bart.

Hovingham Hall, York, 10 February 1857.

Gentlemen,

You will have learnt that the subject-matter of my pamphlet on London Drainage, &c. was submitted in writing to the Engineer of the Metropolitan Board on the 3d of April, and that it was appended in that form to his report; also, that four copies of the above pamphlet were left at the office of the Board of Works, Whitehall Gardens, pursuant to the supposed wish of the Chief Commissioner; previously, however, to his having expressed such wish, I had prepared and partly pledged myself to offer to the daily press some further explanations on the subject, and which appeared in the Herald and Morning Post. My letters have now been added to the pamphlet, and I feel it but right, therefore, to forward the same as enlarged.

Prior to the 28th, I hope to send a sketch of a plan, which might be adopted in carrying out the main culvert works, and I shall be happy (as stated in the preface to my pamphlet) at any time to submit such views in reference thereto, as have occurred to me.

I have, &c.
(signed) *Wm. Worsley.*

To Captain D. Galton, R. E.
James Simpson, Esq., C. E.
Thomas E. Blackwell, Esq., C. E.

(ii.) Letter forwarding Drawing.

Hovingham Hall, York, 24 February 1857.

Sir,

I now beg to hand you my vertical drawing, with further remarks as to the scheme for the main drainage, &c., set forth in "Thames Reform." You will perceive that the scheme leaves building space, which could not fail to be of great value, includes works that would be highly remunerative, supersedes all further river bridges and lateral embankments, greatly facilitates traffic and passages; and that, amongst other benefits, it would also give the Houses of Parliament 100 or more yards additional garden frontage.

The section is adapted to the narrowest part of the river, between the points in question, but 20 or 30 additional feet of width in the scheme would, I think, be desirable.

I hope to be in town shortly, when I shall be happy to wait on yourself and co-referees at any time that may suit your convenience.

I have, &c.
(signed) *Wm. Worsley.*

To Captain D. Galton, R. E.
&c. &c. &c.

N.B.—I must stipulate for leave to take a copy of my drawing, and that it may not be published without my consent.

(iii.) Reference to Drawing A.‡

Levels.

1. The river being diverted, and the quay embankment made as proposed ("Thames Reform," pages 14 and 15) at Blackwall, the flood-wave in the estuary would not have to contend with the down tidal water to that point; the rise of the tide therefore, at such quays, would approximate more to the 14 feet tidal rise at the Nore.

2. The rise of the tide, five or six inches below London Bridge is not, it may be assumed, quite so high now as at the Bridge; but the volume of water below being so much larger, the difference probably would not be great; whatever it was, it would necessarily be in favour of the drainage; whilst the Pool would be equally maintained at an ample depth of 28 feet or more.

Main Culvert.

3. At Battersea Bridge, the depth of the river at low water will be about 9 or 10 feet; the bottom of the main culvert should be raised 12 or 13 feet above the bottom of the river at that point, and as high, all the way to its outfall, ten inches lower down, as the drains which now empty themselves into the river will permit, with a view to maintain a sufficient fall above low-water

* *See* Minutes of Sir W. Worsley's and Mr. Worsley's Evidence, page 470.
† Pamphlet not reprinted in this Appendix.
‡ *See* Plate 10.

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Sir *W. Worsley*, Bart.

water mark at the final outlet of such main culvert. Practically, the level of this culvert at Battersea will be higher than what is shown in the Drawing; but as its levels and fall will, in some degree, depend on the effect of tidal interception, these cannot, at present, be positively laid down; but this is not material, as the due working of the main culvert will depend more on the means provided for its being constantly flushed with a copious head of water from the Battersea reservoir than on the degree of its fall; it would commence just below Battersea Bridge, and might have less inclination for the first two or three miles, than afterwards.

Bed of the River.

4. Under the above changes, the bed of the river between Battersea and the transverse head quay (Thames Reform, page 17) could be laid dry by running so much of the water off as would flow out at low tide, and pumping out the remainder. Portions of such space upwards might also, from time to time, be kept under water to any given point by a low temporary transverse wooden dam, permitting of the spaces above such dam to be laid dry successively, as the progress of the works required; and, as might be desirable, both to facilitate the works, and to prevent effluvia; two temporary wooden sewage culverts would also be required.

5. Commencing at the left of the Drawing, the circles denote pipes for water and gas, which, in order to render them easily accessible, should be merely covered with a flag about one foot six inches above the street-way level, and carried by arches across the thoroughfare streets.

6. The intervals between the lateral traffic ways (some of which should be general thoroughfares to the south side of the town) might be occupied by arched recesses for goods; and to guard against crowding and accidents, there should also be foot thoroughfares, as indicated on the Drawing.

7. A slight deviation from the serpentine course of the proposed improvements may be needful at the existing bridges; in other respects, it is presumed that whilst they will offer no serious impediment to the scheme in question, they will be, at once, most needful and ornamental adjuncts to it.

8. The rest of the Drawing will be found to correspond with the suggestions contained in "Thames Reform."

24 February 1857. *Wm. Worsley.*

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4. Plan for Raising Sewage proposed by Mr. *Slate.*

Plan for raising Sewage.
Mr. *Slate.*

43, Adelaide-road, Haverstock-hill, London,
18 February 1857.

Gentlemen,

I beg to present the accompanying design,* illustrative of an elevating wheel adapted for raising the sewage of the main drainage of the Metropolis.

It may be described as an adaptation of the ancient Persian wheel to the altered circumstances of the requirements, and the greatly increased facilities of manufacture of the present day.

The wheel, as shown in the drawing, has a lift of 30 feet, but the plan, of course, can be adapted to varied elevations.

It is constructed of wrought iron, on a cast iron centre, and combines the powers of the ancient Persian wheel and modern dredging machine, so that whatever comes down the sewer, whether bricks or silt, carcases or bales of goods, shall inevitably be lifted with the sewage and pitched into the upper level.

I propose to work the wheel in a building hermetically sealed, and to pass the driving shaft through a water stuffing-box, so that no effluvia from the agitated sewage could possibly escape.

The position of the sewage in course of elevation is shown in the section, due provision being made for the relief of the air from the wheel as it fills.

Such a wheel, in its ordinary state of working, would equal in effect four pumps, each eight feet in diameter, and in case of a large accession of water from floods or otherwise, the effect may be greatly increased without an increase of power to work the wheel; indeed it appears to me so entirely to fulfil the specialities and conditions of the case, that I should be glad to have an opportunity of carrying it out, my confident belief being that it would prove so efficient as to offer the means of greatly modifying the lines and levels of the sewers, more especially the latter, as in passing low tracts of land, or gorges and ravines, raised aqueducts or expensive structures may be greatly modified, if not entirely dispensed with, and very large expenditures in the first instance avoided, at a comparatively small annual outlay.

With these remarks I leave the matter in your hands, feeling that you will appreciate the advantages of the machine, and be best enabled to consider the practical working of it as proposed to be applied, as an important adjunct to the main drainage of the Metropolis.

I have, &c
(signed) *Archd. Slate.*

To Capt. D. Galton, R.E.,
Jas. Simpson, Esq., C.E.,
Thos. Blackwell, Esq., C.E.,
29, Great George-street, Westminster.

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* *See* Plate 11.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. W. Couchman.*

15 May 1857.

5.—Minutes of Evidence, &c. of several Gentlemen who have submitted Plans.

(1.) Minutes of Evidence given by *J. W. Couchman*, Esq.

Meeting of Referees, 29, Great George-street, Friday, 15 May.

Mr. *Couchman* attended.

Mr. Couchman stated that his proposition was to divide the whole of London into six districts, four on the north of the Thames and two on the south.

There would be an outlet sewer on the north, beginning at Kensington Crescent, passing through Westbourne and Holloway to West Ham, to receive the contents of all the reception sewers which would fall into it right and left. It would be at a great depth, and might be worked by tunnelling without any danger.

Of the reception sewers, one would commence at Blackfriars Bridge and fall into the main sewer at Kensington.

One of the reception sewers on the south would begin at Battersea and go to Woolwich. Mr. Couchman said the sewers would pass through clay, sand, and gravel, and he expected to meet with some water.

All the sewage would have to be pumped by his system, and he proposed to divide the surface from the house drainage, so as to get the latter as little diluted as possible, for the purpose of applying it to agricultural land as a manure.

Mr. Couchman stated that he had turned his attention for a long time to the subject; he had been engaged as an assistant to Mr. Hawksley.

Mr. Couchman said that he was convinced of the value of the sewage as a liquid manure; he did not think it could ever be converted profitably into solid manure, and even if so made, it would be impossible to abstract all the ammonia from the supernatant water. He did not think farmers were yet sufficiently aware of the value of the sewage water. Thought a compost might be made of the sewage water by mixing soil with it, so as to absorb the liquid part of it.

With regard to the separate system, Mr. Couchman estimated the average expense of altering the drains per house, to adapt them to the separate system, at about 9*l.* or 10*l.* per house.

In answer to a question, Mr. Couchman said that he did not see any difficulty in constructing the sewers at the crossings of streets. The new sewers which must be made, Mr. Couchman proposed to construct for the house drainage, the existing ones being allowed to carry off the surface waters.

In answer to Captain Galton, Mr. Couchman said that he was aware there would be difficulty in preventing people making connexions between the house and surface drains in case it were convenient to do so; but thought not to any great extent. Believed, however, that it would be possible to maintain the integrity of the two systems, though it might take some time to overcome prejudices, &c.

Mr. Couchman admitted that early in the morning the surface drains would be very much effected by the filth thrown out into the streets in the low parts of the town. This objection he believed would be only temporary, *i.e.*, till the new system was brought into proper action.

Mr. Couchman, in the "Concise Statements," had provided for 2,000,000 cubic feet per diem; but did not consider that would be sufficient. Had estimated that he would have to provide for from 16 to 18 gallons per head of water daily. Some portion of this would be carried off from the sinks and kitchens, which would thus pass into the surface drains.

All the surface water would go down through the present sewers, and be discharged at the existing outlets without any modification.

Thought it would be illegal, according to the strict and literal meaning of the Act, to throw any part of the Fleet, even up to its source, where it is already polluted, into the river.

In answer to a question, Mr. Couchman stated that he had had no experience in pumping sewage under pressure through iron pipes. Did not think they would get coated with deposit, great care being taken to exclude all roadgrit, &c., from the sewers.

Thought there would be no difficulty in pumping the sewage up sufficiently high to command a large area of country for the purposes of applying it to agriculture.

Mr. Couchman estimated the amount of fertilising matter in 16 gallons of sewage at about one and a half per cent.

The culverts which he proposed would have two feet fall per mile.

In answer to a question, Mr. Couchman said that pumping engines would be erected at the outfalls, and the sewage pumped into the Thames till the farmers began to use it, and the engines would then pump it along mains into the country.

The cost of distribution, and all expenses, including five per cent. on the outlay, Mr. Couchman estimated at 2*s.* per 1,000 gallons, or about 1*d.* per ton. The value of 1,000 gallons, in effect, Mr. Couchman believed would be equal to that of 6*l.* 10*s.* or half a ton of guano.

Mr. Couchman said that he spoke to the value of sewage manure from his own experience in Hertfordshire, on a chalk soil.

The way in which this sewage had been applied was in a compost with hedge rubbish and earth, as mentioned above. Mr. Couchman considered that, besides the ammonia contained in the sewage itself, contact with the atmosphere would produce in this compost a further amount of that valuable fertilising property.

Did not think chemical agency could convert sewage profitably into a solid manure. He did not propose to use this sewage for the purpose of supplying moisture in addition to other constituents of vegetable structure, as it would require far too great an amount of it; but had no doubt that, at proper seasons, on meadow land particularly, it would be highly advantageous as a manure: at the same time would more strongly recommend its application in a mixture of earth, decayed vegetable matter, or such mineral matter as the soil of the ground or fields might be deficient in, and which, in most cases, could be procured by excavation in parts of every estate.

(2.) Minutes of Evidence given by *J. Bailey Denton*, Esq., C. E.

Mr. *J. Bailey Denton.*

(1.)

Meeting of Referees, 29, Great George-street, Monday, 4 May.

Mr. *Bailey Denton* attended.

In answer to a question, Mr. Denton said, that, with reference to his plan, he did not anticipate any great difficulty in crossing the River as proposed.

Mr. Denton would not pledge himself to either a liquid or other application of sewage to land, not considering the subject sufficiently matured yet, but believed that it might eventually be used profitably for purposes of irrigation.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. Bailey Denton*, C. E.

4 May 1857.

Mr. Denton had had great experience in land drainage and irrigation generally, but not with regard to the application of sewage to the soil.

Though Mr. Denton did not wish to give a positive opinion as to the relative merits of a solid and liquid application of sewage, he said he was inclined to believe that irrigation would be better than the manufacture of solid manure for two reasons. 1st. That in many instances the application would be less expensive. 2d. That as the operation combined the two services of watering and fertilising, it would be more beneficial to soils of certain descriptions and under certain conditions. This belief Mr. Denton founded on a certain amount of experience afforded by the use of the sewage of his own house and offices on adjacent land. Mr. Denton found that it was worth his while to apply the sewage so long as it flowed to the land by gravitation, or only required a small amount of pumping, which his gardener or a farm labourer could afford to give; but that directly it required removal to any distance, the profit became very doubtful.

Mr. Denton said, that it was found that it required 8 feet 4 inches in depth of sewage water to give to the land an equal amount of fertilising matter to that afforded by an ordinary dressing of manure.

Mr. Denton promised the results of some experimentsas to land drainage.*

In answer to a question, Mr Denton said, he proposed, in his design of 1849, to underdrain the marsh lands on the bank of the Thames, before irrigating them, being thoroughly convinced that no irrigation of clay soils or stiff loams could be perfectly satisfactory, till not only surface drainage, but also under drainage, had been carried out; the marsh lands on both sides of the Thames seaward of London being of a stiff and tenacious character for the most part.

Mr. Denton believed one great advantage of draining the marsh lands would be, that it would be possible to apply to them the sewage of London in whatever state it was discharged; a richer sewage would be applicable to the meadow land, the very land, and almost the only kind of land, which would beneficially absorb so potent an application, while the poorer sewage might be applied to the garden grounds, which require, simply, copious and frequent waterings of a very mild character.

Mr. Denton related the way in which he applied the sewage of his own house to the land by means of sub-irrigation, that is, by means of earthenware pipes 18 inches deep, with a cross drainage beneath, 4 feet 6 inches deep. He was not prepared with sufficient data to enable him to make the results of his experience public.

Mr. Denton referred to a particular case of irrigation and drainage works in Lincolnshire, of which he promised details.

Mr. Denton, in answer to a question, said, that he proposed, in the scheme of Metropolitan Drainage in 1849, to carry off the roof and surface drainage direct into the Thames, by separate channels from those which were to convey the house sewage out of London.

Mr. Denton was not now prepared with the details of the question, but thought it would be least expensive to have separate surface drains on either side of the street, and therefore most desirable; but had not gone closely into the question of cost.

Mr. Denton said, with regard to the rain-fall in London, that he found three-fourths of an inch not unfrequently fell; and thought, consequently, it would be less expensive to carry this direct into the Thames, than to attempt to provide for so large an amount of inoffensive water in the proposed new intercepting sewers, which should be confined to that which was offensive only.

Mr. Denton said, that he was aware the rain-water pipes in London constantly carried away the filth and refuse of the houses, from being improperly connected with upstairs water-closets; and allowed there would be great difficulty in separating the house from the surface drainage; but stated the general result of his consideration of the subject to be this. He had known and recorded as much as a fall of 0·75-inch of rain in 24 hours, the greater part of which had sometimes fallen in one or two hours, and therefore thought, as such a sudden fall might amount to 50 tons per statute acre, it would be very undesirable to attempt to carry this off in the intercepting sewers about to be constructed; but, considering the whole question, and having regard to the use of the present sewers, which conveyed away both surface drainage and house sewage, he was not prepared to say that the difficulties to be overcome would not more than counterbalance the advantages attending a separation of the rain-fall from the sewage.

Mr. Denton, in illustration of the rapidity with which water was discharged from drained clay lands under certain conditions, alluded to a case of drainage in which he had observed a flow of 2·9 gallons on one day increased to 103 gallons on the next, after a fall of 0·542-inch of rain. In this case the rain-water discharged passed through 4 feet of gault clay soil.

Mr. Denton, in answer to a question, said, that he found in the wetter months of December, January, and February the undrained clay lands in the neighbourhood of the metropolis would be saturated to the full, and that a very large proportion of the rain-fall would flow off the surface, while, in the same land drained, he has known, on an occasion of a fall of half-an-inch of rain, half the fall to be voided by the drains, and the rest gradually be carried away through the drains, none, however, flowing off the surface if the land were properly cultivated.

Mr. Denton thought it would be very desirable to allow some of the London sewage to flow in such a direction as to be available for the agricultural districts west of London, where garden-ground is more general, and the soil more open in character; thinking it certain that the time would come when gardeners and farmers would be only too glad to avail themselves of it for application to the land.

Mr. Denton would carry any of this sewage, not so used, into the low level sewer, if the point of delivery should necessarily be fixed below the higher level intercepting sewers.

Mr. Denton said that his observations (which he promised to send in) extended not only to clay lands, but also to chalk soils.

Mr. Denton said, with reference to the absorbent and retentive nature of clays, that he found last year that, after a considerable fall of rain during September, October, and November, the clay lands vented none of their water till the 27th November; and from that moment, any, the slightest fall, found its way out in large proportions, until spring came with its rapid evaporation and vigorous growth of vegetation.

Mr. Denton, in answer to a question, said, that the largest quantity of rain he had known carried off by under drains in 24 hours, after the ground had been previously saturated, was 2,750 gallons per acre, when the rainfall was 2,959 gallons per acre; but this was after continued rain in large quantities, and every pore and tube of the soil was filled to overflowing. Ordinarily, the proportion immediately discharged by clay-land underdrains during the winter months does not reach half the amount of the rain-fall. These observations were tendered in reference to the question of irrigation, as a means of disposing of the sewage.

* *See* Appendix III., page 117.

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Plans of Drainage.

Evidence.

Mr. *J. Bailey Denton*, C.E.

9 May 1857.

(ii.)

LETTER (Supplemental to Evidence) from Mr. *Denton* to Mr. *Simpson*.

52, Parliament-street, Westminster, 9 May 1857.

Dear Sir,

I ENCLOSE you the draft of my unconnected remarks, which your Secretary put into my hands on Monday last. I have made some corrections.

When I ventured to address you and your colleagues on this subject, my principal object was to bring under your consideration the claim of the competitors of 1849. I was not so sanguine as to believe that the designs of that year would bear comparison, in their details, with the matured plan of Mr. Bazalgette of 1856, but I felt that I could fairly ask at your hands an acknowledgment that there did exist (if you found the case to be so) among the plans sent in to the Sewers' Commission in 1849, a scheme similar, in its main features, to the design presented by Mr. Bazalgette to the Metropolitan Board of Works, and sent up to you for approval.

I do not assume, in this appeal, that Mr. Bazalgette's plan will necessarily be the one you will recommend for final adoption, though I am strongly of opinion that, with certain exceptions, it is the best that has been brought forward.

Believing this to be the case, I cannot refrain from asking you and your colleagues to state, in your Report, publicly what I understood you to admit on Monday last: that Mr. Bazalgette's plan is, in its leading features, a counterpart of mine.

I ask this as a recognition of common justice, and the good faith due to public competition.

I cannot lose the opportunity of repeating in general terms the advantage of a straight low-level drain, connecting the Westminster low-level district with the southern low-level districts by a culvert under the Thames. In recommending this course, instead of the circuitous one following the north side, I am influenced by the experience I have gained in the drainage of land; by which I have ever found, when dealing with covered conduits, that a directly straight course is so very far superior to a tortuous one that you can afford to expend a large sum of money in obtaining it without fear of losing the advantage on commercial grounds.

I enclose records* of the passage of rain through, and the discharge of water from, the underdrains of certain soils. These records refer only to January and February of this year; those of the previous and subsequent months, from 1st October 1856 to the 30th April 1857, are being made out and copied for your use. I venture to think that these records clearly show that, although clay soils, if thoroughly drained, discharge their surplus water rapidly when their pores and fissures are filled to repletion by the twofold influences of gravitation and capillary attraction, yet they exhibit the absorbent and retentive qualities of such soils in a way manifestly repugnant to the repeated application, by surface irrigation, of sewage when copiously diluted.

As an instance of this, I beg you will observe that in the month of February, when there was comparatively no rain, the rain which had fallen in the previous month of January rose considerably in the test holes. What the effect of applying four times, or even double, the quantity of the rain-fall would be, I leave for those to demonstrate who advocate the appropriation of the sewage for the purpose of the surface irrigation of clay soils.

I find that the late Mr. Livesey's iron-piping for sewage irrigation cost him 7*l.* per acre, including the hydrants, of which he had one to every 3½ acres. I believe he considered that the cost would be above 8*l.* per acre when the hose and other attendant expenses were added.

I would recommend the Referees to visit Lord Essex's farm near Watford, to which the sewage of the town of Watford is applied in as perfect a way as in any instance to be found, I believe, in England.

I am, &c.

(signed) *J. Bailey Denton.*

James Simpson, Esq.

(3.) MINUTES of EVIDENCE given by *B. Dixon*, Esq., Member of the Metropolitan Board of Works.

Mr. *B. Dixon*.

13 March 1857.

Meeting of Referees, 29, Great George-street, Friday, 13 March.

Mr. *B. Dixon* attended by appointment.

IN answer to a question, Mr. Dixon stated that his experience convinced him that Mr. Forster's observations with a float, as to the flow of the tide, led to wrong conclusions.

Mr. Dixon contended that the flood tide was a surface current, whereas the ebb tide went out in a body.

Mr. Dixon also detailed experiments by which he found that the tide flowed along the banks of the river, while it was ebbing in the centre; also stated that the sewage went to the bottom of the river, and, consequently, Captain Burstal's and Mr. Forster's observations on a float at the top of the river rather misled people seeking to discover how far the sewage proceeds in a day or lunation down the river.

Mr. Dixon exhibited specimens of sewage taken from the Black Ditch and from Ratcliffe Cross Sewer, and of water which had filtered from similar samples placed in the model of the tunnels he proposed for drainage.

Mr. Dixon stated that he had been to Leicester, and seen the manure manufactured at Mr. Wicksteed's works; but did not believe it was really useful for agricultural purposes.

In answer to questions, said that the four tunnels he proposed would hold 2,000,000 cubic feet, which would flow into it at each tide; and this would provide, he believed, for the whole drainage of the north.

Mr. Dixon did not think any nuisance would arise from works for the manufacture of manure, according to his plan.

Stated that he had objections to running sewage 10 miles or more, for he believed that a deposit would be formed on the way, and that the liquor would come out at the end almost pure, so that the sewers would be liable to obstructions. The case would be stronger if the sewers were open, as might be seen at Ash, in Kent.

Mr. Dixon proposed a place called Hornchurch, near Mr. Bazalgette's original point of outfall, to erect his works for the manufacture of manure.

Mr. Dixon believed that water was the best, and, in fact, the only good deodoriser.

In

* *See* Appendix III., page 117.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *B. Dixon*.

13 March 1857.

In answer to a question from Mr. Simpson, he said, that he apprehended very serious results from the abstraction of so large a quantity of water from the river, to be returned to it only at Erith.

Mr. Dixon believed that the result would be that the river would return to the same state in which it was before the demolition of old London Bridge and the introduction of steamers, when the mud and silt collected in the bed of the river, and the Thames was consequently far more filthy than it has ever been since. Also thought that the channel of the river might be materially damaged by the removal of so much scouring water as is now proposed. Believed that the scour would be considerably diminished by the abstraction of land water, because observation had shown him that a flood of land water always increased the duration of ebb, and diminished that of flood tide, thereby increasing the scour.

Mr. Dixon instanced an occasion on which high water at London Bridge had occurred 1 hour 10 minutes before it did at Gravesend, whereas it is usually 1 hour 45 minutes later than the Gravesend high water.

Mr. Dixon mentioned a fact he had observed on the Rainham Marshes, where sheep grazing avoided that part through which a foul drain ran. Believed that a sewer, taken through Essex to the Crouch, would so drain the land that it would be impossible for people to get water to drink.

Mr. Dixon thought that the diminution of the River Thames would have a serious effect on Erith, where, even now, the smell blown by the north wind from London, was at times very bad. Was aware of the effects at Brighton, of the sewerage being washed in by the returning tides to the shore.

Mr. Dixon considered that the effect of taking the sewage to the River Crouch, and there discharging it on to the marsh lands, would be, that the north-east wind and current of the flood tide would carry it again towards and into the River Thames.

Mr. Dixon stated that he did not believe it possible to deodorise sewage in or near London, without creating a nuisance.

(4.) MINUTES OF EVIDENCE given by *R. Dover*, Esq.

Mr. *R. Dover*.

1 April 1857.

Meeting of Referees, 29, Great George-street, Wednesday, 1 April.

Mr. *Dover* attended.

MR. DOVER stated, that no smell whatever resulted from either his works at Essex-street, or any of his operations: and, in fact, that they were perfectly inoffensive.

Stated, that he did not use lime or any other caustic in any part of his process, for many reasons stated in the 10th paragraph of his letter to the Referees.*

Regarding the quantity of phosphates in the sewage, as well as in the deodorised filtered water, and the chemical nature of the residuum, Mr. Dover said he was not a professed chemist, and could not take upon himself to answer the first part of this question, because the quantity of phosphates varied according to the quality of the sewage. As regards the agricultural value of the residuum, Mr. Dover submitted the certificate of its analysis by Mr. Henry Medlock, showing the agricultural value of its chemical composition.

Mr. Dover stated, that he had not had an opportunity of manufacturing a sufficient quantity for the purpose of testing its efficiency; but he exhibited the statements of the late Mr. Milburn and Mr. John Tull, a farmer of eminence in Oxon and Berks, as to its agricultural value.

With regard to works, Mr. Dover said he had nothing more to add to the 7th paragraph of his before-mentioned letter, than that the deodorised filtered water is so clean and pure that it might be very advantageously supplied to fountains in convenient localities; so that the poor might have an abundant supply of this useful element without cost, for washing their houses and linen. This arrangement, he believed, would also save to the parishes the enormous sums they are now paying to the companies for water to flush sewers, public urinals, and for street watering.

Mr. Dover said, that it would not be found necessary to construct works for more than the diurnal discharge of the sewers; also, that no adequate benefit would result to the public from works to intercept more rain-water than double the average diurnal discharge of the sewage.

The kind of reservoirs that will, in Mr. Dover's opinion, best effect all the requirements of the public, are cast iron tanks, to hold between three and five tons each, constructed according to the vertical section sent in; and, with a series of them, the operations would be continuous; each reservoir filling consecutively, and in the same manner emptying, in a given space of time, say within one hour, or 24 times per 24 hours. Works so constructed, Mr. Dover considered, would be the least expensive and most reproductive, and so perfectly efficient that they could never get out of order, while the wear and tear would be next to nothing. Their continuous working, also, could never be affected or impeded by either storms or any other similar casualties.

Mr. Dover also stated, that each ton of sewage of the average quality discharged from the sewers of London, deodorised according to his process, would yield 7 lbs. to 8 lbs. of dry solid manure, and that, consequently, 300 tons of sewage would produce fully a ton of manure. The quantity of valuable ammoniacal matters wasted daily in the Thames exceeds 1,000 tons.

The quantity of deodorising materials required to convert the putrescent matters in 300 tons of sewage into manure would be 600 lbs. hydrochloric acid, 50 lbs. protosulphate of iron, and 40 lbs. chloride of sodium, costing altogether 2*l.*; and, with this addition, the analysis shows that those matters, in a dry state, are worth 4*l.* to 5*l.* per ton.

* *See* page 364.

(5.) MINUTES of EVIDENCE given by Messrs. *L. Gisborne*, C.E., and *H. C. Forde*, C.E.

Messrs. *L. Gisborne*, C.E., and *H. C. Forde*, C.E.

2 April 1857.

Meeting of Referees, 29, Great George-street, Thursday, 2 April.

Messrs. *L. Gisborne* and *H. C. Forde* attended by appointment.

MR. GISBORNE wished to urge the opinion he entertained, that the low level sewer could be constructed along the river bank at much less cost than along the Strand, Cheapside, &c.

The embankment Mr. Gisborne proposed was not exactly on the line laid down by Mr. Walker, but its deviations were very slight.

Mr. Gisborne would carry out his works by a company, with a capital of 2,000,000*l.*, having a guarantee of four per cent on the outlay.

Mr. Gisborne read a letter from himself to the Metropolitan Commissioners, and put it in as evidence.

Appendix X.

Plans of Drainage.

Evidence.

Messrs. *L. Gisborne*, C. E., and *H. C. Forde*, C. E.

2 April 1857.

On this letter the Committee of Works made the Report, which had been previously sent to the Referees.

Mr. Gisborne explained the way in which his bill had been withdrawn, just before the second reading in 1854, upon the declaration of war, by the advice of Lord Palmerston.

Stated, in answer to a question, that he considered his estimates more than sufficient to cover all expenses.

In answer to Mr. Simpson, Mr. Gisborne said, that he believed he should improve and not deteriorate the wharf property in London. Provision had been made in the estimates for temporary injury done.

Mr. Gisborne read a portion of his plan, pp. 14, 15, 16, in support of this assertion; also, p. 18 in explanation of the new system of drawdocks which he adopted.

The embankment would begin on the north side at Westminster Bridge.

Mr. Gisborne explained at some length the details of his plan. He considered a saving of 64,000 *l.* might be effected on the excavation and carting away of 421,000 cubic feet on the north, and 436,000 cubic feet on the south, which might be used towards the formation of the embankment, and said Mr. Bazalgette agreed in this opinion.

Mr. Gisborne believed that six per cent. might fairly be counted upon as a return for the money.

The total amount of the estimates was 1,900,000 *l.*

Mr. Gisborne believed, that if the Metropolitan Board of Works approved the guarantee, no Committee of the House of Commons would turn the Bill out on that account.

Stated that the Admiralty, the Navigation Committee, and the Commissioners of Works all approved of his plan.

Mr. Gisborne had put himself to a great deal of trouble in order to discover to whom the foreshore of the river belonged, but without success. The Bill which had been in Parliament in 1854 would have settled the question definitively, leaving the Corporation or the Admiralty (to whichever the foreshore now belonged) authority only over that part of the river between the proposed quay walls.

Mr. Gisborne believed that money enough would be paid to the Metropolitan Board of Works out of the half-surplus profits over five per cent., to build three or four new bridges over the Thames.

(6.) Minutes of Evidence given by Messrs. *Gotto & Stothert.*

(i.)

Meeting of Referees, 29, Great George-street, Friday, 3 April.

Messrs. *Gotto & Stothert* attended by appointment.

Messrs. *Gotto & Stothert.*

3 April 1857.

Mr. Stothert explained his deodorising process, leaving sections, plans, &c., and a report detailing the proposals.

Mr. Stothert stated that he proposed to apply the supernatant water to the land, having had decomposition temporarily arrested by the mixture of sulphate of alumina. Decomposition recommences after a period varying from four days in hot weather to a month in cold.

The deodorising materials, charcoal, sulphate of alumina, lime, &c., add to the agricultural value of the manure. The sulphuric acid is used to fix the ammonia, and goes off with the water.

The deposit left in the beds, besides forming the basis of a valuable manure, makes a very useful and cheap charcoal, and ammonia is recovered from it in great quantities.

Messrs. Stothert & Gotto, in calculating the prospective population, have taken the same data which Mr. Bazalgette adopted, and have provided for carrying away 30 gallons per head per diem, but allowing half that quantity to pass off in six hours. They also provide for carrying off rainwater to the extent of one-quarter inch in 24 hours from the urban districts, and one-eighth from the suburban; representing an uniform rain-fall of 1 inch over the whole surface.

The estimated cost of the deodorising works for the north-western district is 120,000 *l.*, and 10,000 *l.* for land.

In answer to a question, Mr Stothert stated, that it would take 2 hours 15 minutes to fill one of the tanks, and when once thus filled, the sewage would flow through it continuously as fast as it reaches the station.

Mr. Stothert thought the supernatant water, until it was appreciated for agricultural purposes, could be very advantageously pumped up for the purpose of flushing the sewers.

Mr. Stothert read a report by Mr. Jebb, Chairman to Metropolitan Commissioners of Sewers, on some experiments made in September 1852 on sewage water with his deodorising powder, showing that the supernatant water possessed the property of deodorising sewage without precipitating the solid parts, illustrating the value of the supernatant water for flushing purposes.

In reply to the suggestion, that Mr. Stothert should mark on a geological map the districts which he proposed to irrigate, he stated, that there were large areas in the vicinity of London occupied by the Bagshot sands, the lower tertiary strata, and the chalk, which would be benefited to an incalculable extent by irrigation with the supernatant water.

A selection from these areas of those most suitable for the purpose would not be difficult, but it is found that actually to define them would be attended with a larger expenditure of time in personal examination and taking levels, than would admit of the results being given in so particular and specific a manner as Messrs. Gotto & Stothert would wish. It might, however, suffice for the present to state, that for the north-east district the whole of the country between the River Thames, and nearly a straight line drawn from the outlet works of this district at Bow to Southend, would for the most part be thus immeasurably improved.

For the north-west district, from Hounslow westward, the supernatant water may be employed with advantage.

For the south-east district, the country east and south of the depôt or outlet station on the Deptford Creek, being the development of the sands and mottled clays of the lower tertiary and chalk lands, are available for the purposes here contemplated.

For the south-west district, all the country south of Croydon and Epsom, and west of Esher, may be profitably irrigated.

In answer to a question, Mr. Simpson gave the estimated amount of water supplied by the companies, viz., 100 million gallons a day, and the rain-fall of one-quarter of an inch, or 400 million gallons a day, which it was proposed to provide for.

Mr. Gotto explained, that the quantity of house-drainage proposed to be taken off by his plan was 112½ million gallons a day, and the sewers large enough to carry off half this quantity in six hours: and, with regard to the rain-fall, his plan provides for draining a 1-inch rain-fall, with flood provision for the greatest storms known.

Mr. Gotto said, that he was prepared to undertake, with a company, the whole construction of the works, &c., in consideration of a constant 4 per cent. guarantee from the Government.

The whole estimate of the drainage and deodorising works would be 1,500,000 *l.*; and a detailed estimate was handed in.

Appendix X.

Plans of Drainage.

Evidence.

Messrs. *Gotto & Stothert.*

3 April 1857.

Mr. Gotto explained that his proposed division of surface and house-drainage was only partial; that all water which fell on the roofs of houses, &c., passed into the house drains, while that which fell in gardens, streets, &c., would pass away in the surface drains, and this partial division would only take place in the outlying districts, and not in the thickly populated parts.

The water from the roads, streets, &c., in the north-west district, for example, would be allowed to flow into the Regent's Canal at the highest level, an advantage which the Canal Company would no doubt be willing to compensate for by allowing their surplus water to be used for flushing.

The whole of the drainage would be intercepted from the river.

Mr. Gotto called the attention of the Referees to the fact, that the area for pumping is reduced in this plan to an extent smaller than that proposed in any other, and also that the horse-power required would be as 800 to 2,700 for both north and south, laid down as necessary by Mr. Bazalgette.

Mr. Gotto desired it to be understood, that by this plan there would be a constant discharge without pumping above high water for the drainage of the largest area hitherto contemplated, and that there will also be a constant discharge by pumping from the smallest area hitherto proposed, and that none of the inverts of the lowest sewers are below low water.

(ii.)

Meeting of Referees, 29, Great George-street, Monday, 4 May.

4 May 1857.

Messrs. *Gotto & Stothert* attended by appointment.

Mr. Gotto handed in a map showing a vast area of country round London which could be profitably irrigated with the supernatant water, such lands being of a permeable nature; but Mr. Gotto proposed at first to limit the irrigating operations to an area of about 45 square miles for each of the four districts, making the further extension of the irrigating process dependent upon the effect produced, and the appreciation of this liquid manure by the agriculturalists.

The spare engine power proposed at each outlet would be adequate to lift the proposed limited quantity.

From the outlet works of the north-east district he proposed to pump up six million tons per annum of the water to an elevated spot at Romford in Essex, for the purpose of irrigating, by gravitation, 45 square miles.

From the south-east outlet, Mr. Gotto would pump up, along a distance of three miles, a similar quantity to such an elevation on Shooter's-hill, as would command, by gravitation, the irrigation of an equal extent of country.

From the north-west outlet works he proposed to pump a distance of eight miles to Hounslow, so as to command an area for irrigation similar to the two former.

Part of the supernatant water from the south-west district it was suggested should be pumped a distance of 10 miles to Banstead.

Mr. Gotto did not wish to commit himself absolutely to these suggestions, because positively to define the most suitable localities for irrigation would involve much more personal examination of the country and levels than it had been possible to devote to that part of the subject.

In answer to a question, Mr. Stothert said, it was impossible to precipitate the most valuable salts in the sewage. It was found by experiments conducted for him by M. Gannal, of Paris, some years ago, and confirmed by English chemists, that after the other solids had been precipitated there remained 340 lbs. of fertilising desiccated salts in every 100 tons of the supernatant water, showing its value as a liquid manure.

Mr. Stothert said he had omitted to state before, that his object being to arrest temporarily decomposition, he had found that the addition of a minute quantity of peat or other essential oil would continue to arrest decomposition for a further period, to admit of its application to the land without the slightest nuisance.

Mr. Gotto said, that he proposed to pump into the country, from each of his four stations, an amount of clarified water (after the solids had been precipitated) equal to 800 cubic feet per minute, distributing 200 tons per annum per acre. A portion of the remainder he would pump for the purpose of flushing the sewers, and the rest would flow perfectly clear direct into the Thames, except at times of excessive storm.

In answer to a question, Mr. Stothert said, that the preparation of his sulphate of alumina was a very simple process.

The average height at each station to which the liquid manure was to be raised would be about 110 feet. To this he added the head to overcome friction according to the distance in each case. Three feet pipes would be used.

Mr. Gotto wished it to be understood, that in respect of the area to be irrigated he had only sketched an outline of what might be done, and wished to show that there were suitable lands within a reasonable distance round London to which the sewage might be pumped for the purpose of irrigating.

Mr. Gotto stated, that it was now admitted on all hands, that the disinfection of sewage was practicable, and he was convinced that there was also a commercial value in sewage, but the extent of such value was not yet ascertained. It would, of course, depend upon the cost of the manufacture of the solid manure, and of pumping, as regards the liquid manure; a distinguishing feature in this plan being, that the clear supernatant water was equally available with the solid precipitate.

Messrs. Gotto and Stothert did not think they could count upon more than a net profit of 10 *s.* per ton on the solid manure, but they were very unwilling to commit themselves to any sum as the probable profit of the solid and liquid manure, and wished only to maintain the feasibility of the process they proposed.

In answer to a question, Mr. Gotto said, there was no fear of the pipes used for pumping the liquid manure becoming coated or filled up with mud, as those at Stanley Bridge had done, from the fact that he proposed to pump nothing but clear water, though containing valuable fertilising properties.

Mr. Gotto said, that their plan would not interfere with, or cause any alteration in the sewers as they now exist throughout the more thickly populated parts of London, where surface-water would flow with the house drainage as it now does. This district was coloured red and blue on the general map of London, sent in by Messrs. Gotto & Stothert, and was embraced by the Regent's and Kensington Canals on the north, and a straight line from Battersea to Deptford on the south. In the parts outside this boundary, existing houses, as well as those hereafter to be built, would be drained precisely as hitherto, and new outfalls provided for the house drainage, including rainwater falling upon back yards, &c.

He was anxious to clear up an impression that appeared to exist, that they contemplated two sets of drains for every house.

The intended drainage of the outlying districts would differ from the existing drainage of the mass of London in that the rainwater from roads, streets, and open spaces, would be conveyed down the present natural watercourses unpolluted by house drainage.

In fact, the following are the general opinions at which they have arrived:

1. That it is imperative, on sanitary grounds, that the sewage should be deodorised.

2. That this is now universally admitted to be practicable.

3. That, in order to make this operation result in commercial profit, and upon other sanitary considerations more fully explained in the report, it is of primary importance to reduce the dilution of the sewage as much as

Appendix X. Plans of Drainage. Evidence. Messrs. *Gotto & Stothert.* 4 May 1857.

as possible; which is effected in this plan by carrying off direct into the river the majority of the rain-water from the outlying districts, and conveying the house drainage from such areas direct to the respective depôts for purification.

The importance of this arrangement will be apparent, when it is shown that over about three-quarters of the area this separation is to take place.

The circle delineated by Messrs. Gotto & Stothert, within which they would not alter the existing drainage, might perhaps be slightly modified by enlargement, or the contrary, upon further examination, in carrying out the work

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(7.) Minutes of Evidence given by *Samuel Hughes*, Esq., C.E., of Park-street, Westminster.

(i.)

Mr. *S. Hughes*, C.E. 30 April 1857.

Meeting of Referees, 29, Great George-street, Thursday, 30 April.

Mr. *Hughes* attended by appointment.

Mr. Hughes believed Mr. Bazalgette's sewers quite insufficient for the amount of rain-fall, understanding him to take off only ¼th of an inch from the urban and ⅓th from the suburban districts.

Mr. Hughes believed Mr. Bazalgette intended to make the present sewers relieve his main sewers, when overcharged, by means of self-acting sluices or sluices worked by hand. This, Mr. Simpson informed Mr. Hughes, Mr. Bazalgette did not intend to do, but to carry the sewage off by strictures, *i.e.* by smaller sewers issuing from the main intercepting ones.

This information, Mr. Hughes said, altered his objections and threw them into a different shape. To impede the storm-waters by simple strictures might relieve the sewers from danger of blowing up and certain other inconveniences, but it was very questionable whether any system of strictures could be devised at all adequate to meet the difficulty of discharging storm-waters.

Mr. Hughes had other objections; one was, that even if the Metropolitan Board of Works' plan were carried out the defects of the present sewers would be by no means removed, many of the lateral sewers having in parts no inclination towards the Thames whatever, while some even fell in the contrary direction.

Mr. Hughes would wish to see an entirely separate system of sewers for rain-fall and sewage matter proper.

Mr. Hughes would include the rain from the housetops and gutters in the surface drains, to be carried off into the river without undergoing any process.

Mr. Hughes was aware that the present state of many back streets and courts in the lower parts of London was now very bad, and the consequence was that much dirt and filth went down the gully holes in the streets; but believed that, by proper arrangements for the cleansing of the streets, &c., the nuisance might be abated, or even altogether removed, and the rain-water would then pass into the sewers comparatively unpolluted.

Mr. Hughes knew that the expense of constructing a new and separate system of drains would be very great, but did not estimate it at so much as 10 *l.* a house on 200,000 houses, equal to 2,000,000 *l.*, a cost suggested as probable by Mr. Simpson.

Mr. Hughes stated that he considered one great recommendation to his plan to be, that by carrying the surface water into the Thames, he would be able to get a greatly increased fall, and could consequently make his sewers of proportionately diminished size.

Mr. Hughes alluded to a case of a sewer which had been found blocked up in Parker-street, in the Westminster district, while a new sewer was being made by a contractor for Corpus Christi College, Oxford. He believed that this had become blocked up from its having been originally formed in a defective manner, without regard to levels, like many other sewers now existing in the Westminster district of the Board of Works, of which Mr. Hughes was a member.

The existence of this sewer in Parker-street was so entirely unknown to every one, that it does not appear marked or indicated in any way on the very complete sewer plans handed over by the Metropolitan Board to the Westminster District Board. The latter, being thus quite unaware of its existence, called on the College to construct a new sewer for the drainage of the basement floors in Parker-street. The old sewer was not discovered till the contractor broke up the ground to put in the new one, when the old one was found entirely choked up with earth and rubbish. This old sewer was ten times the size of the new one which was substituted for it.

Mr. Hughes also wished to allude to the effect upon the river of the abstraction of so much rain-water from it.

Mr. Hughes said he had not gone deeply into this question, but thought it was worthy of very careful consideration. He was not prepared to say, that, supposing all the fresh water abstracted from the river, the tide would not rise to as great a height as it does now, but thought that the scour, as it ebbed out, would be diminished from the absence of land-water. Considers it would be dangerous to disturb the present *régime* of the River Thames. Believes the sectional area of the river is due to the concurrent natural action of the tides and the land-water from a definite drainage area, and that any alteration in the conditions under which these act would be attended by a change of sectional area, which might be very injurious to the navigation of the river.

Stated that he knew the outfalls of most of the sewers in the Westminster district. Men are employed both by the District Board and by the Metropolitan Board to watch the outfalls, and see that the flaps are closed at every tide. Were it not for this a great part of Westminster would be flooded at every high tide.

In answer to a question from Mr. Simpson, as to whether he thought it would be an advantage to the King's Scholars' Pond Sewer to have the upland water abstracted from it, Mr. Hughes said that he did not know the drainage area of that sewer, but knew more of the others in the district.

Mr. Hughes related the fact, that water broke into the cellars of many people in the district, and he could only suppose it came from springs, the whole of the gravel being largely charged with water. Mr. Hughes considered it would be an advantage to rid the gravel of this water, which was little more than a nuisance, its quality not being good enough to be pumped for use.

Mr. Hughes maintained, that though he could not claim accuracy of details with regard to his plan, the principle, if good, might be approved, and it would then remain to go into all the particulars of the arrangements, which would justify the expenditure of as much trouble and time as Mr. Bazalgette had devoted to his plan.

Mr. Hughes said that the nuisance of smells arising from the sewers in his district was very great, and he was satisfied, by extended inquiry and observation, that this arises not only from the water being backed up by tidal action, but also from the defective construction of the present sewers, in which are many reversed inclinations and numerous depressions, where decomposing matter lodges to the depth of several inches, and even feet in some cases.

If

If the plan of the Metropolitan Board were to be adopted a large expenditure would still be necessary to cure this serious evil; but if the land water be confined, as proposed, to the present sewers, no expensive works would be necessary to the latter, as it is supposed they would be amply adequate in their present state to the carrying off all the rainfall of the district. Were all the sewerage proper excluded from the present sewers, there would no longer be effluvia, even in cases of stagnation in the worst constructed sewers.

Appendix X. Plans of Drainage. Evidence. Mr. *S. Hughes*, C.E. 30 April 1857.

(ii.)

Paper Supplemental to Evidence.

Sewage Irrigation.

Expression for the horse-power required to overcome the friction of water passing through pipes, communicated by Mr. *Samuel Hughes*, C.E.

Put D = diameter of the pipe in feet.
U = velocity of the water in feet per second.
H = head in feet necessary to overcome friction for each mile in length of the pipe.
C = a coefficient which has been determined by experiment.

Then the general form of the equation, as shown in Hughes on Water Works, page 333, is

$$H = \frac{C\,U^2}{D} \quad \ldots\ldots\ldots (1).$$

The value of *c*, according to Prony, is - - - - - 2·25.
" " Eytelwein - - - - - 2·112.

And Mr. Blackwell proposes to use 2·3, in order to be on the side of safety, and to allow amply for bends and other irregularities.

To apply the above equation in the case of a pipe 3 feet diameter, when the velocity is 3 feet per second, we have

D = 3 and U = 3. Hence, using Prony's coefficient,

$$H = \frac{2{\cdot}25 \times 3^2}{3} = 6{\cdot}75 \text{ feet per mile for friction.}$$

The horse-power per 1,000 gallons will be $\frac{1000 \times 10\,H}{33000} = \frac{10\,H}{33}$.

And substituting the value of H, in equation 1, the expression becomes

$$\frac{22{\cdot}5\,U^2}{33\,D} = HP, \qquad \text{or} \qquad \frac{2\,U^2}{3\,D} = HP \text{ nearly.}$$

Where U = 3 feet per second, and D = 3 feet diam., we have

$\frac{22{\cdot}5 \times 9}{33 \times 3} = 2{\cdot}045$, the horse-power required to send 1,000 gallons a minute through a mile of 3-feet pipe with a velocity of 3 lineal feet per second.

For large engines, exceeding 100 horse-power, I calculate the cost of horse-power per annum, according to an estimate at page 272 of Hughes on Waterworks. This estimate is the result of a very extensive investigation into the actual cost of working single-acting Cornish engines.

According to this estimate, when coals are 10*s.* per ton, the cost per annum of an engine working night and day will be 10 *l.* per horse-power.

When coals are 15*s.* per ton, the cost per annum will be 13 *l.* per horse-power.
When coals are 20*s.* per ton, the cost per annum will be 16 *l.* per horse-power.
When coals are 25*s.* per ton, the cost will be 19 *l.* per horse-power.

The above prices are for the actual working of the engine, computed according to Watt's standard of 33,000 lbs., raised a foot high per minute, and include every expense of coals, wages, oil, tallow, materials for packing, cleaning, &c.; but include no allowance for interest of capital or depreciation of machinery.

14, Park-street, Westminster, 15 July 1857. *Samuel Hughes.*

(8.) Minutes of Evidence given by Messrs. *Ieyes & Hull*, of Northampton.

Messrs. *Ieyes & Hull.* 27 January 1857.

Meeting of Referees, 29, Great George-street, Tuesday, 27 January.

Messrs. *Ieyes & Hull* attended by appointment.

Messrs. Ieyes & Hull stated, that they were aware that the system of pumping and deodorisation of sewage proposed by them was not new. They claimed only to be the first to advocate the application of it to barren sands.

Mr. Simpson informed the gentlemen, that the subject of deodorisation fell more especially under the notice of the Commission appointed by Government to inquire into the utilisation of the sewage of towns; but that if they thought proper to send in a plan, with particulars of pumping stations required, and estimates of cost, the Referees would entertain the matter.

Messrs. Ieyes & Hull said they wished to gather the opinion of the Referees whether the plan were likely to be feasible or not, and if so, they proposed sending in a detailed plan.

The Referees said, that they saw various objections, such as the difficulty of obtaining land, &c.

Messrs. Ieyes & Hull had reason to think there would be no such difficulty.

In answer to questions, Messrs. Ieyes & Hull said there were deodorising works at Northampton; the sewage water passed through charcoal, and the supernatant water was left clear after percolation. The average was five gallons of liquid to a person.

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Messrs. *Ieyes & Hull.*

27 January 1857.

Messrs. Ieyes & Hull said that the culvert at Northampton was 2 ft. 6 in. in diameter, and the fall 1 in 990. The population of Northampton was 30,000. The residuum of the filtration sold for 3 *l.* or 4 *l.* a ton.

Messrs. Ieyes and Hull proposed to pump away the sewage of London continuously. They considered that they had over-estimated in their letter the amount of land required for the reception of sewage.

They believed one acre at each outlet would be as much as could be fertilised in one day.

An allusion having been made to Woking Common, Mr. Simpson told Messrs. Ieyes and Hull that the subsoil there, of a large area, was impervious, so that the sewage water could not be drained through it.

Messrs. Ieyes & Hull said, that they had not come to any definite arrangement what lands round London should be fertilised in the way proposed.

Mr. *John Leslie.*

1 and 2 April 1857.

(9.) Minutes of Evidence given by *John Leslie*, Esq., Member of the Metropolitan Board of Works.

(i.)

Mr. *John Leslie* attended at meetings of the Referees, Thursday and Friday, 1 and 2 April.

The substance of Mr. Leslie's evidence is contained in the letter addressed by him to the Referees, February 28, 1857. (See page 399.)

(ii.)

25 July 1857.

Meeting of Referees, 29, Great George-street, Saturday, 25 July.

Mr. *John Leslie* attended by appointment.

Mr. Leslie said that he had been on the Westminster and Metropolitan Commissions of Sewers during the last 20 years.

Mr. Leslie supported his views of the system of separation of house and rainfall drainage, for the purpose of keeping in the river as much water as possible.

Mr. Leslie did not mean to say that it would not be necessary to institute filters at the outlets of the rain-water channels, but thought that no serious objection to the plan, as he believed that the street-cleansing would soon be more efficiently carried out by the powers under the Metropolis Local Management Act, by the various parishes and district boards, and the consequent dirt of the rain-water would then be considerably diminished.

Mr. Leslie did not think the channels to carry off rain-waters would require to be of as large dimensions as the existing sewers.

In answer to Mr. Simpson, with regard to his proposed crossings of the Thames, Mr. Leslie said, that in his letter of the 28th February, he stated that he wished to cross the Thames at three points, of which one would be the Thames Tunnel, none of the districts east of that point being touched by his proposition.

Mr. Leslie had several borings, showing the nature of the soil at the point suggested by Mr. Simpson from Blackwall to the Greenwich Marshes, from which he anticipated no difficulties. Mr. Leslie had every confidence in the strength of the Thames Tunnel. With regard to the crossing from Blackwall point as suggested, Mr. Leslie did not doubt its practicability; Mr. Bazalgette proposed to cross at the same place, as suggested by Mr. Simpson.

Mr. Leslie thought an advantage of the separate system for the metropolitan drainage was, that there would be less interference with the great public thoroughfares, the Strand, Fleet-street, and other parts of the metropolis.

In answer to Mr. Blackwell, Mr. Leslie said that he was not aware of any place where the separation system was carried out. It was afterwards stated by the Referees, that Richmond, Tottenham, and Edmonton were drained on the separate system.

Mr. Leslie further called attention to the important point, as to the navigation of the Thames being much interfered with by the entire removal of the rain and house supply waters, which now fall into the Thames from both banks from Putney eastward; and he urged this as an important advantage of the separate system, by allowing the rain water which falls at such lengthened intervals being delivered into the nearest point of the Thames to where it falls at all hours of the tide.

Mr. *J. R. M'Clean*, C. E.

14 March 1857, and 30 April.

(10.) Minutes of Evidence given by *J. R. M'Clean*, Esq., C.E.

Meetings of Referees, 29, Great George-street, 14 March and 30 April.

Mr. *M'Clean* attended by appointment.

Mr. M'Clean stated that the whole of the Southminster and Dengey Marsh Land, about 20,000 acres, adjoining the proposed main outfall sewer, had been reclaimed at various periods. It is situated on the coast of Essex, between the rivers Blackwater and Crouch. There is a large tract of slob outside the present sea walls capable of being reclaimed, and for that purpose an Act of Parliament was obtained (Sir John Rennie, engineer), in session, 1852. Also a large tract on the south side of the Crouch, called the Maplin Sands, which was also included in the Act called "The South Essex Estuary and Reclamation Act."

Mr. M'Clean handed in an Admiralty Report and Chart, and observed,—

At present the silting up is very gradual, and no work has been executed under the powers of the Act.

This

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This land requires the manure of London, which is brought down in barges to the Crouch at considerable cost.

The level of high water at spring tides in Burnham Creek is 2 feet lower than at London Bridge. Burnham Creek is the outfall of the Crouch, and the tide flows as far as Battle Bridge.

Mr. M'Clean does not consider the present outfall sewers into the Thames proper positions for deodorising or manure works; they are surrounded with population, and any such works would create a nuisance. The sewage should be carried away from London to be applied to the land in its normal liquid state.

Mr. M'Clean stated that the district through which the proposed sewer is to run was in great want of manure.

The proposed sewer will be 20 feet diameter, not a perfect circle, and covered for a length of nearly 29 miles. The soil through which the sewer will pass is plastic clay and alluvial deposit. It will cross the River Crouch at Great Ilford, above the point where the river is navigable.

The distance to Battle Bridge from West Ham is 26 miles. The sewer will be covered; the fall will be 8 inches per mile. The distance from Battle Bridge to the outfall is 16 miles; the fall 4 inches per mile. The sewer will be open through the Marsh Land.

Mr. Bazalgette stated that he had taken the flow of sewage and rain-fall at 39,000 cubic feet per minute Mr. Bazalgette gives in his report 45,000 cubic feet per minute; the difference arises from the sewage in the latter case being estimated as flowing into the Thames for three hours after high water. According to the system now proposed it would flow at all times of tide.

Mr. M'Clean proposes to use the sewage throughout the whole length of the sewer in a fluid state, as the level of the sewer will admit of irrigation by gravitation alone throughout its entire length. The area of land which may be treated in this way may be estimated roughly at 100,000 acres. In addition it is proposed to use some of the present creeks of the river Crouch as settling ponds for the London muck, which may be carted or boated away to the adjoining lands. It is also proposed to have chemical works both for the manufacture of manure and other products. The locality is extremely favourable, as there is not much probability of a large population, and the facilities of sending the manure both by sea and by projected railways will be great. Believes more in the distribution of the sewage in its liquid state than after deodorisation. Glasgow and Edinburgh afford good examples.

The sewage would also be used for silting up the land outside the present sea walls. Does not propose to embank the whole of the land to be reclaimed in the first instance. It is not sufficiently high for natural drainage, and to raise it must be the work of time.

Mr. M'Clean handed in the estimate of the outfall sewer, which would amount to - - - - - - - - - -	£. 1,600,000
In addition to the above, intercepting sewers between Putney and Southwark Bridge and Woolwich and Southwark Bridge, and between Southwark Bridge and West Ham, and pumping engines, &c., (the details of which have been furnished), would amount to, say -	450,000
making the cost of the works - - - - - - -	£. 2,050,000

For conveying the sewage into the Thames at Erith, or to the sea below Burnham Creek about the same; all other works required being common to the two systems.

Mr. M'Clean stated that, after great consideration, he had arrived at the conclusion that it was impossible to select any other position for a gravitation outfall sewer to sea than the one proposed. On the south side of the Thames the Medway would interfere, and on the north the various creeks and railways.

On the south side of Thames, Mr. M'Clean proposed that the channels of the Effra and Earl Sewers between the points of interception and the River Thames should be used for storm waters only, that is, when the rain-fall exceeds, say, half-an-inch in 24 hours. Below the point of interception, the sewage should fall into the sewers connected with the main intercepting sewers. Considered the system of allowing sewage to flow into brooks to be highly objectionable. Where it has already been done, it might be impossible to alter it without great expense; but in new cases, and more especially where there is a drainage from agricultural districts above the town, all the new sewers should be below the level of the brook, and supplied with water from it during floods passing out at lower outfalls. There would not be any difficulty in adopting this system below the point of interception and the Thames, either to the Effra or the Earl Sewers; these portions might be kept for storm waters only.

By this system, the floods, instead of being injurious, would be highly beneficial in cleansing out the whole of the sewers. The original brook course would eventually become dry, if buildings extended up the stream, on account of the rain-water being absorbed in the new sewers.

In the marsh-lands at Southminster, near the proposed outfall, the flood of water of the natural brook is extremely beneficial in cleansing out the watercourses used in summer for watering cattle as it circulates through the ditches, and scours away the stagnant water and deposits that have accumulated during the dry season.

Does not think the proposed sewers in the low districts of the south side would be insufficient to carry off storm waters. The principal outfalls are available at all times of tide, viz., the Wandle, the Falcon, and the Effra. No better outfalls can be obtained on that side of the river. In the event of floods, the gates between the intercepting sewer and these outfalls would be closed, and the pumping-engines, lifting 13,000 cubic feet per minute, would be more than sufficient to keep the district completely free from floods. There would be a constant flow of 13,000 cubic feet per minute in addition to the existing means. All the tables published giving the discharge of sewage and rain-fall at the various outfall sewers, appear to be erroneous. In the Tables lately published as an Appendix to a Lecture by Mr. Bazalgette, the Earl Sewer is stated to have discharged 5,000,000 cubic feet of rainfall and sewage in 24 hours, which is impossible with its present dimensions and fall, and taking into consideration that it only discharges (on account of the rise of the tides) during eight out of the 24 hours. Again the outfall sewers discharging into the Thames, at various places between the Effra at Vauxhall Bridge and Earl Sewer at the Commercial Docks, are tabulated as having discharged one-third more rain (exclusive of sewage) than actually fell, during the period of the experiment, over the whole area stated to be drained.

Is of opinion, that providing means for the flood-water to pass through all the sewers, instead of one intercepting sewer, would be highly beneficial.

It is when heavy storms take place after dry seasons, that the sewers discharge the greatest quantity of sewage. Weirs in the sewers, to allow the flood-water to flow into the Thames on all occasions, would leave the river nearly as much polluted as at present.

It is evident that this is intended by Mr. Bazalgette, as the high level intercepting sewer on the south side is reduced to 4 feet diameter where it unites with the outfall sewer below Deptford Creek.

Does not consider the high level sewer on the south side necessary. Approves of gravitation intercepting sewers, and proposed the system in 1849; but this is not a gravitation sewer, as the sewage has to be pumped up at Erith, or discharged into the Ravensbourne, near Deptford. The temptation to save pumping, and send all the sewage into the river at Deptford, will be too great if the small sewer is constructed, and the river will continue in a polluted state.

With regard to the system of drainage on the north side of the Thames, Mr. M'Clean stated, that he did not see any difficulty in conveying the sewage over Southwark Bridge.

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Mr. *J. R. M'Clean.*

14 March 1857, and 30 April.

There are at present 8 girders nearly 6 feet apart, and having sufficient space to admit of three wrought-iron aqueducts, one between the two inner girders, and one between the second and third on each side of the roadway, without interfering with either the strength or appearance of the bridge. The level to which the sewage would be pumped at the highest part of the bridge, affords sufficient head without waste of power to send it through the sewer to West Ham.

The sewer will not have to be constructed through any crowded thoroughfare. It will unite with the system proposed by Mr. Bazalgette at Windmill-street, but has been estimated as far as West Ham for the purpose of comparing the cost of the two systems.

Objects to the high level sewer on the north side. If constructed, as shown, it will be at one time a torrent, and at another dry. One main intercepting gravitation sewer would be better than two. The water proposed to be intercepted by the high level sewer ought to flow into the proposed middle intercepting gravitation sewer as proposed in 1849. The proper point of interception of the River Fleet is at Battle Bridge. The existing channel below that point ought to be used for flood-water only.

Does not think the low level system well arranged. The sewage of the district about St. Paul's, the highest part of the City, is placed on the low level system. The sewers are too large and too deep, and will be very difficult to construct in narrow thoroughfares. It would be much better if they were separated into districts, and each district pumped into the main gravitation sewer.

There is no provision made in Mr. Bazalgette's outfall for the sewage of the western district.

The proposed outfall to the German Ocean is sufficient for the whole sewage of the metropolis, and also for the suburban districts, even should they become as densely populated as the metropolis.*

(11.) Minutes of Evidence given by *J. J. Morewood*, Esq.

(i.)

Meeting of the Referees, 29 Great George-street, Thursday, 2 April 1857.

Mr. *Morewood* attended by appointment.

Mr. *J. J. Morewood.*

2 April 1857.

Mr. Morewood stated, that the present plan was, in substance, the same as that submitted to Parliament in 1853, by the Great London Drainage Company.

Mr. Morewood did not propose, in the first instance, to go into any of the details, but only to support the main lines of drainage.

Mr. Morewood considered that deodorisation should be carried on either at the mouth of each sewer, or near blocks of houses, or near every house in the outlying districts; but he considered that this was impracticable in the densely populated area for which his two tunnels were arranged—one on each side of the metropolis; and that therefore he considered that the Government should have guaranteed three per cent. to a company who would not require more than 1,000,000 *l.* of capital for the work.

With regard to the north side of the Thames, Mr. Morewood stated, in answer to a question, that the least fall in his northern tunnel was about three feet per mile.

Mr. Bazalgette's northern low level sewer, with a second tunnel along Oxford-street, was to take off 23,000 cubic feet per minute from the area referred to, while Mr. Morewood's one sewer was to be of a capacity sufficient for the same amount.

In answer to a question, Mr. Morewood stated that he considered that deodorisation of the sewage brought his proposal within the clause of the Metropolis Local Management Act, providing that the drainage should be carried beyond the metropolitan boundary; but that the clause giving a new limit to the metropolis was, in respect to intercepting drainage, so entirely at variance with every thing previously established, for it involved so large, and he believed so unnecessary, an outlay of money, and it was carried in so thin a House, and with so little consideration, that he did not think it would be difficult to obtain a modification of the Act, if the words inserted in Committee in the 135th clause, "and deodorising works," did not bring his proposal within the enactment.

Mr. Morewood also stated, that his plan afforded peculiar facilities for carrying the drainage far down the river, if this were deemed necessary.

Mr. Morewood stated, that it was generally admitted that very great relief would be afforded, if only deodorised water were passed into the sewers and into the Thames, at low water, within the metropolis; but that far greater, and he believed the greatest attainable relief, would be conferred to the metropolis and to the Thames, if deodorised water were conveyed to the top of the tide, 10 or 12 miles down the river; which, practically, was a removal to a point 20 miles lower down than was proposed by all those who advocate deodorisation within the metropolis.

Mr. Morewood stated, that he was ready to organise a company to deodorise, under heavy penalties, all the sewage of London, both north and south; and that, when he had expected to have obtained a hearing on the part of the Metropolitan Board of Works, on the 22d October last, he was prepared to make the Board a definite proposal.

Mr.

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*The following Letter and Enclosure was received subsequently to Mr. *M'Clean's* first attendance upon the Referees.

Covent Garden, W. C., 19 March 1857.

Gentlemen,

We are informed that, amongst other plans for your consideration, in reference to the proposed transport of the Metropolitan sewage from London, a plan has been laid before you, contemplating the "construction of an outfall Sewer in the county of Essex, from the eastern side of the River Lea to the German Ocean, between the confluence therewith of the rivers Crouch and Blackwater," by Mr. Henry Shaw, of Billericay, for which plan the usual Parliamentary Notices were given, and deposits made in November and December last.

The line of the Sewer proposed by Mr. Shaw's plan crosses Lord Petre's property, in the county of Essex, for a considerable length, and moreover, the outfall is in very near proximity to other property of his Lordship in that neighbourhood, and is strongly objected to by him.

We feel it, therefore, our duty to apprise you of the fact of his Lordship's objection to the plan proposed, as a measure prejudicial to his interests without any due public necessity, and, in corroboration, enclose a letter addressed to us by his Lordship on the subject.

We have, &c.
(signed) *Few & Co.*

To James Simpson, Esq., and Others,
Referees of the Projects for Removal of the Metropolitan Sewage.

18, Grosvenor-street, 18 March 1857.

Gentlemen,

As I understand that the project for conveying the sewage of the Metropolis into the German Ocean, near my property at Asheldam, in the county of Essex, has been laid before the three engineers selected by Government, with other plans, for the removal of the Metropolitan sewage, I request you at once to make known to the Referees that the first-mentioned plan is strongly objected to by me, and that you have my directions to present every opposition to its obtaining the sanction of the Legislature.

I am, &c.
(signed) *Petre.*

Messrs. Few & Co.

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Mr. *J. J. Morewood.*

2 April 1857.

Mr. Morewood objected to the high level sewers, because they would abstract the storm waters, which now acted as flushing powers, with a beneficial effect upon the intervening and low districts.

In answer to a question, Mr. Morewood said that he would not be ready, if the Referees adopted Mr. Bazalgette's plan, to take the sewage and deodorise it at the risk of a company. He objected to Mr. Bazalgette's high level sewers, and believed the expense unnecessary, especially when it was considered that the scouring power of a rainfall was thereby lost to the low level sewers; and Mr. Morewood also objected to the site of the eastern pumping establishment adopted by Mr. Bazalgette.

In answer to Mr. Simpson, Mr. Morewood stated, that he believed the smell which arose from the sewers came from the main lines in which the sewage was daily ponded back by the tide, and not so much from the lateral drains having a continuous flow; but from whatever source the smell arose, Mr. Morewood stated that the south wind blowing into the open sewer mouths, on the banks of the Thames, carried the smell into every water closet, and through every street gulley north of the Thames.

Mr. Morewood did not believe much decomposition would take place in the sewers, if their contents were promptly discharged, and mentioned the experience of a friend of his at Charing Cross, in corroboration of his views.

Mr. Morewood believed that all the sewage of London could be removed to the marshes and deodorised within three hours from the time it first entered the sewers. Mr. Morewood proposed, after it had been deodorised by lime or other means, to let the deodorised water into the river and carry it off by the night tides; but he stated that there was nothing in his plan to prevent the water from being carried still lower down than he had proposed.

Mr. Morewood did not believe local deodorising works could be constructed in London, from the expense of property, and from the vast extent of traffic contiguous to the banks of the Thames.

Mr. Morewood did not think that much harm had been done by storms—not even that of August, 1846; and considered that if nature and existing arrangements had provided no means of safety for the lower districts from floods, the people on the higher parts of the town should not be called upon to pay for the means of relieving the low lands from the floods to which they might by nature be liable; but that all parties receiving an artificial supply of water ought to pay for its efficient removal, and especially so when it had been converted into sewage.

Mr. Morewood would provide for a rainfall of a quarter of an inch in 24 hours reaching the sewers, which had been calculated as equal to a fall on the ground of five-eighths of an inch. Mr. Morewood therefore proposed his tunnel to carry off the 1-100th part of an inch of rain an hour, beyond double the ordinary sewage flow, equal to a second 1-100th part of an inch an hour. There would also be the reservoir capacity of the tunnel, which, in particular cases, would enable the quantity to be doubled.

Mr. Morewood handed in a tabular statement showing the area and population, &c., for which his plan would provide, and so arranged as to secure a constant flow to the sewer refuse at the rate of 2½ miles per hour.*

Mr. Morewood stated, that he had always considered that special provision should be made for Westminster, in consequence of its being the seat of Government, and in consequence of its low situation; that to afford the relief referred to, the capacity of the tunnel for Westminster was required to carry off 6,944 cubic feet per minute; and that for the purpose of giving extra relief to Westminster, the tunnel which he had submitted to Parliament in 1848 and in 1853 had a capacity of 13,000 cubic feet per minute at Charing Cross.

Mr. Morewood read some evidence from Mr. Roe, Mr. Herslet, Mr. Phillips, and Mr. Newman, given a to the damage done on the north and the south sides of the river by the storm in August 1846, which proved that very little injury had been done to property, except in the case of a few houses over an uncovered portion of the Fleet Sewer.

Mr. Morewood believed that there were not more than eight days in the year not provided for by his system, and when the storm waters would have to pass over into the river; but that this would not have once occurred during last year.

Mr. Morewood read a statement to prove that in cases where rain-water had to flow over into the Thames, it would be comparatively pure, from the increased velocity which is given to the sewage by the first portion of the rain-water which reaches the sewers; the statement referred to being from the consulting engineers to the late Metropolitan Commissioners of Sewers, in speaking of the advantages which would result from "an intercepting sewer capable of discharging double the ordinary amount of sewage." The same statement concludes as follows: "If we further assume a still larger capacity for the intercepting sewer, it is evident that the period will be prolonged before the overflow into the river takes place, during heavy falls of rain; and the river will, in this proportion, be further relieved from pollution."

The ordinary sewage-flow on the north side is about 6,000 cubic feet per minute, and Mr. Morewood's tunnel has a capacity to carry off 23,000 with an additional reservoir capacity in the tunnel, equal to about 3,600,000 cubic feet, or of 10,000 cubic feet per minute for six hours, before it would run full bore. This is, therefore, about double the amount of relief contemplated in the statement referred to, and the provision proposed by Mr. Morewood, for Westminster, is in proportion still much larger, so that there will scarcely ever be a day when an overflow into the Thames will occur between Charing Cross and Chelsea.

Mr. Morewood, in answer to a question, believed that much less rain-water reached the sewers than was generally believed, the evaporation and area of absorbing ground being considerable.

Mr. Morewood alluded to Sir W. Cubitt's evidence as to a fall of rain which amounted to 1·15-inch in 17 hours; and of which nothing was seen 12 hours after it had ceased falling; thus showing, that ·04-inch per hour had been carried off for 29 hours, and Mr. Morewood believed that his intercepting tunnels would have carried off the foulest part of the water, and that all the existing capacity to remove storm waters would remain available.

Mr. Morewood also believed, that such rain-falls were generally so partial that, by good management, the intercepting tunnels would generally carry off all the rain water falling in London; and he stated that he had carefully observed every heavy rain-fall which had occurred during the last 25 years, and he had never been able to hear of any injury which justified the construction of works for preventing such injury from again occurring.

Mr. Morewood did not propose to touch the Hackney Brook Sewer, but believed that Mr. Law had a scheme of drainage for the Hackney district, which would cost not more than 80,000 *l.*, and the out-fall of which he proposed to carry down to Mr. Morewood's terminal works, as laid down in a line from Hackney to the Marshes, in a plan prepared by Mr. Law.

Mr. Morewood also did not propose to deal with the drainage of the extreme west of the river, the eastern and central portions of the metropolis, up to Westminster, Pimlico, and Chelsea, requiring to be first provided for; but he saw no difficulty or impediment to hereafter including it in the intercepting system, either by admitting the western drainage into his tunnel, or by the construction of a new sewer through the metropolis at a higher level; and Mr. Morewood stated that then there was the third alternative, which he believed would be not only the cheapest for the western parts, but also the best for the metropolis, viz., local deodorisation combined with discharging the deodorised water on the top of the night tide.

Mr. Morewood said, that the real question between himself and Mr. Bazalgette was, in so far as the works within the metropolis are concerned, whether it was worth the 300,000 *l.* or 500,000 *l.* the high level works would

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* For tabular statement, see page 457.

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would cost, in order thereby to save 4,000 *l.* or 5,000 *l.* per annum in pumping; those high level works being calculated to inflict very serious injury to the metropolis, and constituting a number of blind ends to existing main sewers, involving difficulty and expense.

With regard to the south side, Mr. Morewood stated, that Mr. Bazalgette provided for no increase of population at Deptford, Rotherhithe, &c., a portion of which, if properly drained, would undoubtedly receive a very large increase of inhabitants.

Mr. Morewood showed tables prepared by Mr. Law from the Census Tables, exhibiting Mr. Bazalgette's errors as to the probable increase of population. Mr. Law's Tables and Report showed that, whereas Mr. Bazalgette asserted he had increased the population everywhere to 30,000 per square mile, the average of prospective population provided for by him in reality only amounted to 15,000 per square mile, being in no case more than 28,000, and in one, so low as 6,500 per square mile.

Mr. Morewood's scheme provides for an outfall of 14,000 cubic feet per minute, whereas it is admitted that at present the sewage only amounts to about 2,000 cubic feet per minute.

Mr. Morewood objected to the high level sewers on the south side, on the same grounds as to that on the north, but stated his conviction that very great improvements could be secured by the diversion of one of the upland watercourses, and by local alterations in others.

Mr. Morewood claimed two decisions in favour of his plan, one by the most eminent engineers of the day, the other by the Commissioners of Sewers, who passed a resolution, proposed by Mr. Thwaites, approving of the system, acknowledging that it would effect a saving of not less than 800,000 *l.* to the southern districts.

Mr. Morewood read extracts from Sir John Burgoyne's, Mr. Stephenson's, and Lord Ebrington's speeches, approving his (Mr. Morewood's) plan.

Mr. Morewood's estimate for the entire works was 1,050,000 *l.*

Mr. Morewood objected to the float experiments made by Mr. Foster, as leading to wrong conclusions; for the floats were kept studiously in the middle of the river, and were thus carried very much further up the river by the flood tide than sewage would be. Mr. Morewood mentioned the fact that ice reaches Gravesend in six days, instead of twenty-six, as calculated from the results of those float experiments.

Mr. Morewood handed in various documents in confirmation of his evidence.

Mr. Morewood also stated, that he proposed, in the first instance, to extend the southern tunnel through Greenwich and Deptford to the Surrey Canal only, which would, however, relieve all the lowest and most densely populated area extending to Lambeth; and on the north side he proposed to extend the tunnel to Charing-cross, which would relieve all the districts up to Westminster, and leave the western portions, on each side of the metropolis, to be subsequently arranged, when the proposed local alterations shall have been definitively decided upon; and Mr. Morewood stated, that the extent of works thus proposed for immediate construction could be completed within a space of two years.

(ii.)

(*Letter relating to the above Evidence.*)

1, Barford-terrace, Islington,
16 June 1857, N.

Dear Sir,

On reading over my evidence of the 2d April, I find that that which is stated respecting the Hackney Brook district is indistinct, and requires the additional words: *for certain local alterations, and for a complete system of district sewerage*—(at the bottom of page 6.)

I have known and observed the Hackney Brook for very many years, and Mr. Law always lived near to it, so that his views may be entitled to peculiar weight. He considers the plan of 1856, as adopted by the Metropolitan Board, to be as wrong in principle as the plan of October 1853 adopted by the late Metropolitan Commissioners was wrong in detail and principle.

Yours faithfully,
J. J. Morewood.

H. C. Saunders, Esq.

(iii.)

29 May 1857.

Meeting of the Referees, 29 George-street, Friday, 29 May 1857.

Mr. *Morewood* attended by appointment.

Mr. Morewood, in answer to a question, said that he had made no gaugings of the sewers, which had been quite inaccessible to all but the officers of the Commissions of Sewers. He had provided for 54 million cubic feet of sewage daily, whereas Mr. Bazalgette estimated the present amount at 12¼ million cubic feet per diem. In case of necessity, Mr. Morewood said that his sewers would hold five or six million cubic feet in addition, thus taking away a quantity equal to nearly five times the normal flow of sewage.

Mr. Morewood read a written statement which he had drawn up, in further explanation of his views, and which was afterwards handed in. (See page 12.)

In answer to Captain Galton, Mr. Morewood said that Mr. Bazalgette had under-estimated the population of both sides by 600,000, having omitted to allow for any increase of population in parts of Deptford, &c., which are even now in course of being built upon.

Mr. Morewood, in answer to Mr. Simpson, said that he believed little, if any, of the deodorised sewage water thrown into the river at his outfall, at high water, at Barking Creek, would find its way up into the Pool, seven or eight miles distant, but had no experiments to bring forward as evidence on the subject, considering that the experiments made really established the fact.

Mr. Morewood, in answer to a question, said that his northern tunnel would be through the London clay or strata which have never been previously disturbed, and therefore any statements respecting pest strata did not apply.

Said, that his sewers were calculated to carry off a quarter of an inch of rainfall reaching the sewers per twenty-four hours; anything over the reservoir capacity of them would pass into the river in the same way as proposed by Mr. Bazalgette, and approved by Sir William Cubitt and Mr. Robert Stephenson.

Mr. Morewood said, that the velocity in his proposed tunnels would be sufficient to carry off all foul deposit in the sewers on the first beginning of a storm after dry weather.

Mr. Morewood said, that Mr. Brassey had estimated the cost of the works of the north from Charing Cross to Barking, and the works on the south, at no more than one million of money.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. J. Morewood.*

29 May 1857.

(iv.)

Paper handed in by Mr. *Morewood* at the above Meeting of the Referees.

29 May 1857.

I beg to be allowed to state, that the fullest consideration and examination of the question of the extent or limit of the Metropolitan drainage area, has brought me to the conclusion that the part which most urgently requires the relief to be afforded by tunnel sewers is bounded on the west by the Kensington Canal and Battersea Park, inclusively; by the River Brent and the Hackney Brook on the north; by the Wandle and Surrey hills on the south; and by the River Lea and Essex and Kent Marshes on the east.

The cholera returns of 1832 show that, whilst the cases which occurred on this area amounted to 11,020 there were only 10 cases in the Hackney Brook district; and the cholera map, with the proposed two tunnel sewers marked upon it, shows that they pass through the very districts which most severely suffered from disease on that and on subsequent occasions.

Everybody will, no doubt, concur with me that this is the area which should be first provided with an efficient outfall for its sewer refuse, when he considers its extent,—about seventy times the size of the area which comprises the City of London; and also considers that this area already possesses the largest population in the civilised world; that the important seat of the Legislature, the districts of Westminster, Pimlico, Chelsea, &c., and of Limehouse, Poplar, &c., on the north; and the whole of the most densely-populated parts of the south, are far too low to be naturally drained into the Thames, except at low water, for a few hours during the day; that the inhabitants of all these low-lying districts may fairly demand the removal of the sewer refuse which is daily poured down upon their areas from higher localities; that these low districts are annually threatened with disease of the most extensive and virulent character; and that the increase of house drainage and of the water supply will greatly increase these difficulties and dangers; whilst, on the other hand, the construction of an efficient outfall would be certain to increase the present population of these districts, an increase which would probably more than double the present population of the Surrey side.

These various considerations and the extent of the pollution of the Thames within the area referred to, all combine to claim the proposed works of relief in a manner which cannot be maintained by any other district, and the comparative costliness of the works which would be required for bringing the drainage of the extreme western parts through London, supports the same view. The assessment on the north-western parts is 357,276 *l.*, and the estimate of works 426,380 *l.* or nearly 24*s.* in the pound; whereas the assessment on the remaining area is more than 10,000,000*l.*, and the works 1,000,000 *l.*, or less than 2*s.* in the pound of the annual value.

This is the area comprised in my plan, which became the basis of the Metropolitan Sewers Bill of 1848, the clauses 39, 40, 41, 42, and 43 of which contemplated the construction of these works.

The eminent royal and civil engineers, when appointed to the Metropolitan Commission of Sewers in October 1849, fully investigated the subject, and they finally decided that the two tunnel sewers should be constructed for the very same area, as may be seen by the Commission's Report to Parliament in February 1851 (No. 31); and when the civil engineers resigned, they informed the House of Commons, on the 23d June 1852, that the works which were urgently required would cost 1,000,000 *l.*, an amount which again designated the extent of the area for which relief was sought by the Metropolitan and the City Commission of Sewers in 1852.

The Parliamentary Committee, which was appointed in 1853 to examine my plan, never suggested that it should be extended, but, on the contrary, that the northern tunnel might be curtailed, and this Committee fully approved of the plan, and had the minutes of evidence printed with the avowed object of future legislation; the officers of the Metropolitan and City Commission of Sewers, and the late consulting engineers, reported, in 1854, against extending the area, and the officer of the Metropolitan Board of Works has afresh urged the same view of the case.

Beyond this there is the evidence of Mr. Law, to whom I referred the whole question, his acquaintance with the metropolitan area, his connexion with the construction of the Thames Tunnel and other metropolitan improvements, and his "Observations" on the Thames, peculiarly fitting him for the task. Mr. Law's elaborate Reports are not only limited to the area referred to, but his opinion is most decidedly against its being extended; and I would also urge that the substrata of Westminster, and on the Surrey side of Deptford, &c., is itself a protest against increasing the difficulties of the area by further extensions.

I also have to state, that the same careful consideration has been given to the question of the course of the northern tunnel from Westminster to Tower Hill, and the same unanimous decision was attained. The character of the ground caused the shore of the river to be avoided, and tunnelling under the Strand, Fleet-street, &c., was adopted and approved of, in all the proceedings from 1845 to 1848. When the late Mr. F. Forster became at last aware that he had made a mistake in preferring the bed of the Thames, he expressed a desire to have an opportunity to correct it. When my plan was about to come before the Parliamentary Committee, the officers of the Metropolitan and City Commissions of Sewers expressly reported, in May, 1853: "That portion of the sewer between Whitehall and Walbrook we consider to be preferable to that of Mr. Forster's between the same points." This was afterwards confirmed by them, by evidence and reports. When the late Metropolitan Commission of Sewers instructed Mr. Simpson to report on the Westminster Sewer, and its extension eastwards, the question really was whether it should lie in the shore of the Thames, or under the streets running nearly parallel to the river; the decision was left to the Parliamentary Committee then already appointed, and they approved of tunnelling under the streets.

The question has further been inquired into, and it is believed that the construction of a tunnel sewer in the shore of the Thames from Whitehall to London Bridge, its junctions with the present sewers with overflows, and the extension of the tunnel to Tower-hill, would cost 200,000*l.* more than the line under the streets; that the latter possesses many advantages, and that there need not be any obstruction to the thoroughfare while the work is in progress, as the materials may easily be brought through one or two openings, and there are ample facilities for air shafts.

The subject of the eastern terminal sites and the discharge of the water, has also received very careful consideration; the eminent engineers who formed the Metropolitan Commission for two years adopted identically the same locality which I had submitted to the Government and Parliament from 1845 to 1848; the Parliamentary Committee again and again suggested that it was not necessary to go so far as Barking Creek, this view being supported by the officers of the two Commissions of Sewers, and by the consulting engineers, as also by the reports presented to and printed by the Metropolitan Board of Works. Mr. Law, after a full investigation of the question, has reported to me: "After much careful examination and consideration of the subject, the point which I should select as the most eligible for the pumping station and sewage manure works, would be in the Plaistow Marshes, at T in the accompanying plan, and about 1,500 yards, or four-fifths of a mile beyond the River Lea."

Besides the concurrence referred to, there is the fact that the two Boards specially charged with the subject so far as the Thames is concerned, viz., the Admiralty and the Navigation Committee of the City of London, both gave their sanction to the terminal outfalls into the Thames, which were submitted to the Parliamentary Committee in 1853.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. J. Morewood.*

29 May 1857.

It may be well here to observe, that although I have attended all the discussions of the Metropolitan Board of Works, yet I have been totally unable to discover any reason for their unsettling everything that had been established for many years past in respect to the area which urgently demands relief, and in respect to the course of the northern tunnel sewer, and to the site of the terminal outfall; and I would respectfully urge that Parliament and the metropolis can scarcely be expected to consent to a 3,000,000*l.* scheme, when they ascertain the measure of relief which will be secured, and the measure of approbation already accorded to my scheme of 1,000,000*l.*

The position of the north-eastern pumping station adopted by the Metropolitan Board of Works, at the Abbey Mills, is peculiarly objectionable and too far from the Thames.

There is much misapprehension respecting the size of the proposed tunnel sewers. The Ranelagh is 9 feet by 11¾, the King's Scholars' Pond, 13 feet by 21¾; the Fleet, 19 feet by 12, and the London Bridge, 10 feet by 8; whilst my northern tunnel sewer will be only 4¾ feet by 4¾ in Chelsea, and will increase to 8 feet by 8 at Charing Cross, 10 feet by 10 in the City of London, and gradually increase to 12 feet by 12; and yet with the fall proposed it will carry off four or five times the present sewage flow.

There is similar misapprehension in respect to deodorising works, and the discharge of deodorised water, or even of sewer refuse into the Thames below the town. An immense nuisance is daily caused by so large a population as is congregated together in the metropolis, and the practical question is, how best to neutralise an existing evil and source of annoyance? Lime has long been applied in the case of infected houses and substances, and has, in reference to sewer refuse, been sufficiently tested to prove that it may be applied in the localities approved of by the Parliamentary Committee, and by the engineers referred to; the sewer refuse being deodorised before it is pumped up, the heavier portions being deposited, and limpid water only flowing into the Thames.

The extent of foul deposit which has accumulated in the Thames is so considerable, that during sultry weather the discharge of deodorised water may be found most beneficial, and it may even be desirable to charge the water with a larger quantity of lime to act on the bed of the Thames as it acted upon the foul deposit in the basin in St. James's Park; and this consideration may form an additional reason for not placing the terminal works far from the metropolis, especially when so very large a quantity of water is abstracted from the Thames, &c., by the water companies.

Supposing, for a moment, that deodorising were not carried into execution, still I believe that the past decisions in reference thereto are correct, and that the sewer refuse should not be carried lower down than Barking Creek. Taking it to a lower point will divest it of the influence of the upland waters, and discharging the sewer refuse at Barking Creek at high water, 13 miles below Westminster Bridge, is admitted to be equal to a removal of 25 miles into low water; and especially if passed into the Thames during the night tides, no locality on the banks of the river would have any cause to complain, because a less decomposed quantity of sewer refuse would flow towards the sea; whilst the relief to the inhabitants of the metropolis would be as complete, in so far as the sewers and the river between the bridges and in the Pool are concerned, as if the sewer refuse were carried into the sea.

Deodorisation is however urgently required, not only to neutralise offensive matter, but also because the introduction of the water-closet has reduced us to a state of dependence upon foreign countries for manures and food, and every endeavour should be made to utilise the sewer refuse of the metropolis; but no relief is to be expected from its liquid distribution; and I beg to hand in a statement which I prepared on the subject in 1846, and which was most extensively circulated. The views then expressed have been confirmed by the subsequent failure of every attempt which has been made to accomplish such a liquid distribution.

I have to call attention to the fact, that I propose to make a far larger provision for the removal of the sewer refuse of the metropolitan drainage area referred to, than was done by any other plan.

Mr. H. Austin's "converging" or "sump system," contemplated the removal of the ordinary daily flow of 9,000,000 or 10,000,000 cubic feet.

Mr. John Phillips's single tunnel scheme was for 10,080,000 cubic feet.

This quantity has been generally assumed and provided for by various other plans.

The most recent report printed by the Metropolitan Board of Works assumes that the daily flow is now 12,250,000 cubic feet.

My northern tunnel has a discharging power per 24 hours of	-	33,228,000 cubic feet.*
And the southern „ „ „ of	- -	20,836,800 „ „
TOTAL	- - -	54,064,800 cubic feet.

These tunnel sewers would generally be only one-third full, and, in case of severe storms, they would receive 5,000,000 or 6,000,000 of cubic feet before they would run full bore; and, therefore, the provision made is about five times the present ordinary flow into the Thames; and, besides this, the present sewers would act as reservoirs for storm waters until the tunnels were relieved.

It may be said that the capacity proposed is too large, but a work of such vast public utility ought to be larger than large enough, especially when the whole can be secured for 1,000,000*l.*

In reference to rain-fall it has to be noted, "that the sewer refuse would only require one-fourth of the discharging power of the tunnel sewers for 18 hours out of the 24, and that the actual quantity of rain they would carry away would not be one-fourth, but three-eighths of an inch for the whole day; and if due allowance be made for evaporation and absorption, it may certainly be taken that three-eighths of an inch in the sewers would require, at least, five-eighths to fall upon the ground." As the annual rainfall in the metropolis is not more than 23 inches, falling on 150 days, it is self-evident that a rainfall of five-eighths of an inch or more, must be of rare occurrence. Mr. Roe gives as "the result for a year in which more than an average fall of rain had taken place;" 30 days with a rainfall of a quarter of an inch; 10 with half-inch; 2 with three-quarter inch, and two days with one inch. This would leave four days, when an overflow into the Thames may be assumed, but this would probably be limited to two days, and then to the suburban waters of Hampstead, &c., which would be longest in reaching the tunnel, whilst the larger capacity provided up to Charing Cross would probably altogether prevent any overflow from Westminster, &c.

The heaviest falls of rain occurred when my plan was prominently before Parliament and the public, in June and July 1853; viz.:—

	Inch.
13 June 1853 - - - - - - -	1·15 in 17 hours.
8 July „ - - - - - - -	·63
14 „ „ - - - - - - -	2·63 in 18 hours.
23 „ „ - - - - - - -	1·11

Between

* If the capacity of the Northern Tunnel Sewer at Charing Cross be equal to a discharge of 13,000 cubic feet per minute, and the size be rateably increased at the junction with each one of the present main sewers, then the northern tunnel will have a discharging power per 24 hours of more than 41,000,000 cubic feet.—*See* Letter at the end of Mr. Morewood's Evidence, page 456.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. J. Morewood.*

29 May 1857.

Between the 14th and 28th July, three distinct documents were sent by me to every public journal, showing the sufficiency of the works proposed to the Parliamentary Committee, and contesting the assertions which had been made in favour of the construction of storm-water channels. These documents were inserted in various papers, as in the *Globe* of 25th July 1853. I was never able to find any reply, and I have also been unable to discover that any damage was done by these severe rainfalls of July 1853, or of the last week of October 1855, when 3·03 inches of rain fell in five days. In addition to the evidence already given respecting the storm of August 1846, I have to say, that it appears that no injury was done in the city of London, although the storm occurred at the time of high water; and the city surveyor has stated that one tunnel would be ample of the city area.

The opposing evidence, when the Parliamentary Committee were inquiring into my plan, rested upon erroneous assumptions in respect to rainfall, and upon details in reference to which a mutual understanding was desired with the Commissioners of Sewers, but was refused by them. The sufficiency of my proposal was admitted, by the Committee's declining to receive additional evidence in respect to rainfall (Minutes of Evidence, p. 99), thereby ignoring the opposing statements; and the Committee repeatedly suggested that the terminal works might be placed nearer to the River Lea than the Bill contemplated; Questions 1337, 1727–31, 2319–21, and 3283–4; and the Committee, on a subsequent occasion, informed the House of Commons, that they had fully approved the two tunnels to receive the drainage of the metropolis.—*Hansard*, 2 March 1854.

The same description of this plan was given by the Government on the 4th March 1853, and again on the 27th July 1854, when Lord Palmerston obtained powers to raise money to commence its execution. It is before Parliament, not only by the Minutes of Evidence, but also by Papers moved for by Sir Benjamin Hall (No. 541, 1853); by a petition from me printed by the House on the 13th and 14th July 1853; and by Sessional Paper, No. 427, 1854.

I have also to record, that this drainage plan was already very favourably entertained by the Government of the late Sir Robert Peel in 1845 and 1846, when it was brought under the notice of Lord Lincoln and of Lord Canning, Her Majesty's Chief Commissioners of Woods, &c.; that favourable opinion being also publicly expressed by the Government in the House of Commons in May 1846, and being supported by the late Mr. T. W. Phillipps, the official secretary to the Commission; by the surveyor and active members of the Westminster Commission of Sewers; by Mr. Henry Hobhouse, secretary to the Health of Towns' Commission; by Mr. William Hodges, who drew Lord Lincoln's Act for "the sewerage and drainage of towns;" and by various eminent architects and surveyors.

A bill was accordingly prepared and printed in 1845, and was presented to Parliament in 1846, with the view of showing definitely the powers which would be required for carrying the proposed works into execution. This Bill was before Parliament in 1853, when it passed the second reading by a majority of 111 to 16; but did not receive the sanction of the Committee to a three per cent. clause, which was strongly opposed by the two Commissions of Sewers, although the amount claimed (30,000*l.*) would only have covered the cost of pumping and ordinary wear and tear of machinery, &c.

I beg to hand in the bill, and to remark that nearly 12 years have now elapsed in endeavouring to find some better plan of drainage, or some other mode of executing the proposed works.

I also beg to hand in the following list of borings taken by me in the line of the Northern Tunnel Sewer:—

At Barking Road station, Bow Creek—blue clay at		18 feet
At the Manor Way, by the Abbey Arms	„ „	27 „
At Prince Regent, or Green Gate-lane	„ „	30 „
At Woolwich Ferry-road - - -	„ „	32 „

The Northern Tunnel Sewer commencing at Charing Cross, with a diameter of 8 feet, would pass through blue clay or strata which have never previously been disturbed, and so soon as this tunnel sewer shall have been completed, it would have to be extended towards Parliament-street, &c., and the present sewer from Parliament-street to Percy Wharf might possibly be altogether closed up, which it will probably be found expedient to do. By the Parliamentary Gazette Notice of November 1847, and by the deposited plans and sections, it may be seen that the construction of the northern tunnel up to Charing Cross, with a diameter of 8 feet, was then proposed by the bill, which was withdrawn at the second reading, on the 7th March 1848, because the Government desired to place the measure in their own Sewers Bill of that session.

I would respectfully urge that sufficient support should be given to secure the efficient removal of sewer refuse, and to effect the drainage of the site upon which new Government offices are to be erected; to secure the sanitary improvements which will be obtained by three millions of people, if the plan, as proposed, be carried into execution; * to secure the collection and utilisation of that which now injures the Thames and the atmosphere, and to remove the national disgrace which now attaches to the position of the question.

I would also call attention to that part of the bill embodying my plan, which placed the control under Her Majesty's Chief Commissioner of Works, &c. The favourable consideration which has been given to the subject by the various chief commissioners, since 1845, fully justifies such a proposal. In reference to the words added, as a suggestion, to the 21st clause, viz.:—"that the works should be made under the direction of a competent board of persons to be appointed," I beg to add, that there are various matters, bearing upon the subject,† which have not been brought forward, but which I believe to be of some importance; and these matters would legitimately come before such a board.

URGENCY of Works to relieve the *Thames* and the Sewers.

The urgency of the question of relieving the metropolis from sewer refuse has been so generally admitted, that it may hardly be necessary to refer to the fact:

That during the summer months, the inhabitants are annually exposed to the most imminent danger; That

* The northern tunnel provides for a future population of - - - - 1,916,310
The southern tunnel provides for a future population of - - - - 1,304,734
The Smith-street, and small sewers at Chelsea, and the Eastern Marshes, will add at least - - - - - - - - - - - - - 100,000
3,321,044

Mr. Bazalgette provides on the north for - - - - -		1,041,300	
„ „ for the south - - -	1,049,600	725,000	
„ „ Richmond, &c. - -	103,500	941,100	
			2,707,400

† *See* Letter at end of Evidence, page 456.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. J. Morewood.*

That in July 1855 the engineer to the upper works of the Thames and the water bailiff informed the Lord Mayor, that they "had never before experienced the annoyance and nausea caused by the very impure state of the Thames;" that a continuation of hot dry weather for two months more would have caused serious illness, and, in the event of the recurrence of a dry hot summer, it was fearful to contemplate the mischief which might ensue. It was to be hoped that the Legislature would feel the necessity of immediately dealing with a subject of such vital importance (*Times*, 18 July 1855);

That thereupon all the bankers, merchants, &c. signed a memorial to the Lord Mayor, encouraging him to hold a public meeting, with the view of securing prompt measures of relief, which was however not acted upon;

29 May 1857.

That during 1856, the Metropolitan Board of Works constantly admitted the urgent necessity of an intercepting main drainage scheme, and pledged themselves to an expenditure of 3,000,000*l.* for accomplishing the object desired.

In conclusion, I would beg to observe that I believe commercial enterprise will be found the best and most economical agency for raising the 1,000,000*l.* required for the works proposed by me, for their construction and management, under the control already referred to.

The memorial referred to is respectfully handed in to the Referees.

(signed) *J. J. Morewood.*

(v.)

LETTER from Mr. *Morewood* to Mr. *Saunders*.

1, Barford Terrace, Islington, 7 July 1857.

7 July 1857.

Sir,

I BEG to be allowed to direct the attention of the Referees to the question of expending a considerable sum of money for the extension of the outfall of some of the Westminster sewers into low water mark, as they may deem it advisable to express their opinion on this subject. The largeness of the capacity of the tunnel sewer proposed by me at Charing Cross, viz., 13,000 cubic feet per minute, and the very extensive reservoir capacity of the Westminster sewers, appear to preclude any future overflow of sewer refuse into the Thames, and thus to make an extension into low-water mark unnecessary. If the discharging capacity proposed by me at Charing Cross be adopted, and the tunnel sewer be rateably increased at the junction with each sewer, then its discharging power will be more than 41,000,000 cubic feet, instead of 33,228,000, as stated at p. 8 in the MS. copy of my evidence of May 29.

I have stated, at p. 13, "that there are various matters bearing upon the subject, which have not been brought forward." This partly refers to the desirableness of not reducing the capacity of the northern tunnel, and if the Metropolitan Board of Works had granted me a hearing on the 2d January I should have supported my views by the evidence of others.

I have, &c.

(signed) *J. J. Morewood.*

H. C. Saunders, Esq.

(vi.) APPENDICES to Mr. *Morewood*'s Evidence.

Appendix (A.)

NORTH SIDE.

TABULAR STATEMENT showing the Inclination, Size, &c., of the Northern Tunnel Sewer.

Distance from the Commencement.	Reference to Map.	Name of Sewer Intercepted.	Area of District drained by the same.	Population of District drained in 1851.	Ultimate probable Population of District drained.	Amount of Sewage taken at Maximum Flow.	Amount of Rainfall taken at one quarter of an inch in 24 hours.	Amount of Sewage and Rainfall combined.	Accumulated Amount of Sewage and Rainfall combined.	Length of Sewer between Points of Intercepton.	Level of Invert below Ordnance Datum.	Inclination of Sewer.	Diameter of Sewer.	Discharging Power of Sewer.	Remarks.
Miles Feet			*Acres.*			*Cubic feet per min.*	*Cubic feet per min.*	*Cubic feet per min.*	*Cubic feet per min.*	*Feet.*	*Feet.*		*Feet.*		
0 0	A.	Ranelagh Sewer - -	4,274	123,895	232,661	1,396	2,693	4,089	4,089						The total capacity of the Tunnel Sewer is equal to 3,267,410 cubic feet.
0 5,400	B.	King's Scholars' P. Sewer	390	31,044	35,070	216	246	462	4,551	5,400	6·00	1 in 780	4·86	- -	
1 2,465	C.	Horseferry-road - -	120	14,028	24,400	146	76	222	4,773	3,365	12·92	1 „ 823	5·13	- -	
1 4,300	D.	Wood-street - - -	46	4,296	8,800	53	29	82	4,855	815	17·01	1 „ 843	5·26	- -	
2 420	E.	Westminster Bridge -	58	2,736	3,750	53	37	90	4,945	1,400	17·98	1 „ 850	5·30	- -	
2 494	F.	Westminster Sewer -	1,033	126,615	161,680	970	1,029	1,999	6,944	74	19·63	1 „ 850	5·35	- -	
2 1,964	G.	Regent's Park Tunnel -	606	28,015	20,772	179	382	561	7,505	1,470	19·71	1 „ 1,016	6·34	- -	
2 3,184	H.	Northumberland-street -	430	104,349	104,349	626	271	897	8,402	1,220	21·16	1 „ 1,057	6·59	- -	
2 5,002	K.	Durham-yard - -	160	34,078	34,078	210	101	311	8,713	1,008	22·31	1 „ 1,118	6·97	- -	
2 1,447	L.	Essex-street - - -	83	22,235	22,235	133	52	185	8,898	1,635	24·02	1 „ 1,139	7·10	- -	
3 3,575	M.	Fleet - - - -	4,356	340,186	476,026	2,862	2,745	5,607	14,505	2,128	25·44	1 „ 1,150	7·18	- -	
4 1,582	N.	Walbrook - - -	772	83,720	84,461	507	487	994	15,499	3,287	27·29	1 „ 1,469	9·16	- -	
4 2,560	O.	London Bridge - -	1,551	168,041	168,023	1,214	977	2,191	17,690	978	29·53	1 „ 1,518	9·47	- -	
5 237	P.	Irongate - - -	173	32,319	32,319	104	199	303	17,993	2,057	30·17	1 „ 1,622	10·12	- -	
5 1,707	Q.	Nightingale-lane - -	187	43,065	43,065	262	118	380	18,373	1,470	31·99	1 „ 1,636	10·21	- -	
6 2,447	R.	Ratcliff Cross Stairs -	320	142,070	150,869	905	517	1,422	19,795	6,020	32·80	1 „ 1,653	10·31	- -	
7 3,127	S.	Wade-street - - -	2,302	144,195	295,552	1,773	1,507	3,280	23,075	5,060	36·54	1 „ 1,710	10·70	- -	
										10,040	40·01	1 „ 1,853	11·56	- -	
9 2,607	T.	Pumping Station * -	16,051	1,440,396	1,016,310	11,000	11,376				45·21				

* At this point the line from the Valley of the Hackney Brook (discharging by gravitation) might be brought in as shown by the dotted red line on Drawing No. 1.

2 April 1857.

(signed) *J. J. Morewood.*

233—Sess. 2.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. J. Morewood.*

Appendix (B).

NORTH SIDE.

TABULAR ESTIMATE of the ultimate Population in the District drained by the Fleet Sewer, showing the Manner in which every District has been Estimated.

Letter by which designated on Plan.	NAME OF SUB-DISTRICT OR PARISH.	Amount of Population in 1851.	Assumed ultimate Amount of Population.	Observations on Assumed Population.	Proportion of the ultimate Population which will be within the Valley of the Fleet.	REMARKS.
A.	St. John, Hampstead - -	11,080	112,000	Taken at 60 persons to the acre -	30,350	- - The remainder of this parish drains into the Victoria and Ranelagh sewers.
B.	Regent's Park, sub-district -	31,018	84,000	- - Portion not occupied as park, nearly built over.	20,000	The remainder drains into the Regent's Park sewer.
C.	Tottenham Court, idem -	28,433	28,433	Has already attained its maximum	11,080	- - The remainder drains into the Northumberland-street and Durham-yard sewers.
D.	Gray's Inn-lane, idem -	20,523	20,523	- - Idem - -	20,523	Whole area drains into the Fleet.
E.	Somers Town, idem -	35,041	35,041	- - Idem - -	34,080	The remainder drains into the Durham-yard sewer.
F.	Camden Town, idem -	21,115	25,050	Taken at 150 persons to the acre	25,050	Whole area drains into the Fleet.
G.	Kentish Town, idem -	23,326	81,700	50 "	81,700	- - Idem.
H.	Islington, West - -	47,881	73,050	150 "	61,200	The remainder drains into the Wallbrook and London Bridge sewers.
I.	St. George's, Bloomsbury -	16,907	16,807	Has already attained its maximum	14,700	The remainder drains into the Durham-yard sewer.
K.	St. Giles, South - -	19,051	19,051	- - Idem - -	4,050	- - The remainder drains into the Northumberland-street, Durham-yard, and Essex-street sewers.
L.	Middle Temple - -	124	124	- - Idem - -	124	Whole area drains into the Fleet.
M.	The Liberty of the Rolls -	2,567	2,567	- - Idem - -	2,567	- - Idem.
N.	St. George the Martyr - -	8,703	8,703	- - Idem - -	8,703	- - Idem.
O.	St. Andrew, Eastern - -	13,071	13,071	- - Idem - -	13,071	- - Idem.
P.	St. Andrew, Western - -	10,050	10,050	- - Idem - -	10,050	- - Idem.
Q.	Liberties of Saffron Hill, Hatton Garden, &c. - -	8,728	8,728	- - Idem - -	8,728	- - Idem.
R.	The Charter House - -	277	277	- - Idem - -	277	- - Idem.
S.	St. Sepulchre - -	4,832	4,832	- - Idem - -	4,832	- - Idem.
T.	St. James's, Clerkenwell -	21,520	21,520	- - Idem - -	21,520	- - Idem.
V.	Amwell, sub-district - -	16,720	16,720	- - Idem - -	15,720	- - Idem.
W.	Pentonville, idem - -	11,004	11,004	- - Idem - -	11,004	- - Idem.
X.	Goswell-street, idem - -	15,025	15,025	- - Idem - -	15,025	- - Idem.
Y.	The City - - -	129,128	129,128	- - Idem - -	62,644	- - The remainder drains into Wallbrook, London Bridge, Irongate, and Nightingale-lane sewers.
					476,020	

(signed) *J. J. Morewood.*

2 April 1857.

Appendix (C).

SOUTH SIDE.

TABULAR ESTIMATE of the ultimate Population of the Districts proposed to be Drained.

Reference to Plan.	NAME of SUB-DISTRICT or PARISH.	Whole Area.	Whole Population in 1851.	Area to be Drained.	Population of same in 1851.	Assumed Ultimate Population on same.	REASONS OF ASSUMED INCREASE.
A.	Battersea - - - -	2,177	10,560	2,177	10,560	85,039	- - Taken at 25,000 per square mile as the limit, because of the space which will be occupied by the Park.
B.	Clapham - - - -	1,233	16,290	1,233	16,290	48,164	- - Taken at 25,000 to the mile, the houses being detached with gardens.
C.	Waterloo Road - 1st part -	68	14,088	68	14,088	14,088	Not capable of any further material increase.
D.	Idem - - 2d part -	99	18,348	99	18,348	18,348	- - - - Idem.
E.	Lambeth Church 1st part -	154	18,409	154	18,409	18,409	- - - - Idem.
F.	Idem - - 2d part -	186	26,784	186	26,784	26,784	- - - - Idem.
G.	Kennington - 1st part -	452	24,261	452	24,261	52,969	Taken as ultimately reaching 75,000 to the sq. mile.
H.	Idem - - 2d part -	510	18,848	510	18,848	39,844	- - - - " - - " 50,000 "
I.	Brixton - - - -	1,445	14,610	1,445	14,610	56,445	- - - - " - - " 25,000 "
J.	Norwood - - - -	976	3,977	976	3,977	38,125	- - - - " - - " 25,000 "
K.	Christchurch - - -	74	16,022	74	16,022	16,022	Not capable of any further increase.
L.	St. Saviour's - - -	126	19,709	126	19,709	19,709	- - - Idem.
M.	London Road - - -	112	17,836	112	17,836	17,836	- - - Idem.
N.	Borough Road - St. George -	65	15,862	65	15,862	15,862	- - - Idem.
O.	Kent Road - - - -	105	18,126	105	18,126	18,126	- - - Idem.
P.	Trinity - - - -	142	20,922	142	20,922	22,187	Taken as ultimately reaching 100,000 to the sq. mile.
Q.	St. Mary - Newington -	161	14,033	161	14,033	20,125	- - - - " - - " 80,000 "
R.	St. Peter - - - -	321	29,861	321	29,861	35,109	- - - - " - - " 70,000 "
S.	St. Olave - - - -	47	8,015	47	8,015	8,015	Not capable of any further material increase.
T.	St. John, Horsleydown -	69	11,360	69	11,360	11,360	- - - Idem.
U.	Leather Market - - -	92	15,295	92	15,295	15,295	- - - Idem.
V.	St. Mary - Bermondsey -	142	13,934	142	13,934	22,187	Taken as ultimately reaching 100,000 to the sq. mile.
W.	St. James's - - -	427	18,899	427	18,899	50,039	- - - - " - - " 75,000 "
X.	St. George's, Camberwell -	434	15,849	434	15,849	33,906	- - - - " - - " 50,000 "
Y.	Camberwell - - -	1,339	17,742	1,339	17,742	52,305	- - - - " - - " 25,000 "
Z.	Peckham - - - -	1,146	19,444	1,146	19,444	44,766	- - - - " - - " 25,000 "
	Dulwich - - - -	1,423	1,632	1,423	1,632	55,586	- - - - " - - " 25,000 "
a.	Rotherhithe - - -	749	17,805	749	17,805	58,515	- - - - " - - " 50,000 "
b.	St. Paul, Deptford - -	917	20,825	413	9,379	25,812	- - - - " - - " 40,000 "
b.	Hatcham - - - -	670	4,074	617	3,752	28,922	- - - - " - - " 30,000 "
c.	St. Nicholas, Deptford - -	110	7,071	110	7,071	8,594	- - - - " - - " 50,000 "
A.	Portions of Streatham, Croydon, and Lewisham.	- -	- -	2,696	5,900	105,312	- - - - " - - " 25,000 "
				18,110	484,623	1,083,805	

Appendix (D).

SOUTH SIDE.

TABULAR STATEMENT showing the Inclination, Size, &c., of the Southern Tunnel Sewer.

Reference to Drawing.	NAMES of DISTRICTS and SEWERS Drained.	Area of Districts Drained.	Probable ultimate Population of the District.	Amount of Maximum Flow of Sewage.	Amount of Rain-fall taken at ¼ of an Inch in the 24 hours.	Amount of Sewage and Rain-fall combined.	Accumulated Amount of the same.	Length of Sewer between Points of Interception.	Level of Invert between Ordnance Datum.	Inclination of Sewer.	Diameter of Sewer.	REMARKS.
		Acres.		*cub. ft. p' min.*	*cub. ft. p' min.*	*cub. ft. p' min.*	*cub. ft. p' min.*	*feet.*	*feet.*		*feet.*	
	Heath Wall Sewer -	5,431	218,326	1,371	856	2,227	2,227	- -	- -	- -	- -	- - The rain-fall is only taken from one-fourth of the area.
	Effra Sewer - -	5,472	235,195	1,411	1,009	2,420	4,647	- -	- -	- -	- -	- - Whole rain-fall over 310 acres, and one-fourth over 5,162 acres.
	Arnold Sluice - -	177	34,237	205	112	317	4,964	- -	- -	- -	- -	Whole rain-fall over whole area.
	Battle's Bridge Sewer	1,033	153,466	921	651	1,572	6,536	- -	- -	- -	- -	- - - Idem.
	Duffield Sewer - -	1,944	179,650	1,078	1,036	2,114	8,650	- -	- -	- -	- -	- - Whole rain-fall over 1,544 acres, and one-fourth over 400 acres.
	Earl Sewer - -	3,578	187,219	1,123	1,492	2,615	11,265	- -	- -	- -	- -	- - Whole rain-fall over 1,965 acres, and one-fourth over 1,613 acres.
	Deptford Sewer - -	475	31,406	188	300	488	11,753	- -	- -	- -	- -	Whole rain-fall over whole area.
	Ravensbourne and Sydenham Sewer -	4,800	187,500	1,125	756	1,881	13,634	- -	27·38	- -	- -	One quarter of rain-fall over whole area.
	Lee Green Sewer -	1,550	60,547	363	244	607	14,241	2,100	- -	1 in 2,488	9·93	- - - Idem.
	Sewer at Church-street, Greenwich - -	100	4,688	28	63	91	14,332	300	28·22	- -	- -	
								- -	28·34	- -	- -	
								4,800	- -	„ 2,543	10·15	
	Sewer at Conduit-lane	400	12,500	75	63	138	14,470	- -	30·20	- -	- -	Whole rainfall over whole area.
								4,000	- -	„ 2,551	10·18	
	Terminal Works -	- -	- -	- -	- -	- -	- -	- -	31·76	- -	- -	
		24,960	1,304,734	7,888	6,582	14,470				„ 2,563	10·23	

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. Murray*, and Mr. *R. W. Mylne*.

16 April 1857.

(12.) Minutes of Evidence given by *John Murray*, Esq., and *R. W. Mylne*, Esq.

Meeting of Referees, 29, Great George-street, 16 April 1857.

Mr. *John Murray* and Mr. *R. W. Mylne* attended by appointment.

Mr. R. W. Mylne produced a longitudinal section of the proposed Catchwater and Tunnel Sewer, with detailed geological sections coloured thereon, collated from borings made by him for the completion of his geological maps of the environs of London.

Mr. Mylne, stated that on the practicability of executing the tunnel sewer under the high lands between Eltham and Shooter's Hill, there were many points which required to be explained, particularly with reference to the level of the chalk stratum, and as to the amount of water contained in it.

Along the brow of high land between Woolwich and Erith, and within the margin of the Thames Valley, the chalk rises to several feet above high water, and, in many instances, at a quarter to half a mile inland, the chalk is excavated down to the high water level, perfectly dry; the maximum water level along that district may be taken at about five feet below Trinity.

By pumping, the water can be lowered from 30 to 40 feet below Trinity, but, beyond that, difficulties and expenses would ensue. At Brampton Place a well exists in the chalk, where large excavations and headings were driven at about Trinity level, in order to obtain water.

East of Burstal Heath to Erith, if the line of sewer be kept a little more inland than indicated on the plan, it would be through chalk, and quite dry, by reason of its level being above high water. Mr. Mylne described the section from Abbey Wood to Erith. The chalk is 100 feet above Trinity high water at Burstal Heath; and it is from 60 to 80 feet to the chalk at Abbey Wood station. If the sewer be carried in the line as shown, it would be in dry sand; if a few yards more inland, solid chalk would occur.

There is no water at the level that the sewer is proposed to pass through, in this particular district.

The chalk at Eltham is 110 feet above high water; there is, however, an up-cast or fault in that locality.

The proposed Catchwater Sewer from Wandsworth Common to Nunhead Cemetery skirts the thickly populated area; and it is placed not so high as to materially reduce the area of the high level district.

The tunnel would pass under Clapham Common, at a depth of 21 feet below the surface.

There would be no difficulty at Wandsworth Common, either from the railway proposed, or from the buildings about to be erected by the Patriotic Fund.

Mr. Mylne proposed to bring part of the northern drainage across the Thames, thinking it unadvisable to carry the sewage in any way whatever through the thickly populated parts of London, comprising the Strand and the City.

Part of Mr. Mylne's objections to the scheme adopted by the Metropolitan Commissioners, is that the northern middle level intercepting sewer would pass under Oxford-street, and other great thoroughfares, instead of, as he would have it, further north, running along the St. John's Wood Road, and through the Regent's Park, and along the line of the Regent's Canal, by which no traffic would in any way be interfered with, whilst the canal would serve as the means of transit for materials and surplus soil.

The area proposed to be drained by engine power on the north low level district, in Mr. Bazalgette's scheme, is 10·87 square miles; whereas Mr. Mylne proposes to drain an area of 13·59 square miles. Mr. Mylne explained this excess by showing that it was accounted for by including an area at Chelsea, which, in the scheme of the Metropolitan Board, belonged to the upper low level district.

There would be no difficulty in carrying out the tunnel along the side of the Regent's Canal, as it would interfere very little with the traffic, and private property would scarcely be disturbed.

As regards the south side Catchwater Sewer, immediately south of the line of the proposed sewer at Eltham, the chalk is perfectly dry to within from 20 to 30 feet of the level of Trinity high water; and a small amount of pumping would reduce this level considerably.

The rainfall of the whole district is drained off from the surface by numerous brooks, and the chalk receives but little supply from any water-shed area.

The greatest depth from the surface at which the tunnel would have to be constructed is through a ridge 250 feet above Trinity high water.

Not half the rain-fall in the Blackheath district would reach the sewers, owing to its pervious character.

The most difficult part of the line of tunnel sewer to execute, Mr. Mylne believed would be at Nottingham-lane.

Just east of the valley of the Ravensbourne, the tunnel would pass through a short length of perfectly dry blue clay, 45 feet thick. The water level at this point would be 20 feet below the proposed invert.

Another difficult portion would be, that immediately west of the Ravensbourne Valley.

Mr. Mylne objected to carrying the main sewers through the low districts of Greenwich and Woolwich, within the margin of the Thames Valley, to the Plumstead Marshes, as being difficult in construction, and through a district likely to be still further thickly populated. To avoid these points, a high level line was sought through an unpopulated district, and it was proposed to tunnel through it at such a depth as would not interfere with private property, and at the same time not so low as to get into the water-bearing stratum.

There are only about seven land proprietors in the five miles through which the tunnel and deep sewer would have to pass, the Crown holding 2½ miles of its extent.

Mr. Mylne said, that on the south side a storm overflow in addition to the Catchwater Sewer was provided, leading into the mouth of the Ravensbourne; but on the north side he had not gone into detail on that question, as the Fleet Sewer would form the main outlet for storms.

In the No. 1, or Southwark low level district, the rain-fall provided for was a quarter of an inch; and on the Wandsworth district, one-eighth of an inch.

Mr. John Murray stated, that in 1849 he had collected a series of observations, and made calculations on the quantity of water passing through some of the principal sewers in London, during extraordinary falls of rain. Some of these observations are given in the Appendix to his Report, submitted to the Metropolitan Commissioners of Sewers, and printed by him in 1852.

The conclusions arrived at, as given below, are general, but the experience of an engineer can readily apply them to places where the surface is either flat, slightly inclined, or otherwise; due regard being paid to the absorbing qualities of the ground, or its exposure to atmospheric currents.

1. That on flat meadow lands the downfall water requires some time to run off, to absorb, and to evaporate. The capacity of the drain may, therefore, be such as to be calculated equal to one-tenth of the whole area deluged with rain.
2. That in a rural district, with a slight inclination, the drains may be calculated equal to one-ninth of the whole area.
3. If semirural, one-eighth of the area.
4. On an undulating surface occupied with villas, one-sixth of the area.
5. On a surface of a suburban or urban character, from one-fifth to one-fourth of the whole area.

In

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. Murray*, and Mr. *R. W. Mylne*.

16 April 1857.

In Mr. Murray's and Mr. Mylne's Report, they have stated the quantity of rain taken by them in the different districts to vary from one-sixteenth to one-fourth of an inch per diem; and they have calculated the capacity of the sewers with regard to the flat and absorbent nature of the ground on which the rain falls.

The size of the Catchwater Sewers at Wandsworth Common is assumed by them to be 8½ feet in diameter; increased to 10 feet diameter at the Nunhead Cemetery.

The Shooter's Hill Tunnel to be 13 feet diameter, and at the outlet in Dartford Marshes 14 feet in diameter.

The estimated cost of the Catchwater Sewer is as follows:—

	£.	£.
From Wandsworth Common to Nunhead Cemetery, a distance of 5⅝ miles, including 2½ per cent. for pumping water, crossing sewers, &c. &c.		134,000
From Nunhead Cemetery to the entrance of the tunnel at Shooter's Hill, a distance of four miles, with 5 per cent. for pumping, &c.		149,000
Shooter's Hill Tunnel, a distance of four miles, and 3 per cent. for pumping		152,000
From end of tunnel to the termination of sewer in Dartford Marshes, a distance of 4½ miles, including pumping water, crossing roads, and temporary works		171,000
		606,000
15 per cent. contingencies		90,900
		696,900
Storage channels and outlet works	300,000	
15 per cent. contingencies	45,000	
		345,000
	£.	1,041,900

Mr. Murray explained the method in which they proposed to store the rain and sewage waters in the lower length of the sewer on the first of flood, when the gates at its mouth would be closed, to prevent any discharge into the Thames until the ebbing of the tide.

He also explained the way in which they proposed to dilute the sewage with water from the river, by admitting it into the storage channels during the periods of drought in summer, previously to the sewage being discharged into the Thames.

In answer to a question, as to the likelihood of silt collecting in the lower length of the sewer, Mr. Murray stated that his observations and experience led him to believe that no such silting would occur, and the works could be so constructed as to prevent it.

Mr. Murray also explained the formula and data which determined the capacity of the proposed Catchwater Sewer.

The storage channels were calculated in the estimate to be covered over, and were capable of containing about 8,000,000 cubic feet of water, but they would not be wanted to this extent for the present requirements of the drainage. They were designed to be so formed as to answer all present purposes, and capable of enlargement when that was deemed necessary.

(13.) Minutes of Evidence given by *Jasper W. Rogers*, Esq.

Mr. *J. W. Rogers*.

20 April 1857.

(i.)

Meeting of Referees, 29, Great George-street, Monday, 20 April.

Mr. *Jasper Rogers* attended by appointment.

Mr. Rogers stated that his plan was founded upon an entire separation of surface and sewage water.

Mr. Rogers believed it would be possible to revent washings, dirt, and other foul matter being passed into the surface water drains, under heavy penalties; and stated that in Belfast, Liverpool, Manchester, and other places, regulations to prevent this being done existed, and were stringently enforced. The new traps for surface-water drains retain the solid matter, and let the water only pass into the sewer.

Mr. Rogers believed that all animal matter discharged into the sewers from kitchens was entirely consumed by the rats.

Mr. Rogers thought, even if animal, vegetable, and foul matter got into the surface drains, that charcoal filters might be erected at the mouth of each of the 60 sewers which now discharge into the Thames, and that the water might thus be perfectly purified.

The extent of sewage pipes in London would be 1,100 miles, giving 18 miles discharging into each of the 60 filter chambers. The amount of semisolid matter reaching each filter would not be more than four or five tons.

The content of the mains in each of the district 18 miles of sewers would be about 126,720 cubic feet; to fully command this extent of main, the vacuum chamber should be, say 30 feet in depth × 80 feet, and 60 feet in length and breadth. That would give an area of 144,000 cubic feet.

The population of London, Mr. Rogers estimated at 3,000,000, and he assumed, for calculation, the semi-solids of the excreta to be for each person 3 oz. per diem = 251 tons 3 cwt. = 4 tons 4 cwt. into each filtering chamber; total per annum, 91,688 tons semi-solids.

The peat charcoal which Mr. Rogers proposed as a filtering medium, he believed would, if properly prepared, withdraw all the salts from the urine, and leave the water perfectly pure.

Mr. Rogers stated that he knew charcoal, prepared faithfully according to his process, had not been used anywhere near London since the year 1850.

Mr. Rogers said, that his plan, submitted to the Referees, differed from those of others in preserving the fertilising portions of the sewage in close pipes, and not permitting it to be discharged into the general sewers with large bodies of water, when its value was lost by the evolvement of its gases, which could not take place when close pipes were used, and that, therefore, no noxious gases would rise as now into the closets and houses.

Mr. Rogers stated, that his charcoal was peculiarly prepared, with a view of absorbing the oxygen; and had been carefully tested and highly approved by a French commission.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. W. Rogers.*

20 April 1857.

Mr. Rogers explained the way in which he used peat charcoal as a deodorising agent for privies, &c., in Dublin* and other places, which totally prevented the escape of any bad odour.

Mr. Rogers thought all soap water ought to pass into the excretory or house refuse pipe; and thinking it impossible to include this only, intended to receive into the same main or pipe all housemaid's slops, washings, &c.

Mr. Rogers, stated that the privies in Dublin, Manchester, Salford, Liverpool, and most other such towns were, in great measure, connected with the dust and ashholes, where partial deodorisation was effected, till the whole contents of the cesspool thus formed was removed by contractors. In Manchester, Salford, and Liverpool, this was done at the expense of the Corporations, and the manure sold or disposed of to meet the cost of removal. The householders gave notice when the removal was required, and the contractors were bound to remove within a given time.

What Mr. Rogers mainly urged for the London drainage was, that an excretory matter or house refuse main should be passed through the present sewers, in order to keep the housewater and rainwater separate.

The cost of connecting the water-closet pipe with the main, Mr. Rogers thought ought to fall individually on each householder, who should be compelled to make the connexion with the new drain for himself. The law compels him to do so now; why not under any new arrangement for the public good?

The 1,100 miles of pipes propdsed to pass through the present sewers, Mr. Rogers thought, would cost about 2,000,000 *l.* The dry tunnels to contain house refuse mains, water and gas mains, and electric wires, &c. Mr. Rogers proposed only for new streets.

Mr. Rogers did not believe there would be any difficulty in laying down close pipes from each house to carry off the excretory matter. Mr. Rogers did not think it could cost 10 *l.* a house to cover the expense, but would ascertain the amount. The calculation should not be made on the house that paid 150 *l.* to 300 *l.* rent per annum, but on the average houses of the district.

(ii.)

9 May 1857.

Meeting of Referees, 29 Great George-street, Saturday, 9 May.

Mr. *Rogers* attended by appointment.

Mr. Rogers read some particulars which he had committed to writing, for the information of the Referees, and which he requested might be added to this day's evidence.

Mr. Rogers said, that he was surprised to hear from the Referees what Mr. Isaacs had previously said* about the offal which found its way into the sewers in the Holborn district. Mr. Rogers said, that it was quite contrary to his own experience; and, although there might be exceptional cases, he believed that such matters seldom, if ever, reached the sewer mouth, as he had already stated; but, if they did, there could be no more difficulty in inflicting punishment for such practices, than in any other illegal act; and this punishment he conceived ought to be inflicted when such acts perilled the health or lives of others.

In answer to a question, Mr. Rogers said, that he proposed to pass his house drain through the existing sewers, which he understood extended at present 1,100 miles. Mr. Rogers believed from 200 to 300 extra miles were proposed to be constructed.

Mr. Rogers said, that the average size of his pipes would be 15 inches in diameter, all of them commencing at 6 inches, and being enlarged gradually in their course to 2 feet at the mouth. He handed in an estimate of the cost of the pipes proposed by him to be laid down.

Mr. Rogers, in answer to a question, said, that the pipes he proposed to use were calculated to bear the ordinary low service pressure, and were amply strong for any pressure which could arise under his proposed plans.

The

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* The following is a Copy of a Correspondence between the Referees and Mr. *Neville*, regarding Mr. *Rogers'* Plan of Drainage as applied to *Dublin*:

(1.)

Letter from the Secretary to the Referees to Mr. *Parke Neville*, City Engineer, *Dublin*.

29, Great George-street, 20 April 1857.

Sir,

Understanding that you are practically conversant with the working of Mr. Rogers' plan of drainage, so far as it has been carried out in Dublin, the gentlemen appointed as Referees by Her Majesty's Chief Commissioner of Works, &c., to whom the question of the drainage of London has been remitted, have desired me to write and ask you to be so good as to forward them a brief account of the system as now working in Dublin, with a summary of the results (whether favourable or otherwise) of its adoption, and a statement of its present cost. The Referees would also be glad to have your opinion upon the feasibility of adopting a similar plan in London, with the reasons for the conclusion at which you may arrive.

Will you also have the kindness to state the assumed value, as well the actual selling price of the manure obtained by Mr. Rogers' process from the sewage—deodorised with his patent peat charcoal, as well as particulars of the cost of its manufacture. The Referees beg me to apologise to give for thus troubling you in the matter, but feel convinced you will agree with them, that the importance of the question in some measure justifies their demands upon your kindness.

I am, &c.

(signed) *Herbert C. Saunders.*

Parke Neville, Esq., Dublin.

(2.)

Letter from Mr. *Parke Neville* to the Secretary to the Referees.

Engineer's Office, City Hall, Dublin, 22 April 1857.

Sir,

I have to acknowledge the receipt of your letter of the 20th instant, seeking information on the "subject of Mr. Rogers' plan of drainage, so far as it has been carried out in Dublin."

In reply, I beg to inform you that the management of the sewerage of this city has been under my direction, as engineer to the corporation, for the last six years, during which period very extensive new works have been carried out, and others are still in progress, for the improvement of the drainage; but no plan of Mr. Rogers has been to my knowledge applied to them in any way. Mr. Rogers may have, however, made experiments on private drains without my knowledge.

If the Referees require any information on our system of sewerage in Dublin, I will be most happy to answer their inquiries; but I know nothing practically of Mr. Rogers' projects.

I remain, &c.

(signed) *Parke Neville*, City Engineer.

H. C. Saunders, Esq.,
29, Great George-street, Westminster, London.

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* See Mr. Isaacs' Evidence, Appendix VII., page 275.

Appendix X.

Plans of Drainage.

Evidence.

Mr. *J. W. Rogers.*

9 May 1857.

The cost of 1,100 miles of pipes delivered, but not laid down, would not amount to as much as 2,000,000 *l.* He considered the cost of laying down would be considerably less than in other cases. There would be no excavation or filling. The pipes would be let down into the sewers through convenient openings at intervals, and fixed on iron bearings. The cost would be comparatively small. The pipes might be floated up or down the sewers to any point at which they might be required to be laid.

The cost of the 60 filtering chambers would average, say, 5,000 *l.* each.

In answer to a question, Mr. Rogers said, that he might construct his filtering chamber to 20 feet, or in fact to any depth below low-water mark. It would be constructed of plates of cast-iron, of about half-an-inch in thickness, or sufficient to resist the atmospheric pressure, when a vacuum was produced. In reply to observations and questions respecting the foundations of the filtering chambers, he said he required none of the common modes for sinking for foundations in water. The filtering vacuum chambers would be formed in 6 to 12 feet compartments, sunk by means of gravity and exhaustion to a sufficient depth as found convenient; and if rock should present itself, the depth need not of necessity be more than a few feet below low-water mark. The space for the vacuum might as well be upwards as downwards. Mr. Rogers then explained the action of the vacuum chamber, which was only intended to be used as a vacuum power when stoppage of the pipes took place. At all other times the water from the house refuse main would pass through the filtering chamber, falling into the river either at high or low water. The engine power required would be from 3 to 5 horse-power. The work to be done by each engine would be to lift about 5 tons of solids per day, and pump out the water and air when a vacuum was required.

Mr. Rogers read a proposal he wished to make, to let out the sewers to contractors who would undertake the erection of filtering chambers, and the removal, without nuisance, of the sewage, consenting, moreover, to pay 3¼ per cent. on the actual outlay upon the sewer mains.

In answer to a question, Mr. Rogers said, filtering works had been constructed at Uxbridge, the arrangement being taken from his plans, but not by him; and also at Belfast, but not in Dublin. Here were public facts to prove that the filtration had been satisfactory, although the matter collected from the present arrangement of sewers could not pay for the collection.

Mr. Rogers said that, according to his process, the charcoal filter was never coated by excretory matter. If it were attempted to employ downward filtration, it would inevitably become choked up. His patent plan consisted in upward filtration.

Mr. Rogers then explained how the filtration was effected upwards, through a layer of broken metals, which prevented the night-soil ever coming into contact with the peat charcoal; the fluids were in fact compelled to pass through the pores of charcoal themselves, and deposit in those pores the impurities afloat. These were parts of the secrets of his arrangement; but there were other details which would appear in the specification of his patent.

Mr. Rogers was confident that the time would come when at least one-half of the local taxes of towns would be returned to the ratepayers from the profits of the sewage and general refuse.

Mr. Rogers had not provided for the refuse of stables in these proposals; intending to deal with them in a different manner, by the immediate application of peat charcoal to counteract at once the evil suffered by the escape of ammonia from the urine, which specially affected the sight of horses.

Mr. Rogers said, that he would communicate by letter to the Referees as to the security, &c., to be given by the contractors to whom he alluded for the effectual carrying out of the terms of their contract.

Mr. Rogers said, he understood that any amount of the foreshore of the river might be let out by the Government, without any compensation being paid to the owners of wharves in the neighbourhood; but even supposing it not to be the case, the space required for the chambers being so moderate, he could not suppose that any serious difficulty could arise on that score.

Mr. Rogers said, he did not believe there would be any difficulty in forming the vacuum and filtering chambers on the banks. If he found it impossible to sink it beneath low-water mark, there would be no objection to erecting the whole of the chamber (30 feet in depth) above the level of the shore, except about 3 or 4 feet to allow for the deposit of the solid matter.

In answer to a question, Mr. Rogers said, that an engine of not more than 3 to 5 horse-power would be required at each of the 60 filtering chambers. The engine represented in the section attached to the proposition submitted, is similar to those he has been working for the last 10 years, occupying a space of 2 by 4 feet, and the power would be more than ample for any work to be done in the filtering and vacuum chamber.

In reply to the fact pointed out, that many of the districts of London were several feet below high water-mark, and that the sewers frequently became dammed up by water, Mr. Rogers considered such facts to be much in favour of his proposition, inasmuch as that the rise of the tide into the sewers could not prevent the discharge of the matter through the proposed house-refuse mains into the filtering chamber. The action of the mains and the chambers would be the same under every circumstance; and if surface-water was held back by the influx of the tide, no check whatever would take place to the discharge of house-refuse within the pipe; it would flow uninterruptedly into the chamber. And as to the influx of the tide into the sewers generally, Mr. Rogers stated that it could be entirely prevented by the use of his patent tide-valve, as shown in the section of the filtering chamber; it closes of itself, is unerring in its action, and totally prevents the admission of tidal water, whilst it opens of itself, and permits the internal water to escape at the fall of tide.

As regards the anticipated difficulty of finding space for the filtering chambers within the banks of the river, Mr. Rogers conceives it may be met very simply. The chambers may be formed entirely below the surface of the carriage way at the end of each street, down which the main sewers from each district pass to the river. The space under the carriage way will be generally ample for the purpose; it can be had without cost; and the only inconvenience to arise will be from the taking up and relaying the gas and water mains at the extremity of the street, for the lengths of the chambers—an operation of very minor consequence.

(iii.)

Paper received from Mr. *Rogers*, in further Explanation of Points connected with his Evidence.

With respect to the cost of connecting the water-closet pipes with the proposed mains, as required at the last interview, Mr. Rogers finds that 6-inch pipes can be supplied at 1 *s.* 9 *d.* per foot in quantity, and taking the average length of connecting-pipe at 40 feet, the whole expense would be from 4 *l.* to 5 *l.* for each house.

Mr. Rogers has ascertained that, according to the existing law, not yet enforced throughout a large portion of the metropolis, and which obliges householders to fill up their cesspools, and discharge excretory matter into the general sewer at their own cost, the expense for each house, where done, has been generally from 20 *l.* to 40 *l.*

If such a law was passed by the Legislature on the ground of public good, a similar law requiring much less expenditure in connecting the water-closet pipes with the mains could, Mr. Rogers conceives, scarcely be objected to; and, assuming that the house-refuse mains be adopted, Mr. Rogers would suggest that the connexion with the houses should be made by the contractor for the mains, at fixed rates, which need not exceed on an average the sum stated.

With regard to the injunctions reported to the Referees to have been granted, to restrain the operations of the sewage manure works at Fulham Bridge, after peat charcoal had been used, Mr. Rogers believes, from the

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the inquiries he has made, that indictments were issued before peat charcoal was used, and were withdrawn after its application; but Mr. Rogers does not vouch for the arrangements adopted at Fulham, which, though taken from his plans, require the addition of several details, to make the action of filtration perfect, and the charcoal now in use there has not been made according to his patented process.

Referring to the question mooted as to the consumption by rats of the entrails and other such matter from slaughter houses, supposed to be discharged into the sewers, Mr. Rogers believes it will be found that very little, if any, such matter now reaches them. Every bone and hoof commands a high price, and, with the blood, is carefully collected for chemical purposes; all edible parts, not used for human food, are collected as food for pigs, dogs, and cats, and the entrails are converted into substitutes for bladders; all the grosser refuse being contracted for by the manufacturers of manure. In fact, scarcely any slaughter-house refuse now reaches the sewers, but if it does, the law, as it exists, forbids it, and the practice could be easily prevented.

With regard also to the refuse from kitchens of large establishments, such as hotels, &c., in place of being generally thrown into the sewers, as formerly, they are now collected by many persons throughout London, who have become feeders of pigs, depending on this source of supply, and it is actually in contemplation to form a public company for making the collection general throughout London for that special purpose, to which hotel and eating-house proprietors are very favourably disposed.

Mr. Rogers would beg leave to impress upon the Referees the following facts:—

1. His proposition does not interfere with any existing rights or interests.

2. The laying of the house-refuse main through the present sewers can be accomplished without any engineering difficulty, at a much smaller cost to the Metropolitan Commissioners than any other plan publicly proposed.

3. The ground or space for the filtering chambers will not cost anything, being within the banks of the river.

4. It has already been proved at Uxbridge, Belfast, &c., that the water passed through charcoal filters, on Mr. Rogers's plans, flows away in a transparent state, divested of all apparent impurities; and he would submit that, whether a small amount of phosphates be discoverable or not (to which point the published doubts respecting peat charcoal have been apparently now reduced), it does not affect the question under consideration. Viewed as a sanitary question, the purification of the water, so far as stated, would sufficiently accomplish the purification of the Thames, whilst the solid matter retained in the chambers would be removed perfectly free from odour, and, when passing through the mains, be innoxious. But Mr. Rogers believes that the arrangements he has proposed would divest the water of all phosphates not directly belonging to itself.

5. As regards the injury to the navigation of the river by the contemplated withdrawal of the water now passing into the sewers, either taken from the stream above London, or yielded by rain, Mr. Rogers conceives that considerable advantages would arise from his propositions, by giving back, at the points of natural watershed, the water due to each portion of the stream, and he believes that, if not so done, the river will gradually silt up for want of its usual scour.

Should Mr. Rogers's propositions be considered worthy of adoption, he undertakes to find contractors who will erect filtering and vacuum chambers at their own cost, and supply the deodorising material for the whole refuse matter of London, which they will be bound to remove weekly or daily free from odour and charge; and they will pay 3½ per cent. interest on the cost of the house-refuse mains (to be laid by the Metropolitan Commissioners), commencing from the period each district of sewers be completed; the condition being, that the whole matter discharged through the mains shall be the property of the contractors for 50 years, at the expiration of which time the filtering and vacuum chambers would be handed over to the Metropolitan Commissioners at a valuation, and the contract end, or be continued by future agreement.

The contractors are willing to commence with one district, or even one street, and thus prove the effectiveness of the operation before the final agreement be completed on the terms stated. All risk would therefore be prevented, and, pending the final completion of the mains throughout the metropolis, temporary filtering chambers might be placed at each of the present sewer mouths, and the river thus be at once relieved from the filth now discharged into it.

Mr. Rogers submits the following extracts from the Minutes of the General Board of Health, respecting the deodorising properties of peat charcoal, at last officially acknowledged:—

"Extracts from Minutes on Deodorisers and Disinfectants, by Mr. *Lindsay Blyth*, Chemist to the Board of Health.

"Section 21. Charcoal, in common with other porous bodies, has the power of absorbing and condensing various gases within its pores, and brings them within the sphere of their mutual attraction, whereupon chemical combination ensues. In this way noxious vapours, simultaneously with atmospheric air, may be brought within the influence of its oxygen and destroyed. When chemical action does not take place between the gases so condensed, they may be driven out again by heat unchanged. The peculiar action of charcoal then merely consists in the power it possesses of condensing gases within its pores, the nature of the gases themselves determining their destruction or not, as the case may be.

"Section 24. Various kinds of charcoal have been suggested for the purpose of deodorisation. Peat charcoal Possesses the power of condensing the largest amount of noxious vapours.

(iv.)

Correspondence with a reference to foregoing Evidence, &c.

A.

5, King William-street, Charing Cross, 12 May 1857.

Gentlemen,

With reference to my examination before you on Saturday last, I beg leave to return the draft of my evidence, and I will thank you to be good enough to direct that there be attached thereto the paper I placed before you on that day, the additional replies herewith transmitted, and this letter. I feel that this request is necessary, in consequence of the facts specially alluded to during my examination respecting the rise of tide into the sewers, the observations made upon "the filtering and vacuum chambers," and because it appears to me, from what took place generally, that the plans submitted by me were not fully understood by the Referees. I would, therefore, desire that as full an explanation as is practicable should appear on your minutes, and I shall remain in London specially, in order that I may give all further information you may desire.

1. My proposition specially provides means by which the evils of the influx to sewers of tidal water can be totally obviated, as regards the stoppage by that means of the discharge of house refuge; inasmuch

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much as that the "house-refuse mains" proposed by me will act equally whether the sewers be flooded or not; and if the patent tide valves be attached to the mouth of any sewer they will totally prevent the ingress of the tide, and permit the outflow of internal water. I need scarcely add, that up to this time there is not any tide-valve used which will accomplish that object.

2. The action of the patent "filtering and vacuum chambers" in receiving and permitting the outflow of water from the house-refuse mains, is entirely independent of the aid of a vacuum, and the water will find its way out unchecked, at least up to half-tide, and as the space provided in the vacuum chambers is more than the contents of the whole length of the house-refuse main proposed to be connected, it will be amply large for storing the discharge from half tide to high water and back to half tide again. The action of the vacuum is only necessary in case of stoppage in the pipes; still it may be used daily, and it can be accomplished without the slightest inconvenience.

The quantity of solids to pass into each chamber would not be more than five tons per day. This would be drawn up by the Archimedian screw continuously, and all the water would discharge itself to the depth of low-water mark. Beyond that, the engine withdraws whatever water may be necessary to give sufficient vacuum space when such may be required, and then pumps out the air. It can scarcely be necessary to add that, if a vacuum be produced in the chamber, while the valve of the ingress-pipe is closed, that instantaneously, on the opening of that valve, the matter within the pipes must simultaneously commence to move throughout the whole, towards and into the space where the vacuum exists. Thus the danger of stoppage in the pipes is provided against effectually, although that stoppage may or may not be for months together.

3. My filtering bed acts upwards—downwards for filtration of sewage would be futile to attempt—such matter resting above would speedily form a water-tight mass, but, being below, aided by the means I haveprovided, the gravity of the solids, and the antipathy between them and my first filtering medium (broken cast-iron), the filtration becomes perfect; especially, because I oblige the fluids to pass through the pores of the charcoal, not through the interstices of the bed of charcoal.

Charcoal, as a filtering medium, in place of being a source of expense (as is now so seriously felt in the filtration of water by sand, shells, &c.), is a source of profit; for, when it becomes charged with foul matter, it is double its original value. The cost as simple charcoal is, say from 2*l.* 10*s.* to per ton; the selling price as manure, charged with night-soil, is 5*l.* to 6*l.* The objection raised as to "changing the filtering medium" is, therefore, not tenable, because the more frequent the change, the greater will be the advantage to the operation generally; but, in fact, frequent change is not necessary.

4. As regards the anticipated difficulty respecting the erection of filtering chambers at the mouths of the sewers within the banks of the river, it will equally answer my purpose to construct those chambers under the surface at the end of the streets through which each main sewer passes, and close to the river where it will be unseen, and of no inconvenience and no cost; any difficulty on that score therefore ceases.

5. I would beg it to be specially understood, that the operations at Fulham, to which frequent allusions have been made, and in which peat charcoal was introduced, were not under my direction, nor patents nor plans. The simple facts are: The works are those of the "Metropolitan Sewage Manure Company," proposed by Mr. Edwin Chadwick, for the purpose of supplying liquid manure to the stated extent of 50 miles round London. When put into operation, to the extent of seven miles, indictments were lodged to prevent the nuisance caused, and the company were obliged to use peat charcoal to purify the liquid discharged through the pipes. This effected the purpose, as I am informed, to such an extent as to remove the nuisance, and prevent the prosecution of the indictment; and then the company advertised "charcoal manure," stating that the charcoal was enriched by the filtration through it of "many hundred tons of sewage water."

But I must beg to impress upon the Referees that I have at all times distinctly stated and published, from 1849 to the present time, there were no fertilising properties worth seeking for to be found in the sewage of London, or any large towns, as coming from the present sewer mouths. I have shown it to be, at most, but five per cent. of a poor, cold, and slightly nutritious property. Hence, why I have suggested the mode of collecting the matter in close pipes, when all the original constituents of night-soil will be retained, and no tidal flooding affect the discharge.

And permit me to add that my proposition now before the Referees is not the thought of a day, got up merely for presentation to them; it is the matured results of long attention to the subject, prepared years before their appointment; and, did I not feel convinced it will bear the fullest examination, I should neither lower myself, nor be so wanting in respect to them, as to occupy their time upon the question.

I beg leave to say that it has given me much pleasure to order the supply of peat charcoal wished for by the Referees; but it is due to my own interests, &c., to say, that I do not hold myself accountable for results obtained by tests, &c., made upon other principles and details than such as my own experience and patents require, which I cannot consistently more fully explain, until the specification shall have been registered.

Referring to my letter accompanying this, proposing to find contractors for putting my proposition into effect generally,

I have, &c.
(signed) *Jasper W. Rogers.*

To Captain D. Galton, R. E.
J. Simpson, Esq., C. E.
Thos. E. Blackwell, Esq., C. E.
&c. &c. &c.

B.

5, King William-street, Charing Cross, 12 May 1857.

Gentlemen,

Agreeably to your desires intimated to me at my interview with you on Saturday last, I beg leave to state by letter, as requested, that I shall be prepared to name contractors who will, at their own cost, construct filtering and vacuum chambers, according to my patent, within the banks of the river, or beneath the surface of the carriage-way, at the ends of the streets, through which the excretory main sewers discharge themselves, and they will supply deodorising materials for the whole matter to be collected through the house-refuse mains, proposed by me to be adopted and laid down by the Metropolitan Commissioners.

The contractors will pay 3½ per cent. per annum on the actual cost of the mains, such interest to commence from the period that each of the proposed districts shall have been completed according to my propositions; the condition being that the whole matter to be collected through the mains shall become the property of the contractors for 50 years, at the end of which time the filtering and vacuum chambers shall be handed over to the Commissioners at a valuation; the contract to commence with one district or street, and the agreement to be finally binding on both sides, so soon as the works shall have been put into operation and proved, in accordance with my

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publications, &c. The contractors will be bound to erect the subsequent filtering chambers for each district, simultaneously with the laying of the house-refuse mains through that district by the Commissioners.

On receiving from you a communication that the proposition will be entertained, on condition that the authorities be satisfied with the solvency, &c., of the contractors, I shall take the necessary steps to have such condition fully complied with.

I have, &c.
(signed) *Jasper W. Rogers.*

To Captain Douglas Galton, R. E.
James Simpson, Esq. C. E.
Thos. E. Blackwell, Esq., C. E.

C.

19, Essex-street, Strand, 26 June 1857.

Gentlemen,

Since I had the honour of placing before you my proposition for remedying the evils of the existing sewage system of London, &c., I have sought for a substitute for metal pipes first, because of their cost and their corrosion.

I am happy to say I can now procure a pipe at less than half the cost of metal, which will bear any pressure required, and will not corrode under any circumstances. They can be cast in any convenient size and length.

You will, I am sure, consider that I am correct in immediately acquainting you with these facts, and drawing your attention to the result, namely, that the cost of laying pipes throughout 1,100 miles of sewers as proposed by me, under existing circumstances, need not exceed one million in place of two, as named in my original estimate; and I would beg that you will be kind enough to add this fact to my former communications.

I beg leave to enclose the proposition of "The Patent Slag Company," from whom the pipes may be obtained.

I have, &c.
Jasper W. Rogers.

To Captain D. Galton, R. E.
James Simpson, Esq., C. E.
Thos. E. Blackwell, Esq., C. E.

(*Enclosure in* C.)

British Slag Company, 5, Waterloo-place, Pall-Mall, S. W.
26 June 1857.

Sir,

With regard to the manufacture of pipes, such as you propose to adopt in your plan for improving the sewage system of London, I beg to hand you a specimen of the material of which this company could undertake to make the pipes in question.

Respecting such pipes I can certify the following things:—

They will bear external pressure equal to 15 lbs. on the square inch.

No acid (except fluoric acid to which they would never be exposed) will affect them in the least; nor will they decay or deteriorate by any length of time or atmospheric action.

Of this material, pipes of 9 feet length, with either flanch or spiggot and faucet joints, may be made, of ample strength for all the purposes that could be required of them.

The price would be less than half that of similar cast-iron pipes; in comparison with which they would have the great advantage of being subject to no corrosion. The pipes can be supplied in any quantity.

I have, &c.
J. Dickinson Brunton, Secretary.

J. Rogers, Esq.

(14.) Minutes of Evidence given by Messrs. *Geo. Thornton* and *Thos. Jackson.*

Messrs. *G. Thornton & T. Jackson.*

4 April 1857.

(i.)

Meeting of Referees, 29, Great George-street, Saturday, 4 April.

Mr. *Thornton* attended.

1. Mr. Thornton stated, that his plan was founded on the principle that the upland waters should not be intercepted, but allowed to go for the purposes of flushing through the low level sewers.

2. Mr. Thornton's total estimate would be five millions of money; and, besides the interest, 96,000*l.* a year,* would cover all the expenses of maintenance.

3. In answer to a question, Mr. Thornton stated that he had some borings at the Victoria Docks. His tunnels would there pass through silt principally, but would also touch the London clay.

3*a*. The reservoirs proposed were to hold 40,000,000 gallons. Mr. Thornton believed the largest amount of prospective sewage would be 86,000,000 gallons.

4. Mr. Thornton stated, that his data for calculation, as to quantity of sewage and rain-fall, were given in the Report.

5. The maximum of rain-fall in one month, Mr. Thornton stated to be 5·77 inches in November 1842. Taking the daily average of this, which would amount to ·20 inch in round numbers, and adding the daily average of a year in which 27 inches fell, amounting to ·06 inch, Mr. Thornton had provided for this total (viz. ·26 inch) as the maximum probable rain-fall in any one day.

[Mr. Thornton here asked the Referees to adjourn the interview, in consequence of his indisposition.]

* *See* letter on following page.

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Messrs. *G. Thornton & T. Jackson.*

20 April 1857.

(ii.)

Meeting of the Referees, 29, Great George-street, Monday, 20 April.

Messrs. *Thornton* and *Jackson* attended.

6. Mr. Thornton stated, that he believed the sewage of Sydenham and the high districts surrounding, would be carried into the London district by the Wandle or Ravensbourne, and so carried off by his sewers.

7. The amount of sewage provided for on the south side would be 22,000,000 gallons, and on the north 58,000,000 gallons, making a total of 80,000,000 gallons.

8. Mr. Thornton stated, that his sewers would carry away all storm waters in ordinary cases, and when any overflow was required it was provided at Erith. Mr. Jackson said, he believed storms were generally partial in London, but that the sewers were so large as to provide for almost any amount of storm waters; their proportions being 30 feet by 26.

9. Mr. Thornton stated, that he had provided no ventilating shafts for the sewers, being convinced that the rapid motion would be the means of clearing them from all gases.

10. Believed that there would be no danger of the sewers silting up.

11. In case of a flood when it is high water at Erith, the low districts in London might be flooded, though not so much as at present.

12. In answer to a question, Mr. Thornton said, that he did not expect to provide for rain-fall, such a occurred in July 1853, viz., according to Mr. Blackwell's observations, upwards of five inches during the month; but intended to carry off an average heavy fall.

13. Mr. Thornton thought the great advantage of having no high level sewer was that any heavy rain-fall might then be used as a flushing head to clear the main sewers.

14. Did not attach much value to the manure, and proposed deodorising works as an addition only to his plan, not as an essential part of it.

15. Mr. Thornton did not believe any means of outlet for gases would be necessary, as the occasions on which they would be forced backwards and become a nuisance would be of very rare occurrence.

16. Mr. Thornton, in answer to a question, said that he proposed to discharge into the river at Sea Reach at all times of the ebb tide.

17. Mr. Thornton said, if the sewers were to discharge into the river at B*, the reservoirs would be cut off the estimate, *i.e.*, about 200,000*l.* would be saved.

18. The estimate as far as Erith Reach, including reservoirs, is 3,520,342*l.* The main sewer down to Sea Reach is 5,180,486*l.*

19. The former sum deducted from the latter will give the cost between (B.) and Sea Reach (F).

(iii.)

Letter from Messrs. *Thornton* and *Jackson.*

Gentlemen,

London, 20 April 1857.

We find we have made an error in our calculations for maintaining the works according to our plans and designs; and, including pumping the sewage for one year after completion,—

The sum should be £147,600.

We are, &c.
(signed) *Thornton & Jackson.*

The Committee of Reference,
29, Great George-street.

(iv.)

Letter containing further Particulars with regard to Evidence given at the Meetings of the Referees, 4th and 20th April. — 4 and 20 April 1857.

25, Queen's-road, Regent's Park, 25 April 1857.

Messrs. Thornton & Jackson have the honour to return to the Referees on the London Main Drainage question the original draft of the minutes of conversation which took place between the Referees and themselves on the 4th and 20th inst., and to append the following explanations and additional remarks with respect to the scheme of Main Drainage referred to in the Report and Plans prepared by Messrs. Thornton & Jackson.

The numbers in the margin refer to the corresponding numbers marked in red ink on the copy of the original minutes.

Minutes, Nos. 1 and 13.

Minute, No. 1, is quite correct. With respect to No. 13, on the same subject, the Referees, on the 25th inst., pointed out that main sewers, like the Ranelagh and others, bring considerable streams of water direct from the country districts to the Thames, and that such streams do not, therefore, serve to flush any of the minor sewers. But we strongly object to this waste of scouring power, and consider that the turning of the natural streams from the higher districts into the sewers, is of the greatest importance to the public health of the metropolis, and one of the chief conditions in the question of its main drainage.

Entertaining this conviction, we have accordingly remarked, at page 13 of our Report, "On the contrary, we would suggest that, wherever available, such water should be carefully guided through the sewers of the metropolis, on the principle that they will tend to liquify, and flush out into the deep main, the otherwise torpid and intractable contents of the existing sewers."

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Messrs. *G. Thornton & T. Jackson.*

20 April 1857.

* Minutes, Nos. 2 and 18.

We may further add, that any high level sewer must divert those natural streams which are required to cleanse the lower level sewers; and, to enable the latter to effect their intended purpose of carrying off both solid and liquid matter, before either pass into the stage of decomposition,—

Our estimate is as follows *:—

	£.
For the whole of the works from Kensington Canal on the north, and Battersea Church on the south, to point (B.) at Erith Reach, including reservoirs, engines, &c., complete and ready for working - - - - -	3,520,342
For the maintenance of the whole of the above works, and for the pumping of the sewage for one year from the time of completion, a further sum of -	131,000
or the whole of the works from Kensington Canal on the north, and Battersea Church on the south, to point (F.) at Sea Reach (exclusive of 233,000*l.*, the cost of reservoirs, which with such extension will not be required) - - - - - - - - - - - - - - - - -	5,180,486
For the maintenance of the whole of the above works, and for the pumping of the sewage east of Erith Reach, so as to obtain the requisite fall from the pumps to Sea Reach for one year from the time of completion, a further sum of - - - - - - - - - - - - - - -	147,600
Therefore, cost of main sewer to (B.) at Erith Reach, being - -	3,520,342
And the cost to Sea Reach being - - - - - - -	5,180,486
The net difference between the two will be - - £.	1,660,144

and represents the cost of the extension from (B.) at Erith, to (F.) at Sea Reach.

Minutes, Nos. 3 and 7.

In further explanation of these minutes, we beg to hand in a reduced section of the proposed deep mains, which has marked on it the borings taken at the Victoria Docks, immediately west of Galleon's Reach; and also the observations published in Mr. Mylne's map, though the latter unfortunately shows nothing more than the depth at which the chalk lies on either side of the Thames, except at Lambeth Palace, Hungerford Bridge, London Bridge, the Thames Tunnel, the Isle of Dogs, and near the Grand Surrey Canal. Except from Chelsea to Lambeth, the different strata are not shown, and a general idea only can therefore be formed of the depths of the chalk from the surface. No doubt, however, for the whole distance down to Erith, the strata overlying the chalk will be of the same character, their thicknesses only varying.

Minutes, Nos. 3*a* and 7.

Our Report (page 42) shows that, after deducting for evaporation and the water consumed, there will be a daily quantity of sewage (including storm-water) from

	Gallons.
The north side of the Thames of - - - - - - - - - -	58,387,905
The south side of the Thames of - - - - - - - - - -	22,788,448
	81,176,353

or, in round numbers, 80,000,000 gallons daily. We, therefore, make each reservoir of sufficient capacity to receive 40,000,000 gallons of sewage, or 12 hours' supply during each rising tide. In reality, however, the reservoirs will only have to hold about 8½ hours' supply; viz., from half ebb to low water (3½ hours), and from low water to the turn of high water (5 hours).

Minutes, Nos. 4, 5, and 12.

Our estimate as to the probable quantity of sewage is based, first, on the return made to the General Board of Health, on the daily supply of water pumped into London by the different Metropolitan Water Companies in 1856.

Secondly, on tables A and B, in the Engineer's Pocket Book for 1852-53, shewing the rainfall in the London district.

Table A shows the annual average fall of rain, between 1836 and 1843, to be 26·62 inches, and we have taken it at 27 inches.

Table B shows the average fall for each month in each of those years, and the average annual amount to be 26·778 inches, the evaporation being 15·32. We have taken these figures at 26 and 15 inches respectively.

Mr. Beardmore, however, in his work on hydraulics, shows, by Table 4 A, that the evaporation is much greater than what has been just stated, especially at Plaistow, where observations in reference to this point were taken.

The maximum rainfall shown in the tables, already quoted from the Engineer's Pocket Book, occurred in November 1842, when 5·77 inches fell. Deducting from this the average annual fall of 27 inches, or 2·25 per month, there remains an excess of 3·52 inches, or a daily average of 4,188,825 gallons. This quantity is an extreme one, but we have dealt with it as of daily occurrence, and made provision for it, in the capacity of the deep main sewers, and in the requisite steam power, so that both may be of sufficient magnitude when a heavy storm does occur. To go beyond this, and still further, to enlarge the deep mains and reservoirs, and the power of the engines, would be, in our judgment, to run into a greatly increased outlay, which we should not be justified in recommending in the face of the extremely remote and almost improbable occurrence of a greater fall than that already estimated for.

In this minute the word Thames should be substituted for London.

On referring to our general Ground Plan, it will be seen that there are red lines traced along the course of the Wandle and the Ravensbourne. These indicate the sewers which we suggest should be constructed to receive the sewage of the neighbouring districts before it enters the two streams, and thus prevent them from being polluted. Such sewers, however, are not included in our estimate, as we had no means of forming an opinion as to their required size or length.

It is difficult to fix the exact limits of the rain-fall that will pass into the sewers, unless by carefully tracing up to their sources the courses of all the streams flowing into the Thames, the Wandle and the Ravensbourne Again, except by long and minute observation, it is difficult to ascertain the amount of water that each stream supplies. Perhaps, therefore, the exact extent of the rain-fall ought rather to be regarded as a quantity to be estimated than as an ascertained fact.

In running our line from Wandsworth to Greenwich Park, an area of 16 square miles, we considered that it would include all rain water that was likely in that locality to find its way to the Thames.

The estimated daily quantity of sewage has been shown to be 80,000,000 of gallons, but the united areas of the deep mains on the north and south sides of the river, and of the united main from (C.) to (B.) at Erith Reach, will hold 184,129,356 gallons, or 104 millions of gallons more than the estimated daily supply. In other words, the whole capacity of the deep mains will hold the supply of 2¼ days.

When the deep mains have received the above quantity of sewage, the latter will just rise to the safety overflow at Erith Reach, and pass into the river; but as the pumping power provided will, on an emergency, raise 100,000,000 gallons of sewage daily, it will be seen how improbable it is that the deep main can ever be so filled as to flush back the sewers in the low lying districts of London, as is now the case.

The pumps drawing off the above-named quantity in 24 hours, the deep mains and reservoirs will be able to contain not only their actual capacity of 184,000,000 of gallons, but a further quantity equivalent to what

Appendix X.

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Messrs. *G. Thornton & T. Jackson.*

4 and 20 April 1857.

what the pumps may abstract, or in all 284,000,000 of gallons of sewage in one day, an amount far greater than we consider likely within the range of probability to arise.

Even if the pumps were to be so wholly deranged as to be incapable of working, a very improbable contingency, the overflow at (B.) at any state of the tide is, by the natural fall of the river, about 6 feet lower than at London Bridge, so that the sewer could never be flushed back as at present, even if the sewage rose in the pump wells at (B.), at Erith to high water level.

Referring to the ventilation of the deep mains, we conceive this will be sufficiently accomplished by so arranging, that to the eastward of Galleon's Reach, the covers of the shafts may have some kind of safety-valve placed on them to allow of the temporary or occasional escape of any gases that might be occasioned by the rising of the sewage. In all the other shafts of the deep mains, however, we would suggest that they should be sealed up, and that any air required by the fall of the sewage in the deep mains should be drawn through the tributary sewers.

Minute, No. 9.

As bearing on the question of ventilation, we may perhaps, add, that we see no great difficulty in placing stench traps over every sewer grating in London, and thus preventing the foul gases in them from rising up into the streets.

Minute, No. 10.

We believe the deep mains would never silt up, from this simple circumstance, that if the pumps at the reservoirs worked the sewage close down to the bottom of the deep mains, the run of from 70,000,000 to 80,000,000 of gallons in 24 hours would scour out any refuse that it might meet with.

Minute, No. 14.

We do not attach much value to the solid manure obtained from the sewage, for lime, though it acts as a deodoriser, and will precipitate the solid matter, fixes the carbonic acid, and thus produces carbonite of lime, which is comparatively worthless as a manure. Again, the ammonia (undoubtedly the most valuable fertiliser in liquid sewage) is too volatile to be fixed or absorbed, and passes off into the atmosphere.

Minute, No. 15.

It has been shown how extremely unlikely it is, in our opinion, that any fall of rain will occur so heavy as to impede the free action of the deep mains, or to cause the accumulation of any foul gases in them. But, if such did occur, the overflow at Erith would operate before the gases became liable to be forced back up the ordinary sewers.

Minute, No. 16.

On reference to drawing No. 2 (figure 8), it will be seen, that at the double outlet into Sea Reach there are provided two gates which close by the action of the rising tide, and seal up the double mains (as shown by section, figure 8), till the sewage therein rises above the tide at (F.), or the tide falls below the level of the sewage; in either of which cases the gates will open and allow the sewage to escape. But as the mains from (E.) to (F.) will hold 197,683,200 gallons, or more than 2½ times the estimated daily quantity of sewage, the double main, 12 miles in length, will become a great reservoir, whilst the tide is rising at (F.) at Sea Reach, the sewage from which will only seek an entrance into that Reach after the tide has turned, when it will at once make out direct to sea.

Minute, No. 17.

In further explanation on this point, it may be observed that if it were permitted to pump into the river at (B.) at all times of the tide, the reservoirs now proposed would not then be required, and a consequent reduction of 233,000*l.* would be effected in our estimate of 3,520,342*l.* which would then stand at 3,287,342*l.*

Or, again, the reservoirs might be dispensed with, if the deep mains from Kensington Canal on the north, and Battersea Church on the south to (C.), and from (C.) to (B.), were allowed to act as reservoirs, holding as they do, 184,000,000 gallons of sewage (the estimated daily quantity being only 80,000,000), and if the sewage was pumped out of them from the turn of high water to low water. With this arrangement, however, it would be necessary to double the engine power, as the deep mains would have to be cleared of their contents in 12 instead of 24 hours. The doubling of the engine power would not increase the permanent annual outlay much beyond the interest on the extra cost of the engines, as the latter would necessarily work only half their time.

(signed) *George Thornton.*
Thomas Jackson.

The Referees on the Main Drainage of the Metropolis,
29, Great George-street, Westminster.

(15.) Minutes of Evidence given by *T. W. G. Treeby*, Esq.

Meeting of Referees, 29, Great George-street, Saturday, 2 May.

Mr. *Treeby* attended by appointment.

Mr. *T. W. G. Treeby.*

2 May 1857.

Mr. Treeby stated, that he proposed to carry one high level sewer from Paddington across the Canals, giving nine feet headway in each, conduct it over the Holborn valley in a bridge, and carry the sewage eventually to Essex. Mr. Treeby would combine a railway with the sewer for five miles from Kilburn.

Mr. Treeby proposed to erect ventilating shafts at intervals on the course of the sewer and railway.

Mr. Treeby, at the request of the Referees, pointed out on the map the course of the high level sewer he proposed. It would be in company with the railway, as far as Peel's Monument, St. Martin's-le-Grand; but would then go on alone. In some parts the streets under which it would pass must be raised, in order to allow of sufficient headway being given to the canals over which it would have to pass.

In answer to a question, Mr. Treeby said, that the fall from Albany-street to Bow Creek (seven miles) was five feet; from Bow Creek to point of outfall, 16 feet. At Bow Creek, the bottom of the sewer would be above Trinity high-water mark, 9 feet; difference between high water in London and South End, 7 feet = 16 feet. This will give a fall, when it is a fall at outfall, of 16 feet.* The bottom of sewer to rails of the North Woolwich Railway is 17 feet.

Mr. Treeby said, that the difference between high water at London Bridge and at Southend was 7 feet, and would give a total fall (when it is low water at outfall) from Albany-street to outfall, 34 feet.*

Mr. Treeby proposed iron as the material for the inverts of his sewer, having found that water flowed much more rapidly through that than through brickwork.

Mr. Treeby explained the mode in which he proposed to construct the mouth of his sewer: with floating caissons on each side, and a sluice gate opposite it, to prevent the flow of the sewage, while the tide was rising, and to permit the discharge during the ebb tide.

In answer to several questions, Mr. Treeby said, that the result of his caisson arrangements would be to constitute the sewer into a reservoir during certain hours of the tide.

Mr. Treeby said, that he had not in his plans proposed to deal with anything more then the high level drainage on the north; but wished to explain a mode of adapting the principle of the syphon to the southern drainage. Mr. Treeby then entered into the particulars of this arrangement.

Mr. Treeby, in answer to a question, said, that he believed by his system of syphon he could move water and

* *Sic* in corrected copy.

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Mr. *T. W. G. Treeby.*

2 May 1857.

and stones at the rate of about 10 miles an hour along a line of sewer almost level, by having centrifugal engines at different stations.

Mr. Treeby proposed, by his syphon, to carry all the sewage of the south over to the north side. The drainage of the low districts on the north would be united by iron pipes with that of the south in a 15-feet sewer, constructed parallel to that containing the high level sewage.

Mr. Treeby, in answer to a question, said, that he believed the only way in which the sewage could be profitably applied to the land was in a liquid state. Mr. Treeby had not entered into an estimate, but would make a calculation if desired.

Minutes of Evidence given by Sir *William Worsley*, Bart., of Hovingham Hall, *Yorkshire*, and by — *Worsley*, Esq., Shipowner of *London*.

Sir *W. Worsley*, Bt., and Mr. *Worsley*.

15 May 1857.

Meeting of Referees, 29, Great George-street, Friday, 15 May.

Sir *William Worsley*, Bart., and Mr. *Worsley*, attended by appointment.

Sir W. Worsley said that he had never submitted his drawing (A.) to Mr. Bazalgette. He was aware that it included subjects not properly, according to the letter of the Act, falling within the drainage question, as therein specified, but he looked at the question more largely, that was, as to the bearing of the Act in reference to general improvements, traffic, passage, &c.; and therefore thought himself justified in submitting his drawing (A.), which represented such improvements as might be combined with the main drainage, to the Referees.

Sir William objected very strongly to Mr. Bazalgette's plan, and maintained that the sewage would infallibly be carried back to the inhabited parts of the metropolis. Sir William said his plan would keep the Pool continually at high-water mark, by means of a transverse dam above the pool, and another dam at Limehouse Reach; his scheme was to lay dry the bed of the river between Battersea and London Bridges, so as to be able to construct a cloaca maxima, which should be capable of carrying off the sewage and rain water continuously from both sides of the town, instead of having the contents of all the lateral sewers, now discharging themselves into the river, dammed back, owing to their being, as now, tide-locked for 16 out of every 24 hours.

Sir William did not think there would be any loss of scouring power from stopping the tide by means of dams, for the scouring power of the flood-tide was greater than that of the ebb, and he considered that the quick silting up just after dredging, which had often occurred, was much more owing to the up scour than to the scour of the ebb, and said that the flood-wave made its way in considerably less time.

Sir William would have the bottom of the main culvert a few feet above low-water mark, the whole way from Battersea Bridge to its outfall, so as to allow of a continuous flow of sewage.

Sir William was aware that a great part (he said 12,000 acres) of the ground on either side of the river was below high-water mark, and had been probably a lake or marsh land originally; and, with a view to overcome this low level difficulty, he considered it needful to stop the tidal flow of the river through the town, in order, first, that the drains might discharge themselves continuously into a large cesspool, to be let off a little before low-water; and, secondly, to prevent the injurious and dangerous effects of tidal floods.

Sir William considered, that this was a question to be looked at mainly in a medical point of view, with the object of keeping the districts below high-water mark dry, in place of being constantly saturated, as at present, with exudation from pent-up sewage, and with inundation from occasional tidal floods, and so improving their sanitary condition.

Sir William did not think there would be any difficulty in dealing with the high-level drainage, when once the really difficult part of the case, viz., the low-level drainage, had been satisfactorily disposed of.

Sir William maintained that there was no doubt even if the sewage were discharged into the river 20 miles further down than Erith, or at any distance short of the sea, that it still would find its way up to the metropolis.

In answer to Captain Galton, Sir William said that there would be no fear, under his plan, of the low districts above Battersea (where he proposed to erect locks instead of as now at Teddington) being flooded from the penning up of the waters, for he proposed to throw up a certain amount of embankment on either side of the proposed reservoir, or lake, having covered culverts at the low-level on the outsides of such embankment, which would empty themselves into the main culvert just below Battersea Bridge.

Sir William alluded to the present imperfect state of ventilation of the sewers, which he said would be remedied by his plan; and he explained how full drains under pressure would force bad air back through the traps into the houses they were meant to protect.

In answer to a question, Sir William said that his plan did not so much depend upon a fall, for he proposed to flush his main culvert by an ample flood of water from the reservoir at Battersea, which therefore would act independently of a fall; he would, however, have a fall of five or six inches a mile, or as much as could naturally be got to West Ham.

Sir William said, that he believed by keeping up a continuous flow of sewage, the main culvert would never be full, provided the area of the cesspool was sufficiently large to hold the products of about 12 hours at a few feet deep, and that the sluices of the cesspools were drawn as soon as the tide level would permit; and he believed that the penned-up water of the river above Battersea Bridge would be amply sufficient to flush his main culvert.

Sir William did not think his new cut, which he proposed to keep continually running at high water level, would flood the adjacent districts, provided the usual embankments and catchwater culverts on each side were constructed; that, without its being at all larger than needful for steam tug river craft navigation, it would take off all superfluous and flood river water, and that practically it would be but a moderate sized canal, and at a level very little higher than the district through which it passed.

Sir William was aware that there would be a large amount of compensation to be paid to wharf owners, &c.; but believed that the large extent of new space obtained, as his scheme did not include a width of more than six or seven hundred feet, would more than make up for the amount which might be awarded by way of compensation.

Mr. Worsley stated, that the compensations would lie principally between wharfowners, lightermen, and owners of steamboats. He said that he and his father calculated that the railways proposed to be carried on both sides would do more than compensate, by the easier and quicker conveyance of passengers and merchandise, for the damage done to these people, the loss to the one being paid for by the profits arising to the other.

Mr. Worsley stated, from his own experience, that the advantage of railway communication to the docks would be immense.

Sir William, in answer to a question, said, that he had not entered minutely into the estimates of the cost, but agreed with his son in thinking that the drainage part might be done for 1,000,000 *l.*; that a very fair

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Sir *W. Worsley*, Bt., and Mr. *Worsley*.

15 May 1857.

fair percentage of profit might be obtained on the other works, and that the land reclaimed on both sides of the river for very nearly the whole way from Battersea Bridge to London Bridge, would prove a set off against compensation, if not a source of profit.

In reply to an inquiry as to what course Sir William would adopt with regard to the disposal of the very large quantity of earth and materials to be excavated, Sir William said that he should dig them up and cart them away.

Sir William observed, that he considered the stopping of the tide would lower the level of the high water mark about two feet at London Bridge, and that the new cut might be kept constantly full up to such level.

Sir William explained his reasons for assuming that the sewage, under Mr. Bazalgette's plan, would flow back to the inhabited parts of the town; he maintained that the scour of the flood tide on the bottom of the estuary was mechanically greater than that of the ebb, from the increased perpendicular altitude and pressure of the rising tide, acting most strongly at the bottom in a direction from the sea, tending to propel the water bodily up the river, and thus to stir up and carry forward whatever mud or sewage had been deposited on its bottom; but, that the ebb current, on the contrary, was comparatively superficial, as the water in the estuary could not readily run off, except in proportion with the superficial lowering of the tide at the mouth of the estuary; he thought that the greater degree of rapidity (nearly two to one) in the rise of the flood-wave over the ebb was nearly identical with this position, and considered that nature worked in this way to render the low marsh or lake districts about tidal rivers ultimately fit for occupation.

Sir William had considered what would be the effect on the up tidal wave below London, and thought it would be inconsiderable in regard to current, as the volume of water above bridge at high tide was no more than about three per cent. of that between the bridges and the sea, but that the level to which the tide now usually rises might be lowered at London Bridge by about two feet, as he had before stated.

Sir William stated, that he left the determination of the extent of the area of his cesspool for further inquiry, but that the dimensions of the culvert, &c., were laid down in his drawing (marked A), representing a transverse vertical section of the river; he considered that the cesspool would be actually discharging for about 10 hours out of the 24.

LIST of PLATES to APPENDIX X.

Plate 1. Sketch of Mr. Dover's Apparatus for deodorising and filtering Sewage.

„ 2. Map to illustrate system of Drainage proposed by Messrs. Gotto and Stothert.

„ 3. Sketch of a Screw for lifting Sewage proposed by Mr. Husband.

„ 4. Map to illustrate system of Drainage proposed by Messrs. M'Clean and Stileman.

„ 5. Map to illustrate system of Drainage proposed by Mr. Morewood.

„ 6. Map to illustrate system of Drainage proposed by Mr. Murray and Mr. R. Mylne.

„ 7. Plan to illustrate system of Drainage proposed by Messrs. Richardson and Clark.

„ 8. Sketch to illustrate system of Drainage and Deodorisation proposed by Mr. Jasper Rogers.

„ 9. Map to illustrate system of Drainage proposed by Messrs. G. Thornton and T. Jackson.

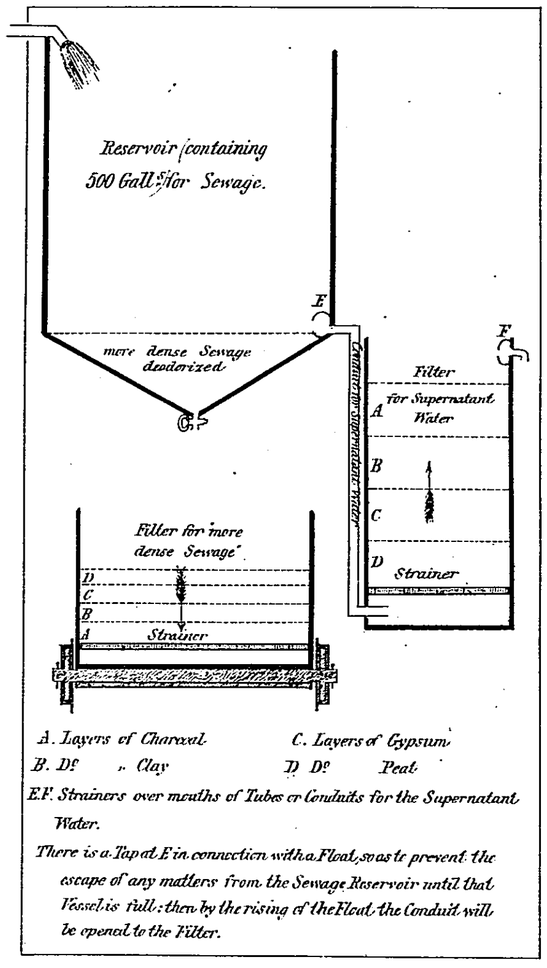
„ 10. Sketch to illustrate system of Drainage and improvement of the Thames proposed by Sir W. Worsley, Bart.

„ 11. Sketch of an Elevating Wheel for Sewage proposed by Mr. Archibald Slate.

APPENDIX, X.
(Plate 1.)

Document D.

Apparatus used for De-odorizing and Filtering Sewage as exhibited to Prof.r Faraday, Lord Ebrington, M.r Pepper, Sir Emerson Tennent &c &c.



A. Layers of Charcoal *C. Layers of Gypsum*
B. Do „ Clay *D Do Peat*

E.F. Strainers over mouths of Tubes or Conduits for the Supernatant Water.

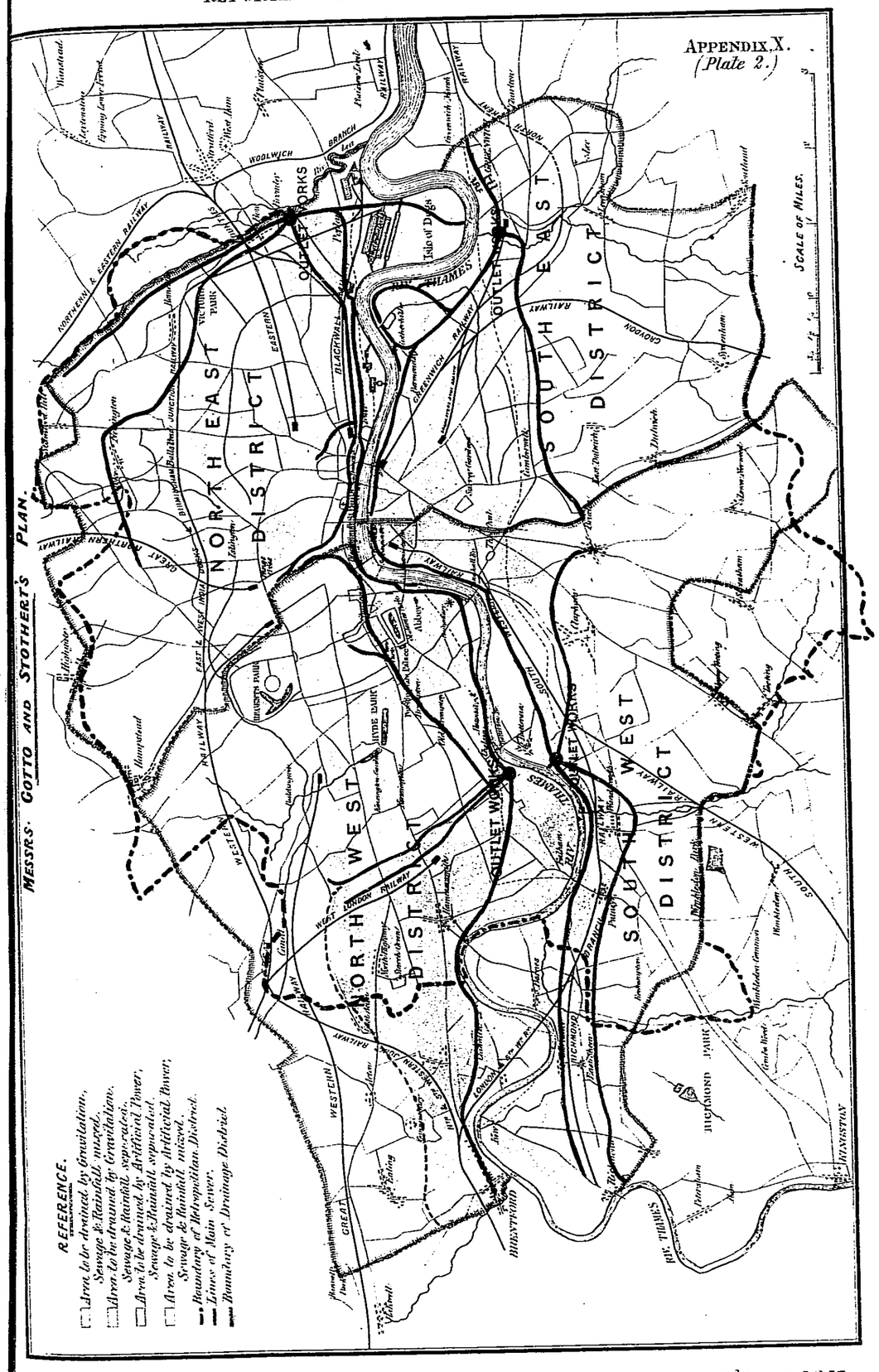
There is a Tap at E in connection with a Float, so as to prevent the escape of any matters from the Sewage Reservoir until that Vessel is full: then by the rising of the Float the Conduit will be opened to the Filter.

Richard Dover.
January 16th 1857.

Penny Lith.

№ 233. Ordered by The House of Commons, to be Printed, 3rd August, 1857.
Henry Hansard, Printer.

APPENDIX X.
(Plate 2.)



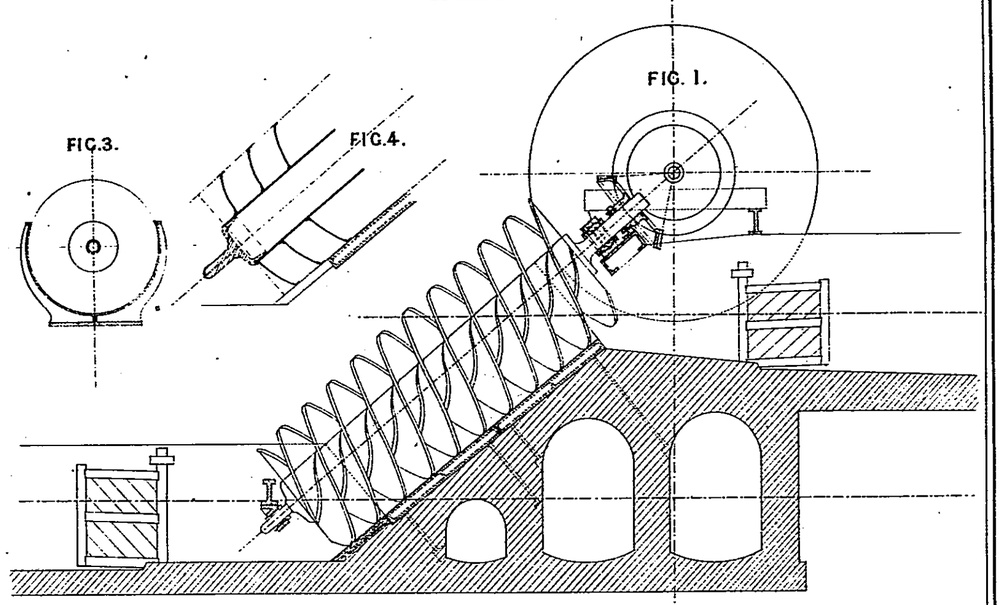
J.Basire, lith.

№ 233. Ordered by The House of Commons, to be Printed, 3rd August, 1857.
Henry Hansard, Printer.

APPENDIX X.
(Plate, 3.)

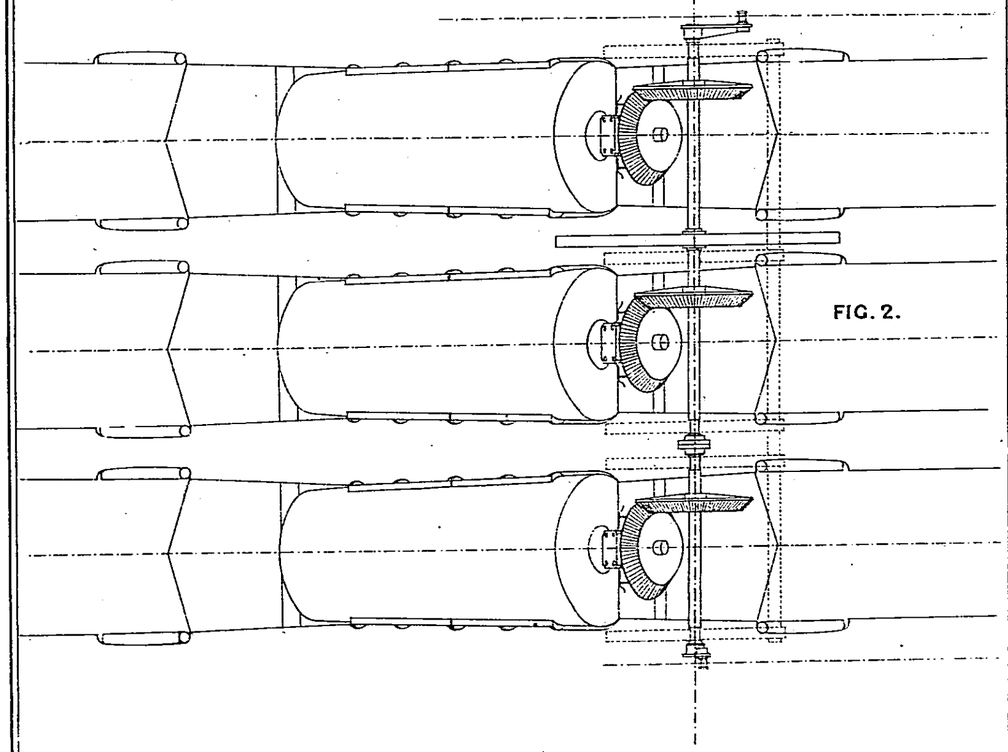
SKETCH OF SCREWS, FOR LIFTING SEWAGE.

PROPOSED BY W. HUSBAND.



REFERENCE.

Fig. 1 *Sectional Elevation through Centre of Screw showing its position in Cradle and disposition of Blades.*
2 *General Plan of 3 Screws in connection shewing mode of driving them.*
3 *Cross Section through Screw Cradle at Right Angles to Axis.*
4 *Longitudinal Section through bottom end of Screw showing form of Blades.*

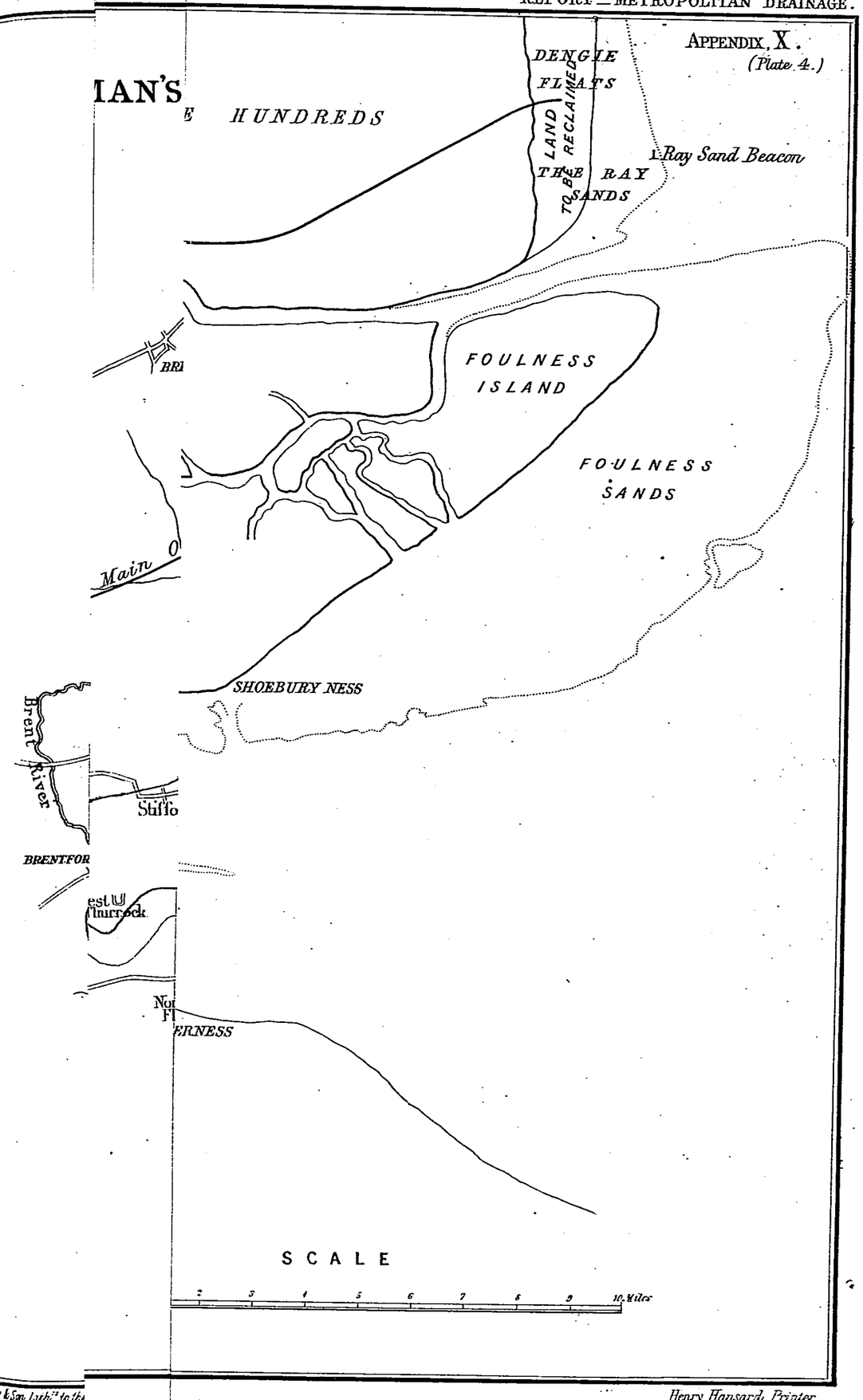


Edk. Prest. Lith. 7 Castle St. Holborn

Nº 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.

Henry Hansard, Printer.

APPENDIX, X.
(Plate 4.)



Day & Son, Lith.rs to the

Henry Hansard, Printer.

Ordered, by The House of Commons, to be Printed, 3rd August, 1857.

MESSRS. Mc CLEAN & STILEMAN'S PLAN.

REFERENCE.

- *Area to be drained by Gravitation.*
- *Area to be drained by Artificial power with One Lift.*
- *Area to be drained by Artificial power with Two Lifts.*
- *Boundary of the Metropolitan District.*
- *Proposed Main Lines of Sewers.*

AREA, 27·32 SQRE MILES

AREA, 21·45 SQRE MILES

AREA, 10·87 SQRE MILES

AREA, 41·75 SQRE MILES

PUMPING STATION—LIFT 37 FEET

PUMPING STATION No 3 LIFT 60 FEET

PUMPING STATION No 4 LIFT 19·5 FEET

Aqueduct across Valley of the LEA

Main Outfall Sewer to the German Ocean

Hollenham, Hornsey, Highgate, Stamford Hill, Stoke Newington, Hampstead, Wilsdon, Kilburn, Islington, Hackney, Kingsland, Stratford, Bow, Paddington, Regents Park, Plaistow, Stepney, Blackwall, Acton, Ealing, Hyde Park, Kensington, Hammersmith, Chiswick, Chelsea, Battersea Park, Bermondsey, Rotherhithe, Peckham, Deptford, Greenwich, Isle of Dogs, Woolwich, Barnes, Mortlake, Fulham, Clapham, Brixton, Putney, Wandsworth, Richmond, Richmond Park, Dulwich, Lewisham, Sydenham, Tooting, Wimbledon, Up. Norwood, Lr. Norwood, Beckenham, Bromley, Croydon, Chiselhurst, Elthan, Erith, Crayford, Dartford, Farningham, Purfleet, Stone, North Fleet, Gravesend, Gravesend Reach, Tilbury Fort, West Thurrock, Grays Thurrock, East Tilbury, West Tilbury, Stifford, Rainham, Barking, Romford, Brentwood, Ingatestone, Ballericay, Langdon Hill, Stamford le hope, Sea Reach, Cliffe, Higham, Higham Creek, Rochester, Chatham, R. Medway, R. Darent, River Cray, R. Ravensbourne, R. Wandle, R. Roding, Bourne Brook, Ingreburn Brook, Halfway Reach, Erith Reach, Long Reach, Brent River, Brentford, Richmond Park

Day & Son, Lith.rs to the Queen.

LEAN & STILEMAN'S PLAN.

APPENDIX. X.
(Plate 4.)

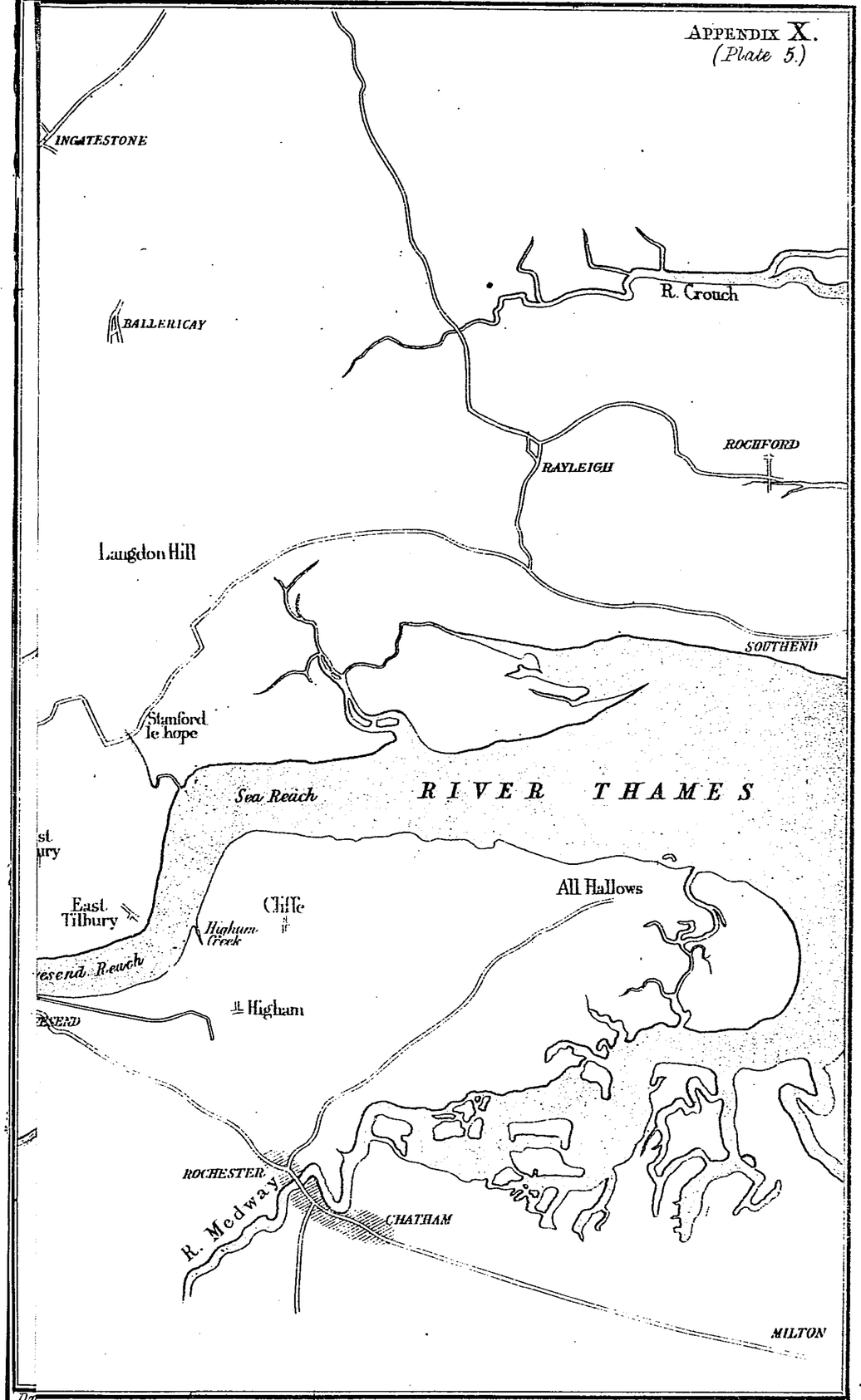
INGATESTONE
BRENTWOOD
BALLERICAY
THE HUNDREDS
DENGIE FLATS
LAND TO BE RECLAIMED
THE RAY SANDS
Ray Sand Beacon
R. Crouch
FOULNESS ISLAND
FOULNESS SANDS
ROCHFORD
RAYLEIGH
ROMFORD
Bourne Brook
Ingrebourn Brook
Main Outfall Sewer to the German Ocean
Langdon Hill
SOUTHEND
SHOEBURY NESS
Rainham
Stanford le hope
Sea Reach
RIVER THAMES
Stifford
West Tilbury
East Tilbury
Cliffe
All Hallows
Higham Creek
Erith
Purfleet
Long Reach
West Thurrock
Grays Thurrock
Tilbury Fort
Gravesend Reach
Grayford
Stone
North Fleet
Higham
GRAVESEND
DARTFORD
SHEERNESS
ROCHESTER
R. Medway
CHATHAM
Farningham
R. Darent

SCALE
0 1 2 3 4 5 6 7 8 9 10 Miles

Henry Hansard, Printer.

No 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.

APPENDIX X.
(Plate 5.)



Harry Hansard, Printer

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Mr. J. J. MOREWOOD'S PLAN.

REFERENCE.

- Areas on the North and South sides to be drained by Artificial Power, with Lifts of 53 feet and 40 feet respectively. — No part to be drained by Gravitation.
- Boundary of Metropolitan Districts.
- Proposed Tunnel Sewers.
- Extension Lines of D.°

AREA 31·25 SQ.re MILES

AREA 39 SQ.re MILES

RESERVOIRS AND PUMPING STATION LIFT 53 FEET

RESERVOIRS

PUMPING STATION LIFT 40 FEET GREENWICH

SCALE

0 1 2 3 4 5 6 7 8 9 10 Miles

Dorr & Son Lith.rs to the Queen

APPENDIX X.
(Plate 5.)

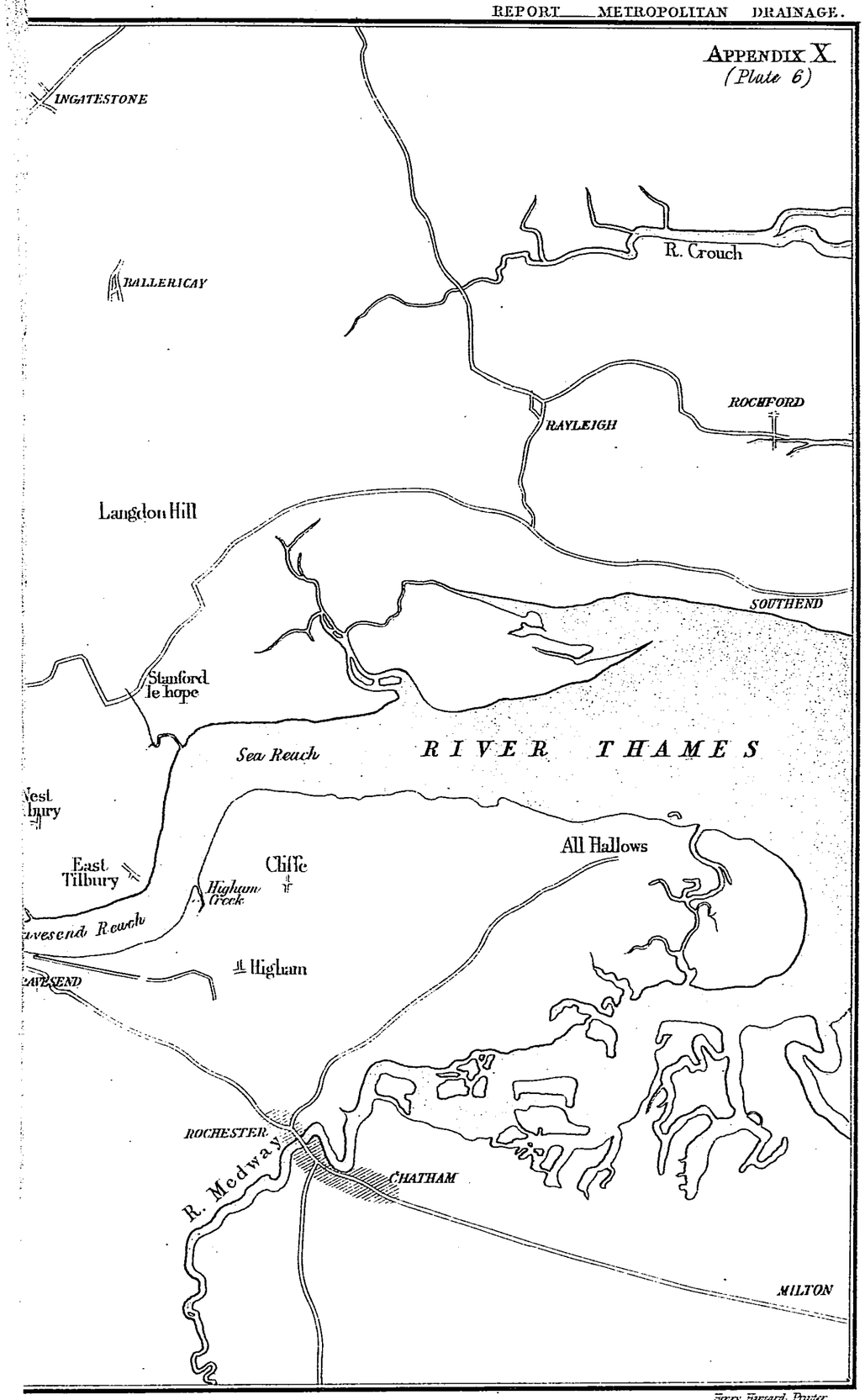
WOOD'S

INGATESTONE
BRENTWOOD
BALLERICAY
R. Crouch
ROCHFORD
RAYLEIGH
Ingrebury Brook
Laugdon Hill
SOUTHEND
Rainham
Stanford le hope
Sea Reach
RIVER THAMES
Stifford
West Tilbury
Purfleet
Grays Thurrock
Long Reach
West Thurrock
East Tilbury
Cliffe
All Hallows
Higham Creek
Tilbury Fort
Gravesend Reach
Stone
North Fleet
Higham
GRAVESEND
ROCHESTER
R. Medway
CHATHAM
R. Darent
MILTON
10 Miles

Henry Hansard, Printer

Nº 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.

APPENDIX X.
(Plate 6)



Harry Hansard, Printer

Nº 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.

JOINT PLAN OF

Mr J. MURRAY AND Mr R. W. MYLNE.

REFERENCE.

- Areas to be drained by Gravitation.
- Areas to be drained by Artificial Power at Stations Nos 1 & 4.
- Areas to be drained by Artificial Power at Stations Nos 2 & 3.
- Boundary of the Metropolitan District.
- Proposed Main Lines of Sewers.

AREA 21·90 SQRE MILES

AREA 18·58 SQRE MILES

AREA 14·58 SQRE MILES

AREA 13·57 SQRE MILES

AREA 10·85 SQRE MILES

AREA 24·64 SQRE MILES

SCALE.

Day & Son Lithrs to the Queen

No 233. Ordered, by The Hou

PLAN OF

D Mr R.W.MYLNE.

APPENDIX X.
(Plate 6)

INGATESTONE
BALLERICAY
BRENTWOOD
R. Crouch
ROCHFORD
RAYLEIGH
Ingrebourn Brook
Langdon Hill
SOUTHEND
Rainham
Stamford le hope
Sea Reach
RIVER THAMES
Stifford
West Tilbury
Sluice Gates
Barking Gates
Purfleet
Long Reach
West Thurrock
Grays Thurrock
East Tilbury
Cliffe
Higham Creek
All Hallows
Tilbury Fort
Gravesend Reach
ford
Stone
North Fleet
Higham
DARTFORD
GRAVESEND
ROCHESTER
R. Medway
CHATHAM
R. Darent
Farningham
MILTON

SCALE.

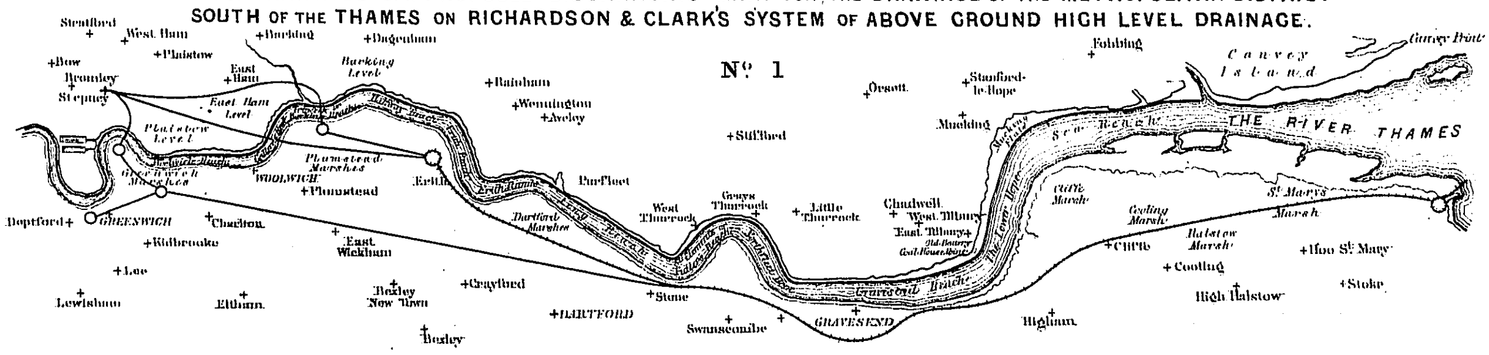
4 5 6 7 8 9 10 Miles.

Henry Hazard, Printer

Nº 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.

PLAN & DRAWINGS OF A PROPOSED DISCHARGING MAIN FOR THE DRAINAGE OF THE METROPOLITAN DISTRICT SOUTH OF THE THAMES ON RICHARDSON & CLARK'S SYSTEM OF ABOVE GROUND HIGH LEVEL DRAINAGE.

Nº 1

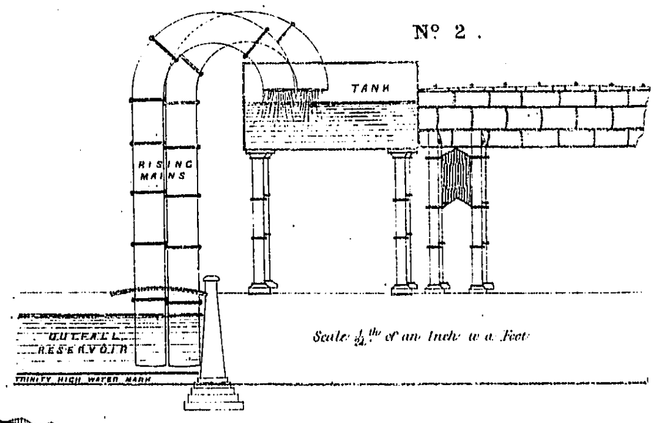


Nº 1. *Plan of the Line from the point of Outfall B.ᵗ to Yantlet Creek.*

Nº 2. *Plan & Elevation shewing the arrangement at the Pumping Station at the Head of the Sewer.*

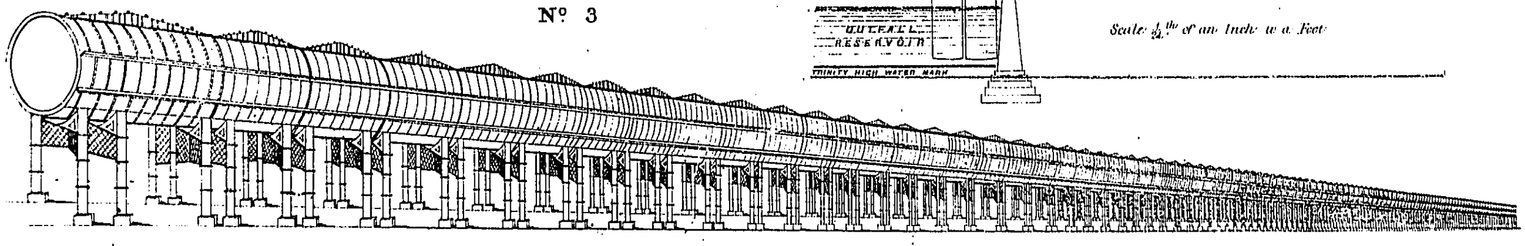
Nº 3. *A view of the sewer above Ground supported on Columns.*

Nº 2.



Scale ½ths of an Inch to a Foot

Nº 3



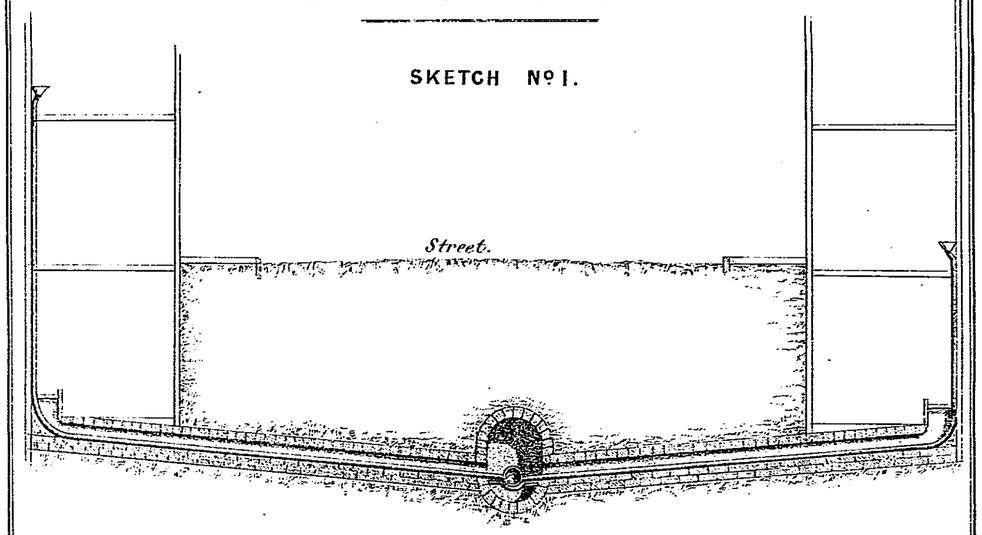
APPENDIX X. (Plate 7.)

Nº 253. Ordered, by The House of Commons, to be Printed, 3rd August 1857.
Henry Hansard, Printer

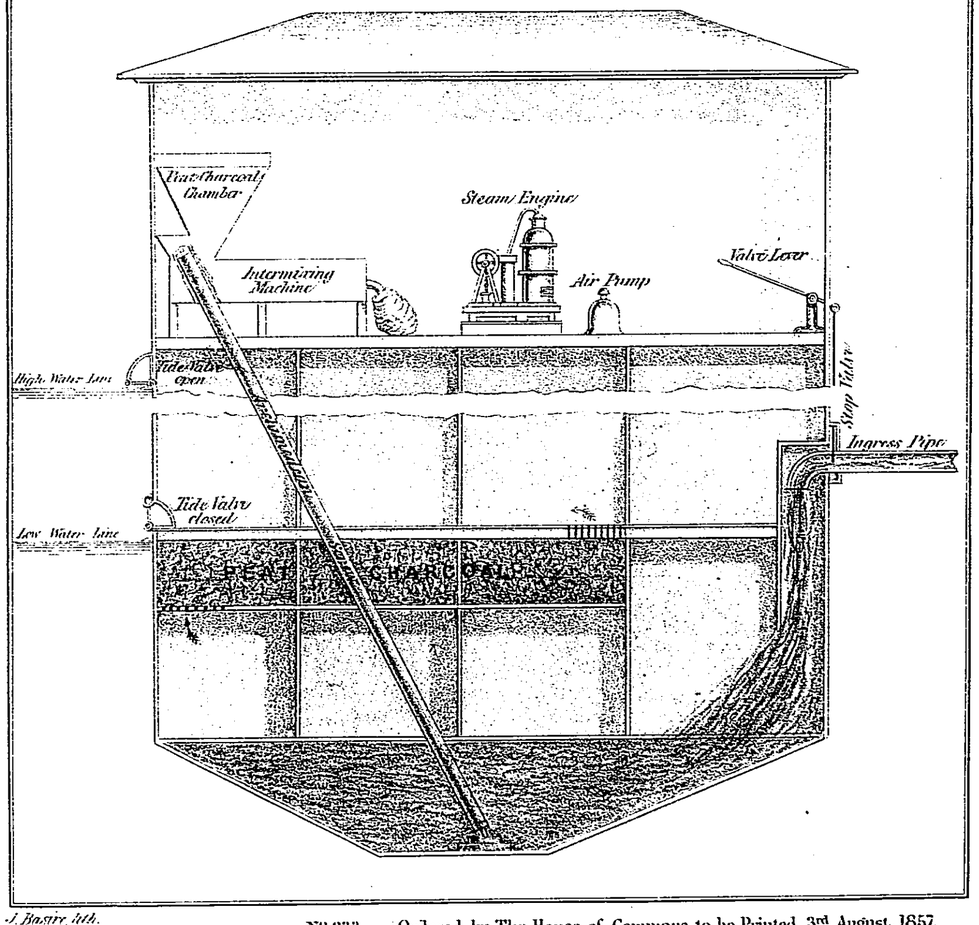
APPENDIX X.
(Plate 8.)

TO ILLUSTRATE Mr. JASPER ROGER'S PLAN.

SKETCH No 1.



SKETCH No 2.



J. Basire, lith.

No 233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.
Henry Hansard, Printer.

Plan

(By Messrs. Thornton & Jackson)

SHEWING THE COURSES OF THE

PROPOSED DEEP MAIN SEWERS

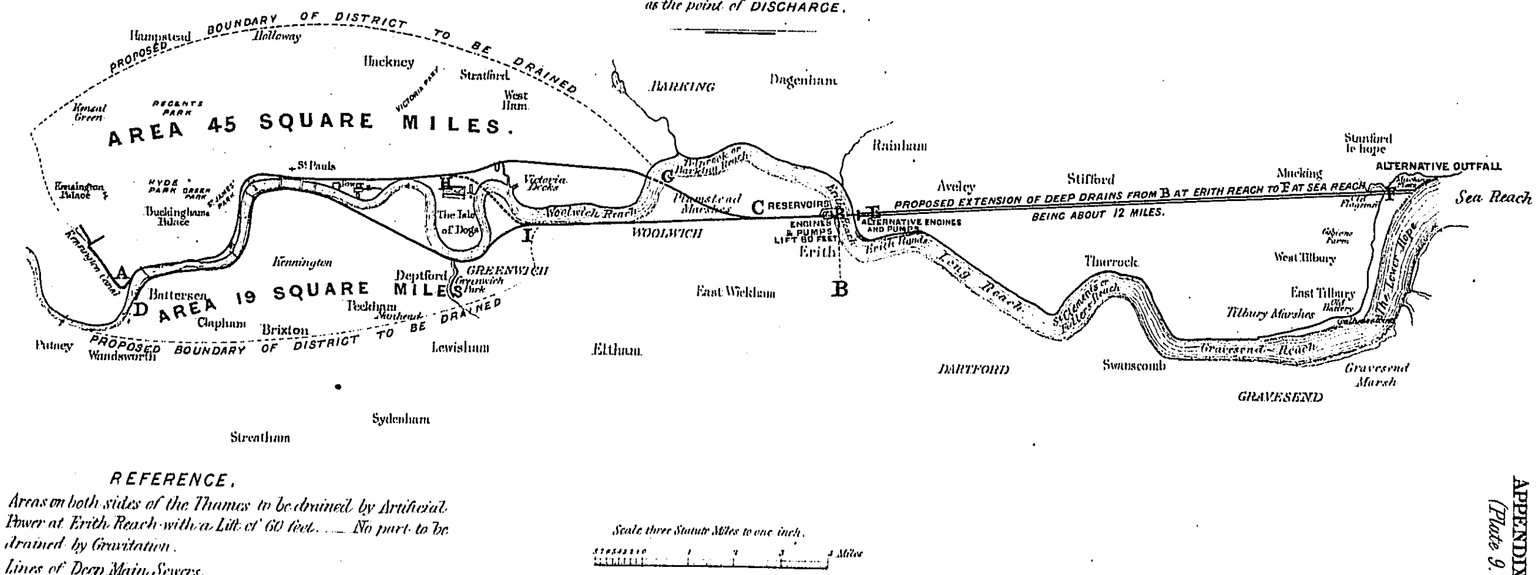
ON EACH SIDE OF THE

RIVER,

From A at Kensington Canal and D at Battersea to B at Erith Reach,

B being fixed by the FIRST COMMISSIONER of HER MAJESTY'S works as the nearest point to the METROPOLIS at which the SEWAGE will be allowed to be discharged into the RIVER.

And also shewing a proposed EXTENSION of the Main Sewers from E to F at Sea Reach, as the point of DISCHARGE.



REFERENCE.

Areas on both sides of the Thames to be drained by Artificial Power at Erith Reach with a Lift of 60 feet. — No part to be drained by Gravitation.

Lines of Deep Main Sewers.

Scale three Statute Miles to one inch.

APPENDIX X. (Plate 9.)

Ord. Rec. Lib.ry Castle St. Milbern. N°233. Ordered, by The House of Commons, to be Printed, 3rd August, 1857.
Harry Hansard, Printer.

Sketch from a Drawing by Sir Wm Worsley, Bart

OF A

TRANSVERSE VERTICAL SECTION

OF

HALF THE RIVER THAMES.

(NORTH SIDE.)

at the narrowest point (680 feet), between Battersea and London Bridges, exemplifying the Main Drainage Scheme, and other "Practical Suggestions for Public Convenience, Health and Recreation," as set forth in "Thames Reform," and as relates to the above portion of the River.

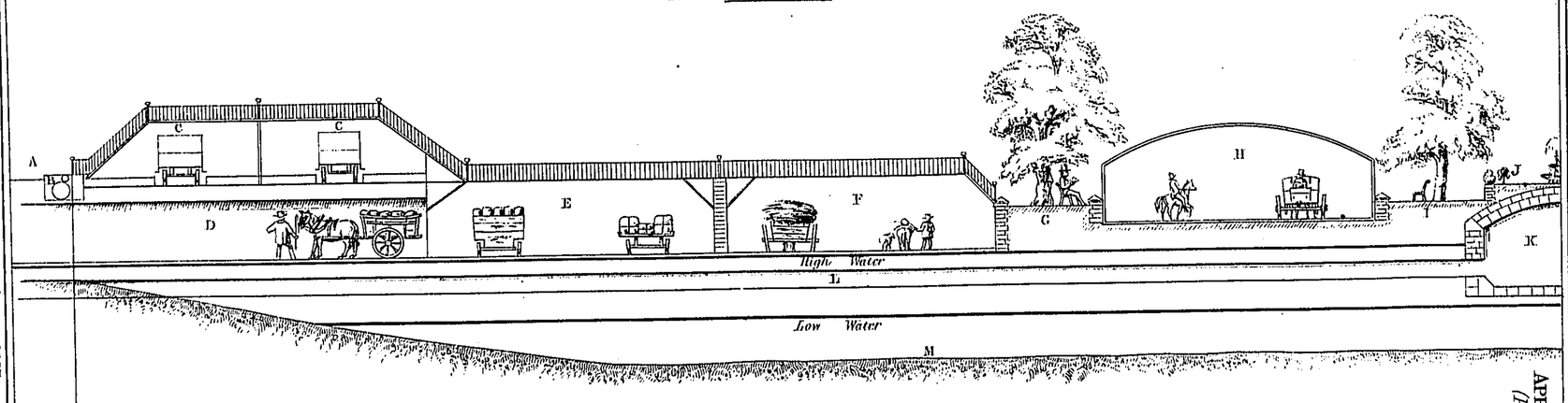
(The South Half of the River would correspond with the North Side.)

REFERENCE.

A *The Side Street.*
B *Covered Gallery for Telegraphic wires, Gas, & Water pipes, continued from Battersea Bridge to London Bridge.*
C *Passenger Railway.*
D *One of the covered Waggon Ways at present leading from the Strand, continued to the Traffic Railway Platform*
E *Traffic Railway from Battersea Bridge to London Bridge.*
F *Do ... Road ... Do ... Do ...*
G *Raised ornamental boulevards Do to be reached by foot bridges at suitable intervals, with steps down to Traffic and Railway Platform.*

REFERENCE.

H *Raised Passenger drive from Battersea to London Bridge, sheltered at intervals, with light green glass, span Roofing.*
I *Raised ornamental boulevard*
J *Raised Terrace, ornamented with Walks, Seats, Shrubs, & Fountains.*
K *Half of the main Culvert running from Battersea Bridge into the Cesspool, & thence to its outfall in the River.*
L *One of the lateral Sewers now running at nearly right angles into the River continued to the Main Culvert*
M *Bed of the River.*



N.B.—The strong black lines represent high and low-water marks.
The present bridges would remain as grand and suitable over-crossings.
Under thorough crossings would have to be introduced where needful.

Scale of Feet
0 5 0 20 30 40

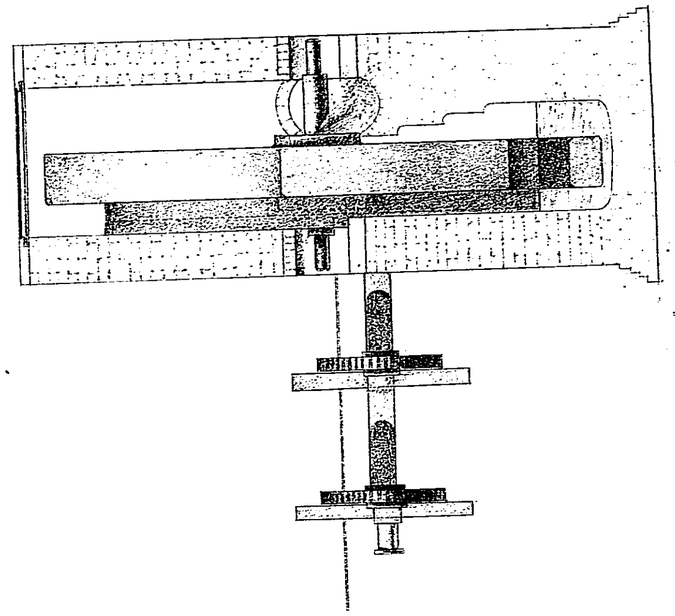
APPENDIX X. (Plate 10.)

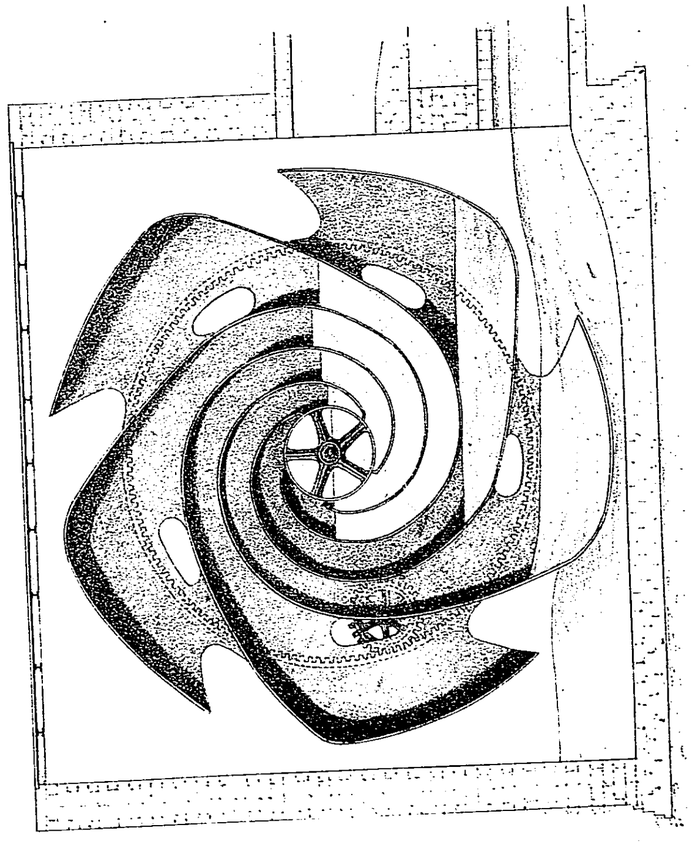
Ordered, by The House of Commons, to be Printed, 3rd August 1857.
Ed. Bar. Lith. Castle St. Leicester Sq. No. 233.
Harry Hansard Printer.

APPENDIX X.
Plate II.

Received 15th May 1857.

ELEVATING WHEEL
FOR
METROPOLITAN SEWAGE,
Proposed by Wm. Arrol Slater.





J. Basire, lithic.

Nº 233. Ordered, by The House of Commons, to be Printed, 3 August 1857.
Henry Hansard, Printer.

APPENDIX XI.

Information on Drainage of *Hamburgh.*

Minutes of Evidence given by Mr. *Lindley*, Civil Engineer, Hamburgh.

Meeting of Referees, 29, Great George-street, Saturday, 25 July 1857.

Mr. *Lindley* attended by appointment.

Mr. Lindley, at the request of the Referees, explained the circumstances of a syphon which he had in use in a sewer at Hamburgh.

The dip occurred in a sewer of 4 feet 9 inches × 5 feet 3 inches, with a general fall of 1 in 3,000.

The dip was about 4 feet in its lowest part under the general fall of 1 in 3,000, and extended for 400 feet.*

The velocity of current in the sewer was, under favourable circumstances, about 3 feet per second. A flushing-gate 3½ feet high, was constructed just above the syphon, with about 2 feet working head; and by means of this, the sewer was kept completely clear.

The inclinations of the approaches to the syphon were formed by O G curves of about 1 in 6.

Mr. Lindley said, that the sewer carried off almost all the rain-water of the district, so that during ordinary times, the sewer was not more than one-fourth filled.

Mr. L. said, that there had been great opposition to the introduction of this syphon in Hamburgh, but the inhabitants had been at last convinced by experiments made on the spot, showing, that heavy objects, even as large as a ball of cast-iron weighing 15 cwt. could be moved from one end to the other; these works have been in full successful operation about 12 years; they had made trials also by tying together granite curb-stones with matting, in bundles, and putting them in the sewer, and these were also washed through. Substances got into the Hamburgh sewers it was impossible to account for, such as brickbats, pieces of granite, stone, &c. which were too large to pass through the gratings in the streets; they however were all washed out by the force of the water.

Mr. Lindley said, that he found many of the sewers, when insufficiently supplied with water, even with a fall of 1 in 100, suffered as much from deposit as this flat sewer of 1 in 3,000. He stated, that he was convinced it was the proportion which the heavy matters bore to the quantity of water passing through the sewers that the amount of the deposit was regulated. A large supply of water was consequently necessary to be provided in all cases of sewerage.

The annual fall of rain at Hamburgh was much the same as that on the east coast of England, viz., 25 inches.

Mr. Lindley had not introduced the separate systems for house-sewage and surface-water at Hamburgh, partly because they would be more expensive, and partly because it would be very injudicious to remove out of the sewers receiving the road dirt all the drainage of the houses. It was a very erroneous belief that sewers were choked up with soil from houses. Mr. Lindley did not think it would be impossible to maintain the separate systems of sewers, but considered the great additional expense a serious objection to their introduction in large towns.

---

* Letter from Mr. *Lindley*.

Hamburgh, 28 July 1857.

Dear Sir,

Upon my return to this place, I measured the length of our syphon sewer under the River Alster, and found it to be 260 feet.

I beg you therefore to correct the statement I made upon this subject, in your office, upon the 25th instant, and remain,

Yours, &c.
W. Lindley

James Simpson, Esq.,
&c. &c. &c.

Appendix XII.

APPENDIX XII.

Agricultural Value of Sewage.

Evidence.

Mr. *Dugald Campbell.*

Information on Agricultural Value of Sewage.

1.—Minutes of Evidence given by Mr. *Dugald Campbell.*

Meeting of Referees, 29, Great George-street, Friday, 29 May.

Mr. *Campbell* attended by appointment.

Mr. Campbell said, in answer to Mr. Simpson, that he was convinced there was no chemical process by which the valuable constituent parts of sewage could be extracted in any remunerative way.

Mr. Campbell said, that sewage-water after deodorisation and precipitation of its solid contents by magnesian limestone, would, he had no doubt, decompose again under heat.

In answer to Mr. Blackwell, Mr. Campbell said, that alum sludge, which was proposed by Mr. Manning, would, as well as a number of other things, combine with portions of the solid organic matter suspended in the sewage-water, and also with some of the organic matter, for instance the fatty acids which are in soap, &c., and form a sort of net work, and by precipitating carry down most of the other solid matter suspended in the water, leaving it tolerably clear, but clear in proportion to the time allowed for its precipitation; but this precipitate would contain few, if any, of the substances acknowledged to be valuable for agricultural purposes, and which exist in sewage. The operation above described would be similar in its results to those produced by finings upon beer.

Mr. Campbell said, that the expense of carting manure, obtained by any of the precipitation processes from sewage, any distance into the country, would exceed the value of the manure.

Mr. Campbell said, that it would be a very easy matter to calculate all the valuable contents per ton of dry matter from sewage. Assuming the population of London to be 2,600,000, he had estimated the value of the contents of the sewage of London at upwards of 836,000*l.*; and a ton of dry matter from sewage, presuming that it contained all the valuable manurial matters which were in the water from which it was extracted, was worth rather more than 15*l.* per ton, made up as follows: salts of ammonia, about 14*l.*, phosphates about 12*s.*, potash salts about 8*s.*

Mr. Campbell was quite of opinion that it would be impossible to go back from the present system of water-closets, but thought deodorisation in each house, by charcoal, would have been one of the simplest means had the old plan of privies still existed.

Mr. Campbell stated that he was convinced, from the experiments he had made, that all chemical processes for making out of sewage-water, as he understands it, manures, either by precipitation or evaporation, would prove in a commercial point of view failures. This opinion was shared by chemists generally. Mr. Way, some time back, had nearly expressed as much in the Journal of the Royal Agricultural Society. The only practical way which Mr. Campbell could see of getting all the manurial value out of the sewage was by irrigation. He thought, if it were possible, an outlet or outlets ought to be sought, so as to carry the sewage of a town to a place where, if it were all discharged, it would not be a nuisance; this was difficult to find; in some cases it might be the sea, in others, lands might be found capable of absorbing it; some lands, and especially sandy soils, would absorb and deodorise an incalculable amount of sewage. The sewage should be carried away or forced from the town out of contact with the atmosphere, by the cheapest means which engineers could suggest, with appliances so that it could be obtained for irrigation by those who might require it, on its passage to the outlet. He had heard of the Stanley Bridge Works, and was aware that a deposit had collected in the pipes, but he thought that by care, that might be avoided. One way would be, before pumping the sewage, to pass it into reservoirs, or through a passage with pits in it, in which the heavier solid matter would deposit as the sewage passed. These might be cleaned out at intervals.

Appendix XII.

Agricultural Value of Sewage.

Evidence.

Mr. *G. E. Lane.*

2.—Minutes of Evidence given by Mr. *G. E. Lane,* late of the Stanley Bridge Sewage Works.

Meeting of Referees, 29, Great George-street, Wednesday, May 13.

Mr. *Lane* attended by appointment.

Mr. Lane said that the Metropolitan Sewage Manure Company's works at Stanley Bridge, near Walham Green, with which he had been connected, were now suspended.

The works received sewage from the Ranelagh sewer, the Company having made a sewer of nearly a mile in length, in order to procure it; they considered the sewage richer than that which they could procure on the site of the works.

Mr. Lane said that the peat charcoal they used at the works was partly Irish and partly from Fullwood, near Sheffield; and he considered the Fullwood charcoal better than any other, it being more bulky and lighter, and therefore superior even to the Irish charcoal.

Mr. Lane observed, that the charcoal medium for filtration lasted from a week to a fortnight, beyond which time the charcoal was of little use, being fully charged. The sewage passed through their filters in the tanks (eight in number) was 80 tons (10 tons in each) per hour. The water passed off was perfectly clear, and without taste; nor did it get bad even when kept for a few days. The water passed off was used for the boilers, but he considered it hard.

The manure sold well, and was approved by almost all who used it; but the cost of charcoal was so great that the manure could not be sold at remunerative prices.

Mr. Lane found the sewage applied in a liquid state very good for plants; when applied to the roots it was good in every respect, but sometimes when used from above, the leaves got covered with scum, and this was injurious to the plants.

Mr. Lane said, the charge for the liquid manure was 35*s.* per acre for a year, with a small extra payment as a rent for the iron pipes laid down, the persons using it supplying their own hose; this hose was generally of leather; gutta percha and canvass not being found to answer.

The reason the Company had suspended operations was, that the persons who used the liquid failed to pay for the use of it, and the concern altogether was unprofitable. The company carried on its operations between five and six years.

Mr. Lane said, that complaints were made to him of the works being a nuisance, but were never officially laid before the Company. The smell when the liquid manure was applied by jet was apparent 300 or 400 yards off; there was no smell when it was applied to the roots.

The manure was sold for 4*l.* a ton; one ton of peat charcoal produced 1¾ ton of manure. There was no smell from the solid manure, or very little; Mr. L. had never been able to detect it himself.

Sulphuric acid diluted in water (from 60 to 100 lbs. to the ton of charcoal) was thrown over the manure when it was taken out of the tanks, to prevent it from heating.

Mr. Lane stated, that the pipes got so firmly charged with solid matter (compressed sewage) that it was impossible to clear them when taken up after the stoppage of the works, without the use of sledge hammers. The obstructions were generally near the ends of the mains, and he was convinced that the whole of the pipes would in the end have been stopped up if the works had been continued. This partly arose from the gratings not being sufficiently fine to prevent large substances getting into the mains, but an improvement in this respect would only in a degree have remedied this; Mr. Lane being convinced that a certain amount of matter would find its way into the pipes. The deposit which was forced out was in hard masses of six and seven feet in length.

Mr. Lane considered flushing might partly remedy this; but the sand would not even then be dislodged in that way.

Mr. Lane related the fact, that one of the principal market-gardeners who used the pipes of the Company for water, assessed his loss from the non-supply of it to an acre of strawberries, for a week only, at a considerable sum.

The liquid sewage had been applied to a strip of grass land with great success; the grass was very rank and coarse however. The liquid sewage was only applied to the land during the six dry months of the year.

The first supply of peat charcoal the Company had was from the Irish Amelioration Society.

Mr. Lane stated that operations at the works had been suspended some time, and all the pipes taken up.

Upwards of 40,000*l.* had been spent in the concern, and he considered it altogether a failure. The manufacture of the manure from sewage with peat charcoal, sulphuric acid, &c., was so expensive that it could not be made profitable.

Appendix XII.

Agricultural Value of Sewage.

Correspondence as to the Irrigation of Land with Sewage Water.

3.—Correspondence as to the Irrigation of Land with Sewage Water.

My dear Sir, 72, George-street, Edinburgh, 12 March 1857.

I send you herewith a letter from Mr. Macpherson, Superintendent of streets and buildings (including drains), which I hope will give the information you want, as to the quality of the sewage water. I believe he is rather above the mark, than otherwise, in stating 20 gallons a day; for though the general consumption of Edinburgh is from 25 to 30 gallons a day, the district he refers to is chiefly in the old town, where there must be much less used than in the new. I send also some information got from the overseer on Craigentinny estate, on the road to Portobello, which is, I have no doubt, correct; but he is quite ready to answer any further questions, if wished. The law agent on the estate tells me, that less than 200 acres produce annually 5,000 *l.*—that in the meadows of the adjoining estate of Lochend, nine crops were once taken off in one year, producing 56 *l.* an acre, and that the usual rent is from 30 *l.* to 40 *l.*

He tells me, moreover, that there is a full account of irrigated meadows in the Encyclopædia Britannica. If there be any other points as to which you want information, I shall be glad to supply it, so far as in my power; I had made another inquiry as to the meadows, but have not yet got an answer; if it contains anything different from what I have sent you, it shall be forwarded. I shall be glad to hear the results of your experiments on the scouring power of water.

I am, &c.,

Thos. E. Blackwell, Esq. (signed) *James Leslie.*

(Enclosures in above Letter.)

(i.)

My dear Sir, Police Chambers, Edinburgh, 10 March 1857.

The information I have regarding the quantity and quality of the sewage water used in the irrigation of the meadows between Edinburgh and Portobello, is as follows:

1st. The population of the drainage area is estimated at 80,000, and allowing 20 gallons to be the quantity of water supplied daily to each person, there will be about 1,600,000 gallons of house drainage passed by the sewer daily. The drainage area is about one square mile and a half in extent.

2d. I understand that it is not the practice to feed off the herbage. The grass is, I think, always cut; why, I have not learned. At Mr. Harold Littledale's model farm, in the parish of Walliasey, near Liverpool, where the practice of irrigation by hose and jet has been in operation for some years, the grass is cut as required.

3d. The irrigation depends upon the season; about once a fortnight or three weeks, in summer, is the average, I have been informed. In cold weather, a longer time is allowed to elapse.

I understand that the number of crops is from six to ten per annum. I do not know the effect of irrigating during winter, but I rather think it is not advantageous.

I am, &c.,

James Leslie, Esq., C.E. (signed) *Charles Macpherson.*

(ii.)

Information from Mr. *A. Bryce*, Overseer, Craigentinny Farm.

All the grass from the permanent meadows, viz., those on which nothing but grass is ever grown, is cut and sold, because, as the ground is soft, the animals, if allowed to feed on the ground, would spoil the plants.

These meadows are irrigated about once every month throughout the whole year; they are under water only while the grass is short, and till the ground is saturated with water; because if the water was allowed to remain on till the grass was long, it would cover the grass with slime and dirt, and so decrease its value.

These meadows are cut about four times a year. Some meadows are watered by hose, but they are used for growing corn and such like crops; they are only watered during the months included from March till September.

The grass from the permanent meadows is sold chiefly for the feeding of cows, because they produce more milk when fed on it than on other kinds of grass.

The average value of the crop from the permanent meadows is from 20 *l.* to 30 *l.* per imperial acre.

Appendix XII.

Agricultural Value of Sewage.

Communications as to Utilisation.

Dr. *Gilbert.*

4.—Communications as to the Utilisation of Sewage.

(1.) Letter from Dr. *Gilbert.*

To the Referees appointed to consider the Plans proposed for the Main Drainage of the Metropolis.

Gentlemen,

I herewith beg to hand you a few observations on the four points submitted in yours of the 10th instant, for my consideration.

"1st. The general consideration of the agricultural value of sewage manure, both liquid and solid."

There cannot be the slightest doubt, that the constituents of town sewage, arising from human excrements and other matters, have in themselves a very high manuring value. Indeed, the conclusion of Mr. Lawes and myself on this point is, that if the constituents in the sewage of the metropolis could be conveniently applied for the production of corn, they would return somewhere about one-third of the wheat consumed by its population. But, owing to the circumstances under which these constituents are presented to us in sewage water, their real practical value cannot be estimated according to their chemical composition, in the manner done with respect to concentrated portable manures. This arises from the immense dilution of the manurial matters by the sewer water. Perhaps the best way of conveying a clear idea on this point is to state that, if the solid and liquid excrements of each individual of a mixed population are supposed to be mixed with water (by supply and rain-fall) at the rate on the average of 50 gallons per head per day, we should then have only nine ounces of the dry substance of human excrements distributed in each ton of the water. By a similar mode of calculation, every ton of the dry matter of the excrements, which, if obtainable in a portable condition free from any admixture, would be worth rather more than a ton of the best Peruvian guano, would in the form of sewage be diluted with very nearly 4,000 tons of water.

I need hardly suggest to a body of engineers, how very different must be the method and cost of distribution, and consequently the practical value, of the ton of dry and pure excrementitious matter—worth in that state, say some 15 *l.*—and of the same ton of matter distributed, on the average, through some 4,000 tons of water, more or less. But the difficulty and increased cost of the general distribution are not the only disadvantages arising from the admixture of the manurial matters with an enormous bulk of water. Thus, if the excrementitious matters were in a dry, portable, and non-putrescent condition, like guano and other concentrated manures—on which assumption alone could their constituents be valued by the same tariff, they could like these substances be stored for any reasonable length of time—they could be applied to the land at the most fitting seasons, and, above all, they would be applicable to almost any crop, and especially to corn. But the same matters, if distributed day by day through (say) 4,000 times their weight of water, must inevitably be used, not only at the best seasons, but day by day, and at all seasons. This dilution and this constancy of supply must also almost, if not entirely, preclude the use of the matters in the direct growth of grain, for which purpose they would otherwise be both the most applicable and the most valuable. They would, in fact, necessarily limit the use of the manurial matters, on the large scale, to the growth of grasses, and perhaps some other succulent crops, by irrigation. I would here remark, that it is a matter much to be regretted, that the public mind should so frequently have been misled as to the applicability of dilute town sewage for crops generally, by reference to the use of liquid manure on farms, where not only the amount of fluid, but its concentration, and the time of its application, are entirely under control. With the very different circumstances of town sewage vanishes entirely the foundation for any conclusions regarding it, from such experience as that alluded to. In the one case we have a limited amount of fluid, any desired amount of concentration by the addition of manures, and perfect control as to the time of application; in the other, the dilution irrevocable, an enormous supply constant, and the time of application almost entirely beyond control.

The question arises then,—Can the valuable matters of sewage water be separated from it in the solid form, and sold at anything like their theoretical value, like guano and other portable manures? This brings me to your second heading of inquiry, namely,—

"2d. An investigation of the probable relations of manufacturing cost and selling price of solid sewage manure, founded upon your own experience."

I conceive that, before entering upon this inquiry, we should first decide whether, by any known means, a solid manure, containing the greater portion of the valuable constituents of the excrementitious matters, can be obtained from sewer water? To this, as a chemist, I answer most unhesitatingly in the negative. I do so the more emphatically, because, though I am perfectly aware that this opinion is not in accordance with the tendency of the views of some chemists of authority, upon whom the public naturally and willingly rely, I am at the same time persuaded that their own judgment would agree with mine, were they, as professional men, to give a detailed instead of a mere general consideration of the subject; and also because, from the attention and study which, in conjunction with Mr. Lawes, I have given to the subject, I am satisfied, not only that the thing has never yet been accomplished, but that, in the present state of chemical knowledge, it is absolutely impossible to accomplish it.

Let

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Agricultural Value of Sewage.

Communications as to Utilisation.

Dr. *Gilbert.*

Let us take, in illustration, the important manurial constituent—nitrogen, or ammonia; the per-centage of which will, in practice, undoubtedly to a great extent determine the value of any solid sewage manure. Not that the other constituents have no calculable value, but it is very much less, weight for weight, than that of the nitrogenous ones, and owing to the great solubility of the latter, they will always be, relatively to the others, in defect; and hence they will, practically, always greatly influence the money value of the manure.

By far the larger proportion of the nitrogenous compounds voided are found already dissolved in the liquid excrements. In sewage, these and the solid excrements are almost infinitely diluted with water, and the tendency of the chemical changes they undergo is, to convert the natural nitrogenous compounds into more, not less, soluble combinations. Indeed, with the exception of a very small amount of the voided nitrogenous matters, which remain as effete particles of food and animal substance in the fæces, the whole of the nitrogenous compounds voided are extremely soluble in water. In fact we should conclude, from knowledge of this kind, that somewhere about 9-10ths of the nitrogenous substance in sewer water must exist there, not merely as suspended matter, but absolutely dissolved. Nor has any chemical method yet been proposed, by which the so dissolved nitrogenous compounds can be re-precipitated, in the solid form, from so dilute a fluid as town sewage. All the excrementitious nitrogenous matter, therefore, which can be obtained in a sedimentary sewage manure, is that small proportion which exists in an undissolved state in the fæces, together with an immaterial proportion carried down mechanically, rather than chemically, with the sediment.

Of the various chemical methods which have been proposed for removing the sedimentary matter from dilute sewage, I believe the so-called lime process to be the most efficient known. All the analyses, however, which have yet been published upon good authority, of the solid sewage manure so produced, perfectly agree with theory as to the small amount of nitrogenous matter which they contain. Professor Hofmann has also recently shown, that when the excrements are treated by lime in a fresh and comparatively undiluted state, the sediment obtained still contains but a very small per-centage of nitrogenous compounds. In fact, so small is the amount of valuable manurial constituents shown to be contained in such solid sewage-manures, that they could only be useful if applied to the land in several times as many tons per acre as would be required in hundredweights of guano, or the pure, dry excrements.

Under these circumstances, it would be useless to go elaborately into the question of manufacturing cost and selling price. It is obvious that such a manure would, on account of the cost of carriage, command no price at all beyond a very limited distance from its place of manufacture. The fact, indeed, that the price of such a manure has, during the last two or three years, been reduced from 2*l.* to 3*l.* per ton to about as many shillings, is a practical corroboration of this opinion. This brings me to the third subject of consideration, namely,—

> "3d. The applicability of any system of utilisation of sewage to the requirements of London."

Assuming the population of London to amount to from two and a half to three millions, the amount of moist sedimentary manure produced from its sewage, by the lime process, would be from 250,000 to 300,000 tons per annum, according to the estimates published by those experienced in that plan. Excluding Sunday as a day of transport, this would require that nearly 1,000 tons of the pasty manure should be removed daily. Such a manure, as has already been said, would contain but a very small proportion of the valuable matters of the sewage. The value of that which it did retain would be eaten up by a very few miles of land carriage; whilst, at the rate, even, of 10 tons per acre, per annum, it would require about 30,000 acres to be devoted to its use, to consume the produce of London. When, however, we consider how small a proportion of the land within a given circuit would be so appropriated, and that but a small proportion, using it at all, would use it in the quantity supposed, some idea may be formed of the area, round London, which would be required to consume its produce of such a solid sewage manure. We must further suppose that, if this mode of utilisation were adopted for London, it would be adopted for other towns and cities also, each supplying its proportional area.

But granting these difficulties surmounted regarding the solid deposit, we have still, with present knowledge and experience, to assume that by far the larger proportion of the valuable matters (probably nearly nine-tenths of the nitrogen) will remain in the supernatant fluid. This being the case, the utilisation of the sewage would not be effected, unless the clarified water were applied for the purposes of irrigation. There can, indeed, be no doubt, that the sewer water, whether before or after the application of the lime process, would, if applied by irrigation, raise enormous crops of grass. Whether, however, it is feasible to appropriate to such a purpose a sufficient area of land to take the constant supply of London, and within such a distance from the metropolis as to render the undertaking remunerative, is a question requiring too much of engineering datum for my own opinion respecting it to be of any real value. This brings me to the fourth point submitted, namely,

> "4th. Your opinion as to what method of dealing with the sewage is, on public grounds, best adapted to the metropolis."

From what I have already said, you will gather that I do not believe chemistry has yet proposed any method by which the valuable constituents of dilute sewage can be remuneratively reclaimed and utilised in the form of a solid manure. But, I take it, the question now

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now is,—What is the best method of dealing with the sewage considered in a sanitary, as well as in a productive and agricultural point of view?

Assuming the excrementitious matters of the metropolis still to be mixed, as at present, with an enormous bulk of water, the most feasible alternatives appear to be—

1. That the sewage matter should be discharged and lost, but more effectually, and at a greater distance from the metropolis than heretofore; thus securing the sanitary objects, not only without any return for the utilisation of the matters, but at a heavy increased outlay.

2. We may suppose the crude sewage, unaffected by any process, instead of being discharged and lost, to be applied for the growth (chiefly) of grass by some method of irrigation.

3. Looking chiefly at the sanitary side of the question, the fluid may be so far disinfected as to allow of its being discharged much higher up, and therefore at much less cost, into the river; in which case the small value of the solid matters, removed from the water, may be considered in reference to the cost of the disinfecting process.

4. After employing some disinfecting method, the value of the solid manure, and that of the supernatant liquid for the purposes of irrigation, may both be set against the cost of the removal and disinfection for sanitary purposes.

The first of these alternatives, that of removing and discharging to waste the whole of the sewage matter, at a sufficient distance, would, of course, serve the sanitary requirements; but at what cost, it is not within my province to speculate upon. Whether such a course, effectual though costly as it would be, should or should not be adopted, would depend upon the judgment which must be formed of the other three methods.

As to the second method, there is no doubt that the unsophisticated sewer water, if applied by irrigation in some way, would raise enormous crops of grass, and secure a very high rental to the land devoted to it. If so applied, the object would, I think, be to limit the cost of main distribution by limiting the area of land, at the risk of somewhat lavish expenditure of manurial substance, rather than to extend it with a view to the economisation of the manure. Whether, and at what distance from London, a sufficient amount of land could be so appropriated? whether a district so devoted would itself be healthy? at what cost the distribution and application could be effected? and, therefore, how far the scheme would lessen the cost of cleansing the metropolis? are questions which it is not for me to answer.

The third and fourth methods seem to be worthy of a serious examination.

Of all the disinfecting methods which have yet been proposed, I believe that which is known as the lime process is by far the most practicable and effective on the large scale. Of the probable value of the solid manure obtained by such means, I have already given my opinion at some length. But the question still remains, whether the clarified fluid is really so far disinfected, and rendered non-putrescible, that it might with impunity be turned into the river much higher up than the crude sewage could be? The only scientific examination of this point with which I am acquainted, namely, that by Dr. R. A. Smith, seemed to indicate that, though at first cleared by the lime process, the fluid after a short time again manifests putrescence. The question of the degree in which it does so, and that of how far the water would still be innocuous, at any rate when again diluted by the Thames, seem to be of the utmost importance, and to demand a thorough experimental investigation. The result might, indeed, vary with the varying conditions of concentration and decomposition, at different times and places.

The fourth alternative is that of disinfecting the sewer water, and at the same time using, as manure, both the solid product and the clarified liquid. I think it probable, that owing to the very low character of the solid product obtainable by the lime method, a considerable portion of it would have to be got rid of in some other way than as manure; whilst the remainder would command a very low price, and its use would be confined within a very limited range of carriage. The advantages of the plan, in a remunerative point of view, would therefore chiefly depend on the return from the use of the clarified liquid for the purposes of irrigation. This clarified liquid would, no doubt, enormously increase the growth, particularly of grasses, to which it might be applied; but its effects would as certainly be less than before the removal of the solid matters, which, when separated, have in themselves so little money value. The chief point to decide would therefore be, whether, provided irrigation be adopted, there would be sufficient sanitary advantages to set against the increased cost in dealing with a disinfected, rather than with a crude sewage, for that purpose.

Upon the whole, keeping in view the great practical difficulties in the way of profitably applying the valuable matters of sewage for agricultural purposes, and looking, therefore, rather to the imperative necessity of cleansing our towns, almost at whatever cost, I feel that the most important step towards progress will be made when the public mind is sufficiently disabused of the present exaggerated notion of the agricultural value, in a practical point of view, of highly dilute sewage matter. At the same time, I believe that the third and fourth suppositions here referred to deserve a thorough experimental examination, before either the great and entirely unremunerative cost of the first, or the probable risks of the second method, be had recourse to.

J. H. Gilbert, PH.D., F.C.S.

Appendix XII.

Information on Agricultural Value of Sewage.

Letters.

Mr. *Stevenson.*

(2.) Letter from Mr. *Stevenson.*

Jarrow Chemical Works, South Shields,
29 June 1857.

My dear Sir,

In reply to your letter, I beg to state that from my experience in chemical manufacture, on a large scale, I am hopeless of the success of any process for recovering the soil after it has been diffused, or dissolved in the great bulk of water supplied to the sewers by the house-top and surface drainage.

Manufacturers can turn to account solutions containing a very small amount of solid matter, by using them instead of water for dissolving fresh materials, but otherwise the solid matter would not pay the cost of separation.

In like manner I believe that it would never be profitable or practicable to separate, by precipitation, the fertilising substances which sewage water contains; evaporating it to a manageable bulk would be too expensive, and precipitating the phosphates, &c. would require an appliance of reservoirs, tanks, settlers, and drying and pumping apparatus, altogether disproportionate to the quantity of materials to be obtained.

Yours, &c.
(signed) *James C. Stevenson.*

T. E. Blackwell, Esq., C. E.

Mr. *Thurlow.*

(3.) Letter from Mr. *Thurlow.*

Baynard's Park, Guildford, Surrey,
30 May 1857.

Sir,

In accordance with the wish you expressed, I have much pleasure in forwarding my opinion on a few points connected with the London drainage, together with some particulars of the system adopted here for utilizing sewage manure.

The case of the drainage of London and Metropolitan districts seems to resolve itself under two heads.

1. Whether such drainage should be emptied within or without the above-mentioned districts.

2. Whether, with a due regard for health, the whole or any part of the proceeds of the drains can be utilized, so as when sold to produce a profitable return.

As to the first question:

The inhabitants of London will naturally demand that all nuisances, whether derived from drains, tanks, or cesspools, should be entirely removed, and as far as my acquaintance with the subject will allow of my giving an opinion, there being at the present time no known ingredient that will at once act both as a deodorizer and disinfectant, it seems impossible to open either sewers or tanks, without a risk of some disagreeable consequences; though such consequences in a densely crowded district may lead to bad results, in an open district they may be perfectly innoxious. It necessarily follows, therefore, that the only safe plan is to carry the sewage beyond the bounds of the Metropolitan districts, in such a way as not to preclude its being there utilized whenever any feasible plan can be introduced.

As to the second point:

The question of the perfect deodorization and disinfecting of sewage is a subject at present quite in its infancy, but from the data which the science of chemistry has placed at our disposal bids fair to become a problem which will be ultimately capable of solution. And I believe the plan which I have adopted in my father's yard could be extended to any given amount of sewage manure with a prospect of some pecuniary return, particularly if what I believe to be the case be in reality a fact, viz., that the human fæces, when drained into *sea* water, will not mix with it, and will most likely, therefore, become at the end of no great lapse of time the means of producing a pestilence in the neighbourhood where such discharge empties itself into the sea.

The plan adopted on the farm at Baynard's, is to have the drains from farm yard, stables, closets, &c., empty themselves in at the top of a tank 12 feet deep by 6 feet diameter; the overflow from this tank, which I call No. 1 tank, is from the top, into five other tanks, of similar dimensions, which are connected with each other at the bottom; the tanks are covered over, having at top of tanks No. 1, No. 2, No. 3, No. 4, and No. 5, a trap which is air-tight, but which can be opened; and at top of No. 6 tank is a pump; there is not the least smell from these tanks; all the cesspools having connexion with the tanks are trapped, which prevents any smell in farm yards, but which previously to the drains being trapped, was as bad as that at present arising from the water gratings in the streets of London.

The solid manure is thus contained in No. 1 tank; the liquid manure in the other five tanks; the overflow from No. 6 tank is by a covered drain, at present running into a brook, but is about being turned over a field to try its effect on lucerne.

Over these tanks is a range of covered sheds, in which superphosphate of lime and other manure is thus made:—Place in the centre of a heap of wood, turf, or other ashes, as many inch or half-inch bones, as may be required (taking care that the bones are well covered with ashes, to prevent air getting to them). Soak the mixture with the liquid manure from the pump over No. 6 tank; after this mixture has remained about three weeks, turn it over (in the same way as a common manure heap in the fields is turned over); at the end of a month turn it over a second time, and after two or three weeks the superphosphate will be fit for use.

For cost of the superphosphate, see Addenda "A."

When the liquid manure has been pumped out, the solid contents of No. 1 tank can be made use of either by putting in a compound of *fresh* gypsum (sulphate of lime) and a small quantity of Epsom salts (sulph. of magnesia) sufficient in quantity to make the contents become a thick paste; place this under shed, with a thin coating of ashes; as soon as dry it can be turned and mixed, when it will be fit for use as manure. There is hardly any smell, but what little there is can be got rid of by sprinkling over a small quantity of chloride of lime. Or the solid contents of No. 1 tank can be made use of by putting into No. 1 tank a sufficient quantity of quick lime to make the contents a thick paste. There is but little smell to this compound, and when dry and well mixed, it will be fit for use as manure.

Either of these compounds will be found to be powerful manures; they have not as yet been "tested," but I fancy the former is the strongest.

For cost of these manures, see Addenda "B."

The application of this system to the drainage of London could be done by having at any given point either one tank or a set of tanks, measuring, say 900,000 cubic feet, at the bottom of and in a line with the

Appendix XII.

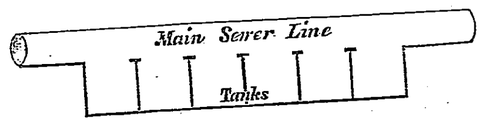
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Mr. *Thurlow.*

the main sewer, in such a way that the sewage, after having by gravitation deposited in the tank or tanks its heavier portions, would again flow on through the main sewer, and so also that the top of the main sewer would act as a cover to these tanks; thus, Fig. (1).

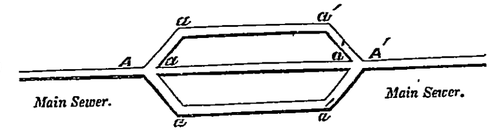
(1.)



I have not the data necessary to calculate the exact amount of tank room necessary; but, supposing the population to be about 3,000,000, a set of tanks containing about 900,000 cubic feet would, I think, suffice for all the solid manure that could be collected by gravitation in 24 hours.

Supposing three or more sets of tanks to be necessary (for the purpose of giving time for their being emptied, which could be accomplished by machinery), they could be arranged as in Fig. (2), having at A'. and A'. the requisite locks for turning the sewage.

(2.)



A.A'. Points for locks for turning sewage.

a.a'. Main sewer, having tanks underneath for collecting solids of sewage.

Should it be considered advisable to try any part of this system, which makes a powerful manure (comparatively speaking at a small cost, and without smell), I should have much pleasure in forwarding any further information in my power.

I am, &c.
(signed) *Thos. Lyon Thurlow.*

To James Simpson, Esq.

(*Appendix to Mr. Thurlow's Letter.*)

ADDENDA (A).

Cost of Superphosphate.

	Lbs.	£. s. d.
28 cwt. of bones (not broken) at 112 lbs. per cwt. =	3,136, and cost here - -	8 - -
18 cart loads of wood ashes of 25 bushels, of 50 lbs. weight per bushel - - - - - - =	22,500, at 6 *d.* per bushel -	11 5 -
Cost of one man turning mixture twice over, at half-day each time, at 2 *s.* per day - - -	- - - - - - - -	- 2 -
Cost of one man breaking whole bones into one-inch bones, say four weeks, at 12 *s.* per week -	- - - - - - -	2 8 -
	25,636 lbs., or about 11 tons, cost	21 15 -

Say 2 *l.* per ton.

Note.—If the usual machinery for bone-breaking were in use, the cost would be nearer 8 *s.* than 2 *l.* 8 *s.*

Or,

	Lbs.		£. s. d.
7 cart loads of turf ashes of 25 bushels, in weight 56 lbs. per bushel - - - - - - =	9,800, cost 5 *s.* per cart load -		1 15 -
4 quarters or 32 bushels of half-inch bones, in weight 40 lbs. per bushel - - - - - =	1,280		
Cost at 17 *s.* per quarter - - -	- -	£. 3 8 -	
Cartage - - - - - -	- -	- 2 6	
Bags - - - - - - -	- -	- 5 -	
		3 15 6 - - -	3 15 6
Cost of one man turning over mixture once, and putting in liquid manure - - - - -	- - - - - - -		- 4 -
	Or, 11,080 lbs, say 5 tons - -		5 14 6

Say 1 *l.* 10 *s.* per ton.

This superphosphate is equal to that 2 *l.* per ton, and, as far as I can judge, as good as that purchased in the market for 6 *l.* per ton.

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Mr. *Thurlow.*

ADDENDA (B).

Cost of Tank Manure.

As far as I can state, in a very rough way, the mixture of No. 1 tank manure are *fresh* gypsum, are about equal in weight; so that putting gypsum at 36 *s.* per ton, and No. 1 tank manure at any small sum, so as not to exceed its value, say 2*s.* per ton, we have

	£.	s.	d.
½ ton of fresh gypsum	–	18	–
½ ton of No. 1 tank manure, say	–	1	–
A small quantity of sulphate of magnesia, say one table spoonful to 1 lb. of No. 1 tank manure	–	6	–
A small quantity of chloride of lime	–	3	–
	1	8	–

Say 1*l.* 10*s.* per ton.

Or,

	£.	s.	d.
10 cwt. of fresh stone lime, in weight 56 lbs. per bushel, at 6*d.* per bushel	–	10	–
10 cwt. of No. 1 tank manure, at 2*s.* per ton	–	1	–
	–	11	–

Say 15*s.* per ton.

Note.—These calculations must be considered only as approximations, exposure to air and damp having much effect on the weight; though even on this supposition, which I do not think is overstated, no inconsiderable revenue might be derived from the sale of manures, as in part an offset to the expense of drainage.

Messrs. *Gibbs & Son.*

5.—Letter from Messrs. *Gibbs & Son,* sending a Pamphlet from which the Standard for Calculation of Agricultural Value of Sewage has been derived by the Referees.

Sir, 15, Bishopsgate-street Within, London, 7 July 1857.

We are in receipt of your favour of this day, with enclosures, requesting information respecting the component parts of guano.

In reply, we scarcely think we can do better than refer you to the source to which we have ourselves to apply for information on that subject, viz., the analytical agricultural chemists of the day, among whom we may name Professor Way and Mr. T. C. Nesbit, both which gentlemen have directed their attention specially to the subject, and are authors of publications* containing data of much interest and value to parties interested in the article of guano.

We return Mr. Bright's letter, and remain, sir,

Yours, &c.

Thomas E. Blackwell, Esq.,
29, Great George-street, S.W.

(signed) *Ant^{o} Gibbs & Son.*

* One of Mr. Nesbit's pamphlets we send separately.

APPENDIX XIII.

Appendix XIII.

Information not falling under former Appendices, with Diagrams, &c.

Information not falling under former Appendices, with Diagrams, &c.

Letter from the Clerk of the Fishmongers' Company.

Letter from the Clerk of the Fishmongers' Company as to the disposal of Condemned Fish, &c.

Sir, Fishmongers' Hall, E. C., 3 June 1857.

I beg to hand you (according to the wish of G. T. Nicholson, Esq.) a return* of the fish seized by the meters appointed by the Fishmongers' Company, for three months last summer; also for three months during last winter; to which I have added some additional information, which I trust may be of service.

The meters have entered into an arrangement for the fish they may seize to be carted away daily to Bromley, in Middlesex, where it is put into a cauldron, and on some vitriol being poured upon it, it is converted into a manure. In the year 1841, on the seizure of some very large quantities of mackerel, the meters having great trouble to dispose thereof, were obliged to convey the same in lighters below Barking, and then threw the same into the River, the most part sinking: but it was found that part lodged on the shores, which, I believe was the reason for that course being discontinued, and the present mode adopted.

The company appoint the meters under the charter granted in 1604, and give to each a deputation, describing their duties, and their power of entry into any house, &c. within the city of London and borough of Southwark, to seize any fish that they may find to be unwholesome or corrupt, or unfit to be sold.

The meters were regularly appointed, and remained in office till 1828, during which year the two then holding office died. The company, during the years 1828 and 1829, took into consideration the question of the Fishmeters, but nothing was done until the 19th July 1832, when a deputation from the Board of Health for the city of London waited upon the company, and on the 1st of August following two new meters were appointed, with a salary of 10*l.* each per annum, according to the charter, the company trusting the corporation of London would, as they received the benefit of all tolls, &c. from the market, make the meters a proper remuneration for their services; but although so appealed to, it was declined. The company therefore raised their pay to 1*l.* per week each, which they have since received.

I am, &c.

Captain Douglas Galton, R.E.,
Board of Trade, Whitehall.

(signed) *W. B. Towse.*

* The enclosed Returns are too long for publication.

LIST OF PLATES TO APPENDIX XIII.

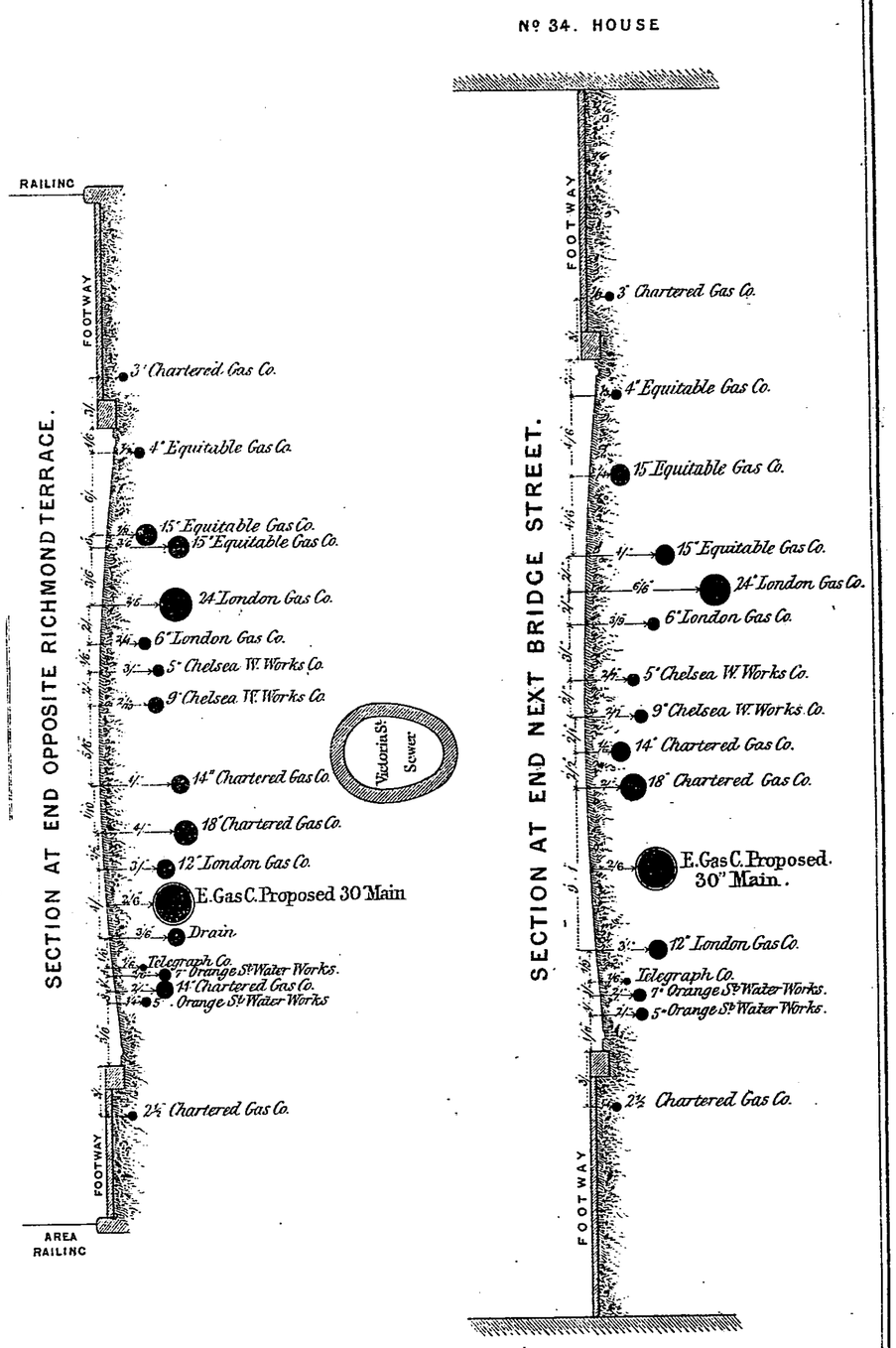
Plate 1. Sections showing the Gas and Water Mains, Telegraph Pipes, &c., under the Roadway in Parliament-street.

„ 2. Plan showing the Gas and Water Mains under Roadway at Regent Circus.

„ 3. Plan showing the Gas and Water Mains under Roadway in Cockspur-street.

APPENDIX XIII.
(Plate, 1.)

SECTION OF PARLIAMENT STREET,
Showing Water-Gas-Mains &c. under Roadway.



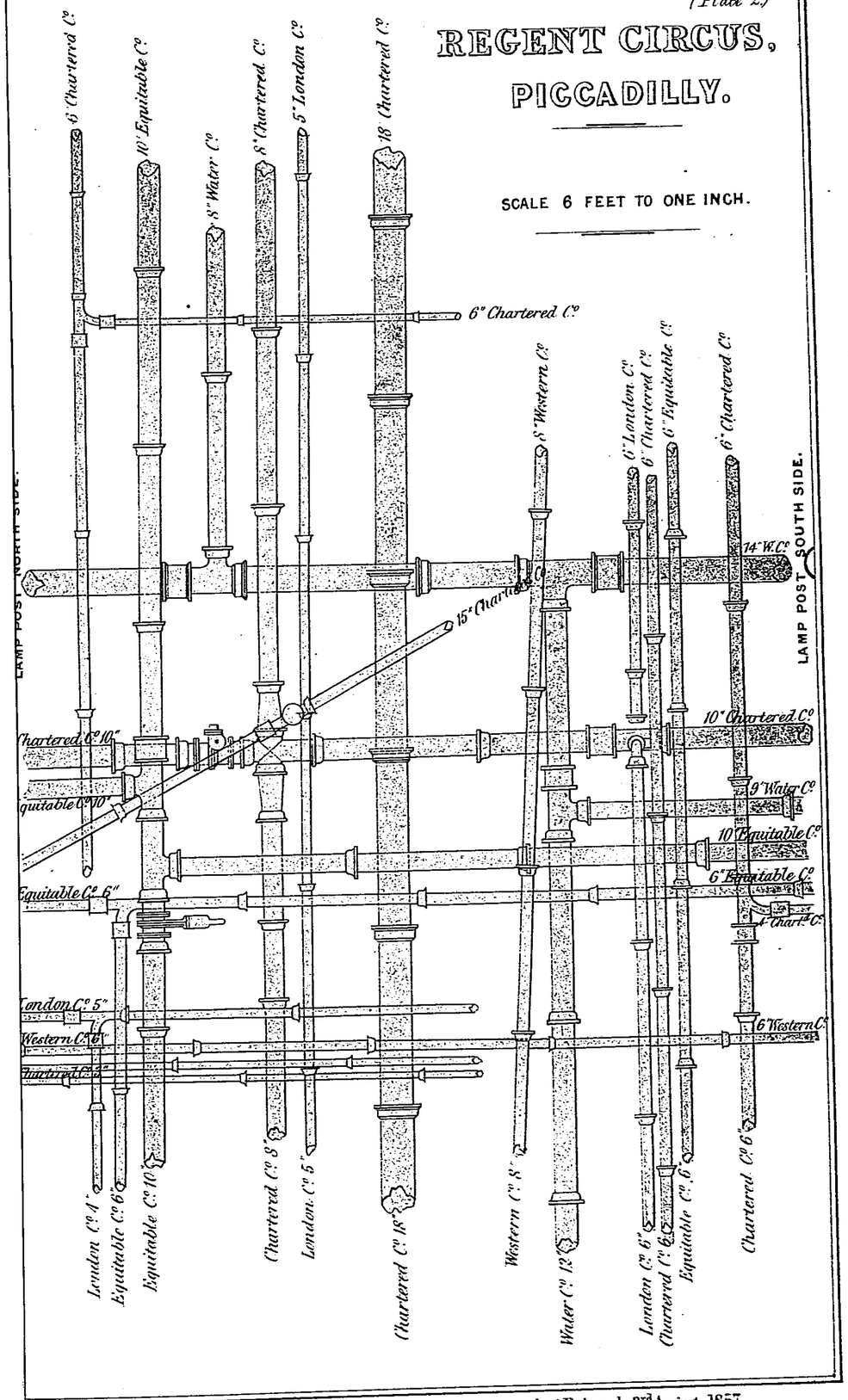
Nº 233. Ordered, by The House of Commons, to be Printed, 3rd August 1857.

Henry Hansard, Printer

APPENDIX XIII.
(Plate 2.)

REGENT CIRCUS, PICCADILLY.

SCALE 6 FEET TO ONE INCH.



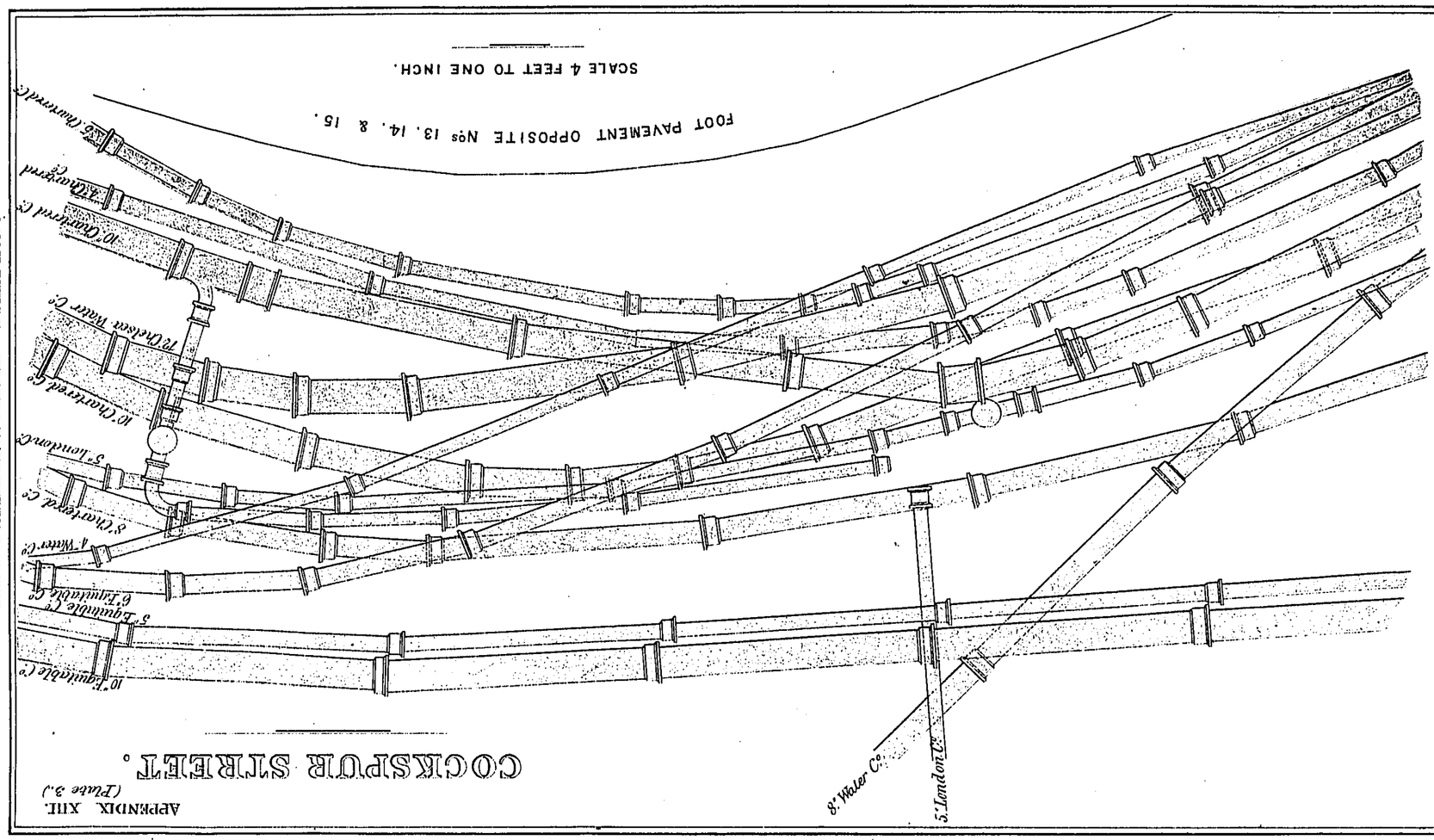
Ordered by The House of Commons to be Printed, 3rd August, 1857.
Henry Hansard Printer.

APPENDIX XIII.
(Plate 3.)

COCKSPUR STREET.

FOOT PAVEMENT OPPOSITE Nos 13. 14. & 15.

SCALE 4 FEET TO ONE INCH.



Nº233. Ordered, by The House of Commons, to be Printed, 3rd August 1857.
Harvey, Hansard, Printer.



ERRATA IN REPORT.

Page 18, in last paragraph but one, *for* "1848," *read* 1849.

Page 27, in line 15, *for* "1848," *read* 1849.