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A NEW IDEA

FOR THE

WATER SUPPLY OF TOWNS,

AND ALSO THE

TROOPS IN INDIA AND THE COLONIES.

A LETTER

ADDRESSED TO

THE SECRETARY OF THE ROYAL COMMISSION ON WATER SUPPLY,

EXPLANATORY OF

THE IMPOSSIBILITY OF GETTING PURE WATER FROM ANY OF THE VARIOUS SOURCES THAT HAVE BEEN ALREADY PROPOUNDED;

AND SUGGESTING

THE CONSTRUCTION OF NON-ABSORBING COLLECTING GROUNDS TO HOLD AND SUPPLY NATURAL AND PURE WATER FOR DRINKING AND COOKING PURPOSES ONLY; AND ALSO THE CONSTRUCTION OF STREET SUBWAYS TO PROTECT THE WATER PIPES FROM EMANATIONS OF GAS;

BY

ARTHUR SYDNEY ORMSBY,
CIVIL ENGINEER.

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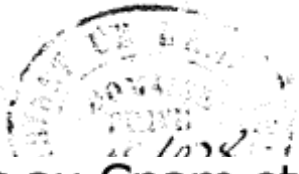


IN EXPLANATION.

THE object of issuing a Second Edition of this Pamphlet is to convey a reply to the following questions that have been put to me, viz.:—

1st. If your plan were adopted, how would the water for drinking and cooking be kept separate from that for common use? and again, How is the water for the former purpose to be brought from the distributing reservoir to the house cistern? (See Sketch No. 1 and page 19.)

2nd. If it be thought undesirable to construct a roof of iron and glass for the purpose of a collecting surface, do you propose any other form of collecting surface without reference to the utilisation of the ground? (See page 30 and Sketch No. 6.)

3rd. Assuming that the Government were to obtain the sanction of Parliament for the expenditure necessary in the first instance, repayable in easy instalments by the Colonies, are you able to suggest a general plan of water supply for the troops stationed in these Colonies and in India? (See pages 32 and 33.)

By adding together the numbers given in column 12 of the table at page 23, it will be seen that I propose to save the lives of FIVE HUNDRED and SIXTY-FOUR SOLDIERS annually.

A. O.

TO

THE SECRETARY

OF

THE ROYAL COMMISSION ON WATER SUPPLY.

Sir,—

I beg leave respectfully to call the attention of the Royal Commissioners to two very important facts connected with waterworks already completed, viz., Paris and Melbourne.

1st. That upon the completion of the Melbourne Waterworks, the analytical chemist, under order of the Victorian Government, and after a most careful analysis, reported that the water supply was poisonous.

2nd. That referring to the extract from the *Times* attached hereto,* it would appear the waterworks of Paris are in a like condition.

It is admitted to be an established fact, by the most competent analytical chemists, that it is by contact with the earth that water contracts those impurities which

* Appendix (B).

are most injurious to health, and yet, notwithstanding this, all the projects which have been put forward for the supply of water to London are founded upon this principle; and in point of fact, if any one of them were to be carried out there would be this risk, and that the Government analytical chemist would have to declare, that water thus obtained was absolutely unfit for public use.

In a pamphlet published by Mr. Thomas Dale, of the Corporation Waterworks, Hull, in which he proposes to supply the Towns of Yorkshire and Lancashire with water from the lakes of Cumberland, there are the following remarks, viz.:

"With regard to domestic supplies, I maintain that first and foremost it is the duty of all corporations to seek for the purest and most plentiful source, and afterwards to devise the most economical means of supply to the millions. Even should higher rates be entailed than at present, I contend that on such an article as pure water, they cannot be felt as a burden by a population whose health is upheld by imbibing the pure, limpid stream.

"The water question is a human stomach question. No chemist has a laboratory equal to his own stomach, and the most elaborate analysis is not to be compared with the wonderfully balanced powers which sustain in healthy action a living organism.

"The supplies from rivers and streams are, therefore, not to be depended upon, from the many circumstances under which the waters are constantly receiving foul discharges.

"The great source of water supply is the ocean. Sea-water in itself, contains large quantities of soluble matter, the

principal being chloride of sodium or common salt, and other ingredients, such as salts of lime and magnesia, but in this state it cannot be adapted to domestic purposes. The atmosphere by evaporation is charged with moisture, which falls upon the earth as rain drops, entirely freed from all oceanic impurities, and being distilled by nature, the purest that can be obtained for all the various uses of mankind, whether for cooking, drinking, washing, or for the requirements of the arts and manufacturers. It follows indisputably, that all impurities rain water may afterwards be found to contain, are due to the soils and rocks with which it comes in contact.

"Filtration is a mechanical operation, and can only remove substances held in water by admixture. Unwholesome water cannot be made wholesome by filtration. Thick sewage water can be filtered, so as to appear pure and bright, but nevertheless, it still retains all its pernicious ingredients. To make polluted water appear pure and bright, subsiding reservoirs and filter beds are constructed, but after all, the subtle poisons the water contains, still remain, and are taken into the human system, spreading disease and death. That direful epidemic cholera, is disseminated by the drinking impure water, this fact has been established beyond a doubt."

I have given the foregoing extract at length, because of its being a concise statement of the medical, chemical, and philosophical opinions expressed in evidence before the Health of Towns Commission and in Maury's Physical Geography, to which I beg leave to refer.

The most important feature, above all others in a sanatory point of view, with reference to the future and requisite supply of water to London should, therefore, be the QUALITY OF THE WATER so supplied.*

* See Appendix (A).

I have had the opportunity (in the course of my professional travels), of making observations on subjects of an engineering character, and amongst others, that of water supply, in the United States, Central America, Australia, New Zealand, Mauritius, India, Egypt, Malta, Gibraltar, Belgium, Holland, Prussia, and in addition an examination of the Welsh and Cumberland Lake districts. Upon my return from the latter places, I drew up a statement setting forth the advantages of obtaining a supply of water for London from Wales, and I submitted it to certain influential parties with the view of obtaining the necessary funds for making a survey upon which I might base my calculations, and form an honest estimate as to cost; I then received a verbal reply, which was at my request subsequently reduced to writing, a copy of which is as follows, viz.,

LONDON,

February 6th, 1866.

DEAR SIR,

In accordance with your request, I beg to say that on the 25th September last you attended our Board, and entered into a long and very interesting statement of a project you had for supplying water to London from Wales, with a view of having this Company give their aid in procuring an Act of Parliament for a Company, to be called "The London and Provincial Welsh Water Supply Company."

The Directors, after expressing their great interest

in the project so clearly explained to them, felt that the comparatively small capital of this Company, did not warrant them in undertaking to act as Promoter, and thereby incur the expense that would attend the application to Parliament to carry out so grand an enterprise.

Yours faithfully,

(Signed)

Manàging Director.

To A. S. ORMSBY, Esq.

From this Letter, I think I may claim the credit of having been one of the first to start the question of supplying London with water from Wales and the Lake districts. Upon further consideration of this important subject, the question obviously suggested itself to me Where do Wales and Cumberland get their own superabundant supply from? and the reply was, of course, just as obvious, From the clouds. I therefore arrived at the conclusion that as the same source is open to all alike, it is only necessary to make proper arrangements in the construction of collecting grounds, in order to obtain a sufficient supply of water of greater purity, and in quantities more than enough to satisfy the immense and enormously increasing requirements of London, and all cities so circumstanced.

Mr. Hemans (M. Council Inst. C.E.) in his paper on the "Future water supply of London" (page 19), assumes "14 inches" as the total quantity of rainfall LOST by evaporation and absorption, and Mr. Bailey

Denton, (M. Inst. C.E.) in the letter addressed by him to Lord Derby, says (pages 8, 9.) :—

"Seeing that under no circumstances can we prevent the influx of refuse fluids into our rivers, and that our highest medical authorities concur in the conclusion that *sewage from infected patients* may communicate infection to those who drink river water, by which clarified sewage has been greatly diluted, ought we not rather to prize the advantages which we possess in having the rivers as drains to carry it off to the sea, than defy the sanatory law which forbids the use of the water of rivers for drinking purposes after they have become drains? Instead of straining after such irreconcileable objects as using river water to dilute sewage, in order that we may drink it, why should we not draw the line between the upper portions of our streams which can be maintained in purity, and the lower portions of the same into which the refuse of towns and populous places must in some shape or other enter, to be discharged to the sea? These questions are important ones, for they apply not only to this Metropolis, but to the country generally."

Various pamphlets have appeared on the subject of water supply, some with reference to that of the provincial towns, and some with regard to the Metropolis. I do not, however, concur in the projects put forward in them,—firstly, because I do not believe that a *perfectly pure* supply of water can be obtained in any of the ways that have been suggested; and secondly, because I do not consider it at all needful to do more than supplement the present supply by an additional quantity of an absolutely pure description.

After a careful study of twelve different schemes* that

* Appendix (C).

have been proposed for the supply of water, eight of which are for London only, I have come to the following conclusions, viz. :—

1st. That it is practically impossible to obtain a sufficiency of water absolutely pure and fit for drinking and cooking *from the earth.*

2ndly. That it is therefore necessary to separate the sources of supply, and the classes of water to be supplied.

3rdly. That by a more perfect conservation of the Thames, New River, &c., it is quite possible to obtain an ample supply of water for all purposes, except drinking and cooking.

4thly. That by collecting rain water *before it falls upon the Earth*, and using the proper means for its purification and storage, it can be distributed in an almost perfect state of purity for human consumption.

Permit me to refer to the *chemical* opinions in the appendix of Mr. Bailey Denton's letter to Lord Derby, from which it will be seen that the evidence there given fully bears me out, in at least three of the above conclusions.

With regard to the fourth point, I beg to remind you, that although the Liverpool or Rivington Waterworks have a collecting ground of 10,400 square acres, and a rainfall of 34 inches per annum, the loss by

evaporation and filtration is so considerable, as to have led the Corporation of Liverpool to entertain the idea of obtaining an additional supply from Wales, and I find the following in a report on the subject, addressed "to the Worshipful the Mayor and Corporation of Liverpool," viz.:—"Every promise made in favor of "the Rivington Pike Works has been falsified; the "water was to be pure—it is at times foul and peaty; "it was to be so abundant as to supersede local wells "and pumping—additional wells have been sunk, and "steam engine power largely added to. New reser- "voirs have also been formed, and compensation water "purchased at heavy costs, still leaving the volume "available much short of the promised supply," and in order to provide "the purest water to be found in "the world," where "the waters are not likely to "be polluted by manufactures," the Corporation of Liverpool is advised to take 20 million gallons of water daily from the River Dee, at "Llantisilio," because "the channel of the Dee down to Llangollen is com- "posed of compact rocks or drift gravel, clean and "smooth, preserving the water singularly pure"! It is, however, evident that the writer has never visited the locality, or he would have discovered that Bala, Llanderval, Llandrillo, Cynwid, Corwen, and several populous villages, situated between Bala Lake and Llantisilio, must discharge their sewage into the Dee within the limits he has mentioned, so that the good people of Liverpool will—at least if they adopt the views of the writer of the report from which these

extracts are taken—run the risk of having the new supply rendered unfit for use before reaching them, if indeed it should ever do so.

I believe that the owner (as well as the people of Bala), will offer the greatest opposition to any interference with that lovely lake, in which they reasonably take an interest and a pride in keeping in that state in which nature left it, and which imparts to it a charm that art only tends to destroy. Travellers of all nations have admired it as the most charming lake scenery in North Wales, and as a considerable traveller myself, I can testify to its being unsurpassed in beauty and attractiveness by any of the many lakes I have visited.

Suppose, however, that the legislature were to step in and say, "YOU MUST NOT TAKE WATER FROM A COUNTRY THAT MAY AT NO DISTANT PERIOD REQUIRE ALL IT POSSESSES," it is evident that Liverpool, and all other towns, would be compelled to construct efficient works for the purpose of saving the quantity of water now lost by absorption, and so secure a supply of water far more than equal to their requirements.

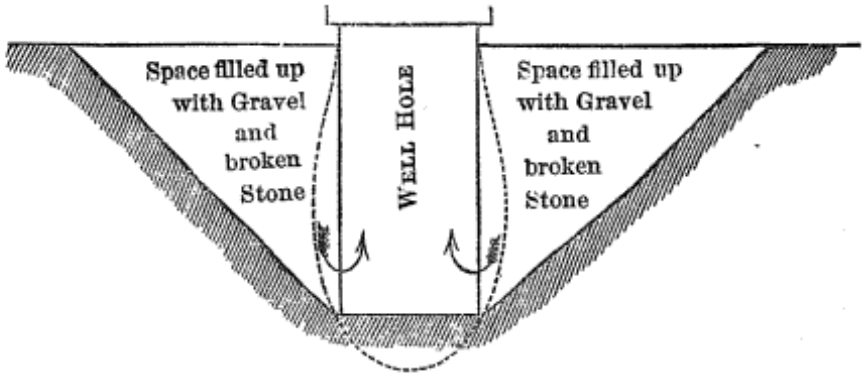
With this object in view, I would propose to construct at eight points around London, artificial collecting grounds, or surfaces covered over, with a light and ornamental iron-glass roof,* so designed that all the water falling upon it may immediately flow off into a receiving reservoir, and pass from thence into a settling, filtering, storage and distributing reservoir, with which the main supply pipes would be connected.

* See Sketch No. 4.

I would propose also to lay down a separate set of iron-zinc mains, and to connect with them, laterally, a separate set of iron-zinc pipes, to supply an iron-zinc cistern placed in the basement of each house.*

The space underneath the roof I propose to let off to market, fruit, and flower gardeners, at from £50 to £200 per acre per annum, and to form a winter garden or sanatorium when the demand for it might arise. The area required at each station to give a gallon per head per diem, would be, say 500 acres, assuming the average rain fall of twenty-four inches, but as the rain fall in some years is considerably greater than in others, while I would make provision to purchase land to the full extent, I would only cover in 100 or 200 acres per annum, so as not to press too hard at first on the pecuniary resources of the proposed Company.

Many towns are supplied with rain water exclusively, in South America, India, &c., and near Venice, the following sketch illustrates the manner of obtaining it,



A conical hole is cut out of the ground to a sufficient depth and then a cylinder of brick or stone is built as a well hole, appertures being left in the sides to allow

* See Sketch No. 1.

the rain water falling upon the surface of the cone to enter the well shaft, which it does in such a pure state as to make it an agreeable drinking water. At Buenos Ayres, I have the evidence of a gentleman who has resided there, to prove, that the water supplied to the inhabitants is rain water taken from the roofs of the houses and preserved in cisterns made of tiles, in the form shewn by the dotted lines in the preceeding sketch, and that it is always pure, well tasted, and cool. The subject will, however, be found more fully mentioned in the following works, viz. :—

1. Sir Woodbine Parish, Consul General, and for many Years resident at Buenos Ayres as English Minister.
2. Captain Thos. J. Page, United States Navy, " La Plata, the Argentine Confederation and Paraguay."
3. Doctor Martin de Moussy, " Description Géographique et Statistique de la Confédération Argentine."
4. Baron Du Gantly, " Descriptif, Géographique et Météorologique."

In Brussels, the water caught on the top of the houses, is conducted to a cistern in the area, and used for drinking and cooking, and generally rain water is used for that purpose instead of pump or river water, which is suitable for cleansing purposes.

In India the hill forts depend upon the rain for their water supply and, as is well known, vessels in passing through the tropics replenish their water tanks from the abundant rain fall prevailing in low latitudes.

The question, if I may so say, of the *abstract purity* of water, with reference to the subject of cholera, is of far greater importance than is generally supposed, at least in India. I was Executive Engineer at Umritsur, in the Punjab, during the cholera of 1860–61, when some 600 Europeans fell victims to "this pestilence that walketh in darkness," and it is my firm belief now, as it was then, that the true cause of that dreadful visitation at Umritsur, as well as at Lahore, was bad water; and I am convinced that when the same predisposing causes again arise, a similar mortality will follow. How can it be otherwise when it is remembered that *there is not a Cantonment in the Punjab supplied with PURE water!* The Government appointed a Commission to report upon the causes which might have led to this frightful mortality and loss of money, each European soldier being reckoned to cost £150, landed in the Punjab; but will you believe it, sir, they never even thought of making an analysis of the water supplied to the troops for drinking and cooking, and to this day the Cantonment. wells and the Cantonment privies are, sanatorily speaking, in communication with one another.

You can have no conception of the absolutely awful state of our eastern cities with regard to the water question; and, while you may, perhaps, say that this subject is beyond the range of the instructions of the present Royal Commission, I humbly submit that our own countrymen and Indian fellow subjects have a right to be heard upon a subject of such great importance to

them, and indirectly so to us, who must, at least, *pay* for getting others to replace them, when sickness or death has decimated their ranks below the proper strength of the Army of India.

In the East, epidemic diseases generally commence in the native quarter during the hot weather, when the bazaars are crammed with unwholesome and unripe fruits, and the Hindoo performs his ablutions in a stagnant tank of liquid abominations, from which also may be seen others drawing this so-called water for drinking or cooking purposes! As a matter of course, cholera follows, and, from the constant communication between the native city and the European Cantonments, the disease spreads from the one to the other with startling rapidity, until

"Thousands lie lowly."

The calamity thus occasioned having originated in the bad water of the city, and flourished by the aid of the bad water of the Cantonments.

Calcutta, for instance, is supplied with water from a large tank communicating with the Hooghly, and the vulture, disturbed in his repast while

"Gorging o'er carcase and limb"

of the floating body of some departed Hindoo, may be seen to fly off with a portion of it in his talons, to enjoy it without disturbance on the parapet of Government House or upon the sloping bank of the reservoir from which the European population is supplied.

I stood by *the* well at Cawnpore, and I thought how dreadful it was to realise the *fact* that all the other wells in the surrounding Cantonment *are* in communication with the common grave of our murdered fellow countrymen and women "whose bones lie scattered in that pit," as the inscription upon their monument declares.

In order to show that bad water produces cholera, I beg to submit the following fact, as it appeared in a very recent impression of one of the daily journals:—

THE POISONOUS WATERS OF THE EAST END.—This morning an inquest was resumed at Poplar on the body of John Davies, aged 20 years. The deceased was mate of the barge Medway, which on Thursday, the 6th, entered Bow Creek. He drank some water on shore from a pump, notwithstanding a man told him the water would poison him. Shortly afterwards he was seized with violent cramps, and on the next day he died from cholera, after great suffering. Some of the water from the pump was sent by order of the Coroner to Dr. Letheby for analysation. The following is the professor's report:—"The water contains 61·5 grains of saline matter per imperial gallon, besides 2·8 grains of organic matter, and much ammonia. The saline matter as well as the organic are chiefly derived from surface drainage, and the presence of ammonia indicates percolation from a sewer or cesspool. The water is quite unfit for drinking purposes, and from the nature of the pollution is very likely to have occasioned choleraic disease, especially if drunk without previous boiling." The Jury returned a verdict, "That the deceased died from choleraic disease, occasioned by drinking polluted water drawn from a certain pump," and they recommended that the attention of the proper authorities should be drawn to the danger of leaving such a dangerous source of disease accessible to the public.

I might multiply instances by reference to other scenes that I have witnessed, but I forbear to trespass upon your valuable time further than to say that I shall be content if what I have said may induce the Right Honorable the Secretary of State for India to appoint a *competent* Commission to enquire into the QUALITY of the water supplied to Her Majesty's military and civil subjects in India, with a view to the adoption of such remedial measures as may be suggested in their report.

Nothing would be easier than to construct collecting grounds, according to my design, at all the military cantonments of India; as the iron and glass could be sent out from England ready to be put together by the troops themselves, a very few acres being enough to collect a sufficient supply for the limited number of Europeans located at each station.

Having thus far brought under your notice the point of first importance connected with the water supply of towns, viz:—

1st. The collection, purification, and storage of water.

I have still further to solicit your attention while I briefly consider

2nd. The impurity to which water is exposed between the distributing reservoirs and the house cistern; and

3rd. The impurity to which it is subject in that cistern.

With the object of showing the evil effects of the present mode of distributing water through the streets, by all the Metropolitan and Provincial Water Companies, I beg leave to submit an extract from the evidence taken before the Health of Towns Commission, where it was stated by Mr. Mylne, Engineer to the New River Water Supply Company, that "very "serious inconvenience is sustained by the gas getting "into the water-pipes . . . . it is a very frequent "occurrence when there are competing Companies; I "believe the joints of the gas pipes are very badly "made. The whole of the earth of some of the streets "in which the pipes are laid is so charged with gases, "that within the boxes of the fire plugs, if they are "covered over in the evening, the vapour collected "in the twelve hours will ignite in the morning. Our "services have been so frequently found charged, that "*complaints are continually being made of gas being* "*carried by them into the houses together with the* "*water*. Instances have occurred where LIGHTS "BEING APPLIED TO OUR WATER PIPES, "THE GAS HAS IGNITED AS IF THE PIPE "WERE A GAS PIPE." And the Commission in its second Report, refers to this latter statement by saying that "*this effect has been witnessed by members* "*of this Commission*."

Evidence such as this appears to be conclusive in proving that, in order to deliver the water contained in the distributing reservoir in a PURE state to each con-

sumer, it is absolutely necessary to prevent the distributing pipes coming in contact with either the gas pipe or the hydro-sulphuretted substratum of the streets, from the time of the water leaving the reservoir to that of its reaching the point of consumption.

Various propositions have been put forward for the construction of subways, and, in fact, some such have been constructed where the gas, water, and telegraph pipes are laid side by side, so as to be easily come at for repairs. This plan is, however, open to two objections, viz. :—

1st. That the water pipes are thereby brought into contact with the gas pipes, and—

2nd. That the difficulty of ventilating those subways is so great that it is dangerous—and, in fact, men have refused—to enter, in order to make the necessary repairs.

Gas, then, must be regarded as a decided enemy to drinking water, and it is therefore absolutely essential that there should be a TOTAL SEPARATION between them. As, however, the interests are too great and the opposition to such a change too powerful for even common sense and the Metropolitan Board of Works to overcome, I would propose that this separation, and the consequent changes in the substratum of the streets, should be effected under the direct sanction of the Legislature and at the expense of the Gas and Water Companies.

Attached hereto are three sketches, showing how

this separation may be accomplished. Fig. 1 represents two arched subways, one for gas exclusively, and the other for water of both kinds and for the telegraph wires. Fig. 2 shows a similar subway for the latter, but without any for gas, advantage being taken of the existing side walls to spring the arch of the subway from. Fig. 3 shows a subway similar to that in fig. 2, but constructed quite independent of any existing walls.

I would not permit either Gas or Water Companies to open the streets in order, even, to get at their own pipes, but I would suggest the employment of a special officer and a staff of men for this purpose, the expense to be defrayed by the various Companies, until some satisfactory way of ventilating the gas subway may be discovered, which shall have the effect of removing the apprehensions of the workmen, as well as the necessity of interfering with the surface of the streets.

The improvements that I have suggested relative to the pipes used in the distribution of water, is common to all the schemes that have been put forward for the supply of London and the provincial towns, and it is not even necessary to wait for the completion of any one of them, in order to reap the advantages of the SEPARATION BETWEEN THE PIPES proposed by me.

Is it not absurd therefore, I humbly ask, to have health officers, inspectors, &c., employed to attend to the sanitory condition of London, if the very water that we drink is to remain in such a poisonous state as

that described in the evidence of Mr. Mylne? And I would further venture to enquire, what is the use of appointing Royal Commissioners if the recommendations made in their report are not acted on? Actually twenty years has all but expired since the Royal Commission on the Health of Towns submitted their report, and yet the evils mentioned therein are still in existence, and hardly a month passes without some dreadful explosion taking place either in the streets of London or the country towns.

Anomalous though it may appear to be, it is not the less true that, in the streets of the City, that claims to be the most remarkable for its science and progress in 1867, it is only necessary to apply a lighted match to the water pipes(!) in order to cause explosion and conflagration, and it is quite possible that many fires whose origin people have failed to discover, may have arisen in this manner.

With reference to the third and last point, viz.: the impurity to which water is subject in house cisterns, I beg to submit the following extract from a very recent daily paper.

"Lead Poisoned Water.—Dr Lankester, the Coroner, and medical officer of health for St. James's, Westminster, has reported to the vestry of that parish that he has analysed the water found in the butts and cisterns in various parts of the parish, and found a large quantity of the water to be rendered unfit for drinking purposes by exposure to the atmosphere and want of cleansing of the receptacles in which it is contained. Certain of the waters also gave indications of containing lead, and he warns persons against drinking such waters, stating, 'I

have no doubt but that this is one of the most common causes of obscure and unexplained illnesses in families.'"

I would remedy this complaint by the adoption of water cisterns made of a non-decomposing material, and removed from contact with any substance calculated to injure the water contained in them.

Since the publication of the first edition of this pamphlet, I find that—notwithstanding what I have said on the subject—there are some who doubt the fitness of rain water for drinking and cooking purposes. With the object of removing their apprehensions I have prepared the following Table from the information given in the "Army Medical Report for 1864." In columns 2 and 6 will be seen the rate of mortality and the source from which the water supply is derived; and I especially point out that Gibraltar, in the west, where the death rate is lowest, is supplied exclusively with rain water, and that Mauritius in the east exhibits a much lower rate than India, which cannot well be accounted for in any other way than that the former is supplied directly from rainfall, while the latter has only the cantonment walls to depend upon, or the rivers, which are equally polluted. In the West Indies rain water is also used, and I am informed by a late planter (Mr. Cauzar) that from time immemorial there has been no other description in British Guiana; that during his residence of thirty years there, he, and the planters of Demerara generally depended on that source alone for water, and that to the present day Georgetown and the troops there are exclusively supplied in that way.

TABLE

Showing the Loss of Life from the use of Bad Water in the Army, the consequent Loss of Money, and the estimated saving of Life and Money by the use of Pure Water.

	PRESENT.								PROPOSED.					
Name of Station.	Death Rate.	Mean Strength.	Invalided 1864.	Prevailing Disease.	Water Supply.	Total Deaths in 1864.	Estimated Cost of a Soldier there.	Value of Men lost yearly.	Reduced Death Rate.	Amount of Reduction per 1000.	Saving of Life yearly.	Amount of Money saved per annum, thus—	Equivalent Capital at 5 per cent.	Sum saved in 10 years.
							£	£				£	£	£
Gibraltar. . .	5·68	5,281	...	...	Rain	30	80	2,400	3·68	2	10	800	16,000	160,000
Malta. . . .	6·53	5,654	...	...	Rain	37	80	2,900	4·03	2·5	14	1,120	22,400	224,000
India	21·93	65,102	1,105	...	Well	1,428	150	214,200	16·93	5	325	48,750	975,000	9,750,000
Canada . . .	11·62	9,724	...	...	River	113	100	11,300	9·12	2·5	24	2,400	48,000	480,000
United Kingdom	9·99	73,252	2,325	...	Various	732	50	36,300	7·99	2	146	7,300	36,500	365,500
Cape Good Hope	8·71	4,123	110	...	River	36	120	4,320	6·71	2	16	1,920	38,400	384,000
Mauritius . .	11·74	1,789	53	...	{Rain & Well}	21	120	2,520	9·74	2	4	480	9,600	96,000
Ceylon . . .	34·59	867	43	...	Well	30	120	2,400	14·59	20	20	2,400	48,000	480,000
Australia . .	13·60	367	195	...	Well	5	150	750	10·60	3	3	450	9,000	90,000
St. Helena . .	7·53	531	...	...	Well	4	120	480	5·53	2	2	240	4,800	48,000
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

NOTE.—The proposed "Reduced Death Rate," given above, which is assumed to be the result of the use of pure water, is founded upon the evidence of medical and other authorities from their observation of ascertained facts. See also evidence of Mr. Edwin Chadwick, C.B.

Another very conclusive argument occurs to me, which is derived from the sacred volume, in favour of rain water for human consumption, for, under the direct guidance of "Jehovah," the royal poet of Israel, in describing a state of the most perfect happiness, remarks that "rain also filleth the pools," or reservoirs, as the word also implies.—(See *Report on the Water-works of Jerusalem*, by Sir JOHN MACNEILL, C.E., LL.D., F.R.S.)

If these facts are not sufficient to prove that rain water is the very *best* and *purest* description of water, I must confess my inability to bring forward anything more conclusive.

But it is also hinted that the water supply in India is good enough, and that it would be better to "let well alone," in reply to such observations I submit the following letter:—

LONDON,

April 11*th*, 1867.

Dear Sir,

In compliance with your wish that I should state the result of my observations, during a ten years' residence in India, with regard to the water supply of the various towns and cantonments I have visited, I beg to inform you that my personal experiences only extend to the provinces of Scinde and the Punjab. In all the cities and towns of these provinces which are

not directly situated on the banks of the principal rivers, **I have found that the quality of the water is far below that standard of purity which is now considered as requisite for the maintenance of health.* The supply in these cases is drawn from wells and is more or less impregnated with deleterious salts, absorbed from the strata through which it percolates.

The waters of the Indus, and its affluents, are heavily charged with silt, and, unless allowed to settle for some considerable time after being drawn from the river, cannot be considered wholesome.† An improved water supply for cooking and drinking purposes is acknowledged to be a great desideratum, and, in my opinion, any scheme that would achieve it at a reasonable cost would command the patronage of the authorities in India, who are quite alive to the importance of the

* Italics are mine.—A. O.

† And, I should say, not even *then*, seeing that it contains, besides its own, the concentrated filth of the five rivers of the Punjab; the Hindoo, who has sought immortality in its waters, and the departed alligator, whose vile carcase, under the burning rays of an eastern sun, may be seen in a state of rapid decomposition, upon its banks. The Municipality of Calcutta are now constructing water-works at an outlay of half-a-million, in order to get water from the Ganges, which it is proposed to filter, apparently forgetting that even this (as Dr. Letheby says) will not deprive it of its poisonous qualities, so that it will still remain the essence of the accumulated sewage of the cities and towns situated upon the banks of the Holy River, combined with the compound essence of Hindoos and alligators, in a state of dissolution.

subject, especially as affecting the health of the troops, whether European or native.

I am, dear Sir,

Yours faithfully,

JOHN BRUNTON, M.INST.C.E.,
F.G.S., F.R.G.S.,
Chief Engineer Scinde Railway.

To A. Ormsby, Esq.

While this letter only relates to Scinde and the Punjab, I can, from my own observation, state that the same objections apply to the water in Bengal, and I can adduce the statements of others to prove that the water supply throughout India, both in quality and quantity, is quite sufficient to account for the heavy death rate given in the Table.

There cannot be a more terrible instance of the fatal effects of bad water than the example afforded by Ceylon *at present*, for the rate of mortality there is 34·59, and the constantly sick 867 per thousand, which is largely in excess of that at any other station of the British army, while the reason of this appalling death and invalid rate is to be found in the following extract from the report of Staff Assistant-Surgeon Martin, M.D., at page 283 of the Parliamentary paper already referred to, wherein he says—

"The almost direct source whence most of the wells are supplied is the lake, the water simply percolating through the

intermediate soil, which is of a light sandy nature. This is shewn by the water in the wells and in the lake being precisely of the same level. This lake is nothing more or less than an enormous cesspool; the receptacle of every possible kind of filthy matter that can be conceived. On almost every side are the native pettahs and villages, with their swarming populations existing totally regardless, and, in fact, with habits diametrically opposed to all hygienic principles. Its banks are resorted to by thousands of natives, who, after bathing, commit the most disgusting nuisances close to the water's edge. Horses and bullocks are daily taken to be bathed in it, and all the dhobeys make use of it for washing their clothes. Moreover, in close proximity to four of these wells are the common latrines made use of by all the native troops and their families. These latrines, or rears, are formed by wooden platforms erected just at the edge of the lake, the excreta simply dropping on its banks. [During the months of April and May the lake is frequently almost entirely dried up, leaving its bed to be acted upon by the sun, which is at this time just passing over the island. The consequence of which is that the most horrible stenches arise from the disengagement of the various noxious gases generated, filling the surrounding atmosphere with their effluvia] or when this mode cannot be adopted pits of about 10 to 12 feet deep are dug in the ground and floored over, in which the feculent matter collects, and is allowed to accumulate until these pits become inconveniently full, when, on application being made, they are emptied. This occurs on an average between every two and three years.

" This state of things having gone on for many years, with immense numbers daily making use of these rears, as a natural result, the ground in the vicinities for many yards must be completely saturated with the fluid, portions of the excrement in a decomposed condition, and especially when the sandy soil

is borne in mind, and when the sides and bottoms of these are unlined.

"The amount of organic matter present, in the best of these wells, is by far more than can be admissible in even indifferent drinking water. Means ought at once to be taken to remedy this great source of evil, for the consumption cannot go on without causing the most baneful effects, and producing very serious detriment to the health of the troops. It is advisable that the whole of these wells be abandoned, and fresh ones made."

It is with great reluctance that I have dragged this very unattractive extract from the obscurity of a "blue book," and I have only done so with the object of arousing sympathy for the gallant and devoted sufferers, and that the strongest expression of opinion may be given against the continuance of such a disgraceful state of affairs in our colonies.

I do not agree with the writer in suggesting that the present wells should be filled up and others opened, because the source of the supply is so utterly vile and polluted that—"who can bring a clean thing out of an unclean? not one;" and I therefore conclude that if there is one place more than another, where my plan of obtaining *pure* water for the supply of populations is applicable (and urgent), it is at the Fort of Colombo in Ceylon. The rainfall is so considerable that it would only be necessary to cover in a very few acres indeed so as to supply two gallons per head per diem to a population of 3,000 persons, and, in addition to that, to fill the stowage reservoirs, the making of which would be the principal source of expense.

In the case of Malta, where the death rate is only 6·53 per thousand, the report says:—

"The surface rocks, on which the chief cities and villages are built, are either a soft porous limestone or, as in the case of Valetta and its neighbouring cities, a soft freestone, which readily imbibes water to the extent of one-third of its bulk Through the rock the drains and sewers are cut, in it are contained the rain-water reservoirs which underlie the foundations of the houses. The tanks are generally well cemented, but the former are mere deep and narrow trenches in which the sewage accumulates from defective structure, want of rainfall in summer, and insufficient water supply for flushing. The proximity of the one to the other is dangerous in the extreme, and *leakages from the surface and from the drains into the reservoirs are by no means uncommon.*"

The death rate in Australia and Canada is very high, and, although, in the latter case, I have not sufficient information to discover the cause, I can well imagine that the mortality at the former place is the result of the barracks being very close to Batman's Swamp, from which there is no doubt that the Cantonment wells are supplied.

The foregoing extracts are sufficient to prove how great the *necessity* is that there should be a total reformation of the existing system of water supply to our troops on foreign stations; a further perusal of the table will show the sum that may reasonably be devoted to that object. Column 12 shows the number of lives proposed to be saved per annum, column 13 the value of those lives, column 14 the equivalent capital at 5 per

cent. for one year, and column 15 the amount saved in ten years, and it is this sum, or a portion of it, that I propose each colony shall expend, without delay, in order that the water supply may be so improved as to reduce the death rate as low, if not lower, than in column 10.

There are three ways in which I propose to collect rain water, viz.:—Firstly, in the manner described in sketches 4 and 5, which I have already referred to at pages 11 and 12; Secondly, by that explained in sketch No. 6; and Thirdly, according to that described in sketch No. 7; so that it will quite depend upon the pecuniary resources at command and the wants of the locality, as to which plan may be most advantageously adopted. When the proposed site is comparatively worthless for the purposes of cultivation, sketch 6 will, most probably, be the best and the cheapest; but when land is very valuable, and the want of a covered space for fruit, flowers, and vegetables may have become questions of importance, then it may be found most advisable to adopt that shown in sketches 4 or 7.

The second form of non-absorbing collecting surface proposed by me is of the cheapest and simplest description, neither iron or glass being used in its construction, the manner of which is as follows:—After fixing upon the site of the intended collecting surface, I construct the reservoirs of stone, brick, concrete, and cement, &c., &c., according to the description of material most available; I then lay down a longitudinal pipe, running through and under the centre of each collecting sur-

face, and terminating in the receiving reservoir. The arrangement of the collecting surfaces may be illustrated by a chess board, where each square would represent a collecting basin, the centre of which would be about two feet lower than the sides. The lines between those squares would represent walls twelve inches thick, built about two feet high,* and filled in behind with earth to such a height as to admit of a bed of concrete, one foot thick, being laid upon it, so that its upper surface may be in a true right line between the inner edge of the wall and the centre of the basin, as shown in sketch No. 6. Upon this bed of concrete, I propose to lay Bangor, or other equally good and durable slates, set in cement, and when this is done, the water works are completed, so that the entire rainfall will immediately flow off into the central pipe or chamber which communicates with the receiving reservoir, into which the rainfall will thus be conducted almost as soon as it touches the non-absorbing surface of the collecting ground.

I think it will be admitted that this plan is as simple and inexpensive as it is possible to be, in order to obtain the desired result, and that it is well adapted for provincial towns, large country residences, and above all, for the supply of our troops at foreign stations. The size—and consequent expense—will depend upon the *numbers* to be supplied, the *quantity* per head per diem,

* These walls may be dispensed with where the filling is sound and fit to support the concrete.

and the amount of *rainfall*, all of which must be given before even an approximate estimate can be arrived at.

I would suggest the construction of waterworks on this plan *without delay* at Ceylon, and various places in India, for there the rainfall is 76½ inches, or say, in round numbers, that there is an available fall of 6 feet. As each cubic foot contains 6¼ gallons of water, the rainfall upon each square foot of surface is say 37 gallons, and this multiplied by 43,560, which is the number of square feet in a square acre, gives 1,611,720 gallons as the produce of only one square acre.

Then, if the garrison, including their families, be say 3,000, and that each of them were to consume two gallons per head per diem, the number of gallons that would be required per annum would be 2,190,000, while the quantity supplied by only two square acres of "non-absorbing collecting surface" would be 3,223,440 gallons, or 1,033,440 gallons more than the demand; so that, in fact, *an acre and a-half of collecting surface and a reservoir is all that is required to meet the pressing demands of our troops in Ceylon*; and I believe that, with proper arrangements, these waterworks might be ready to receive next year's rainfall. Malta, Australia, Canada, New Zealand, and the West Indies, would come next, and from my previous knowledge of those places, I could act with the greater facility. The same arguments apply to nearly the whole of India, and, with the aid of the Stanley Engineers, and certain instructions which my experience in India would enable me to suggest, I have no doubt that I could have all the

works going on at the same time, and every station of the army abroad supplied with water within three years, the effect of which would soon be seen by the diminished mortality of the troops, and the consequent reduction of the cost of maintaining the garrison.

I beg leave respectfully to call the attention of the authorities to this most important question, and, at the same time, to say that, with the necessary authority, I could commence the works *simultaneously* at all the foreign stations of the British army.

The great question that I advocate is analytical PURITY, and this can only be arrived at by taking the supply from the source that I have suggested; and it is to be remembered that where there is a heavy rainfall and a small population, the plan that I propose may be most economically applied. But, with reference to the supply of London, let us suppose that after adopting some of the other plans that have been put forward, the citizens should awake some fine morning to find that a few of the principal reservoirs have burst in the same manner that other reservoirs have recently done, how would the inhabitants like then to hear that—as is the case with Dublin *now*—"it "may perhaps be eighteen months before the damage "can be repaired, or that the water supply can be "resumed!" In any case, the *maintenance* of works, spread over so large an area, must be enormously expensive compared with either of those designed by me, which, in addition to the other advantages I have mentioned, avoids the manifest injustice of (in the words of the Proverb) "robbing Peter to pay Paul."

The water supply—obtainable in the way I propose—may be made available in twelve to fifteen months from the date of commencement, and none of the other Water Companies will be interfered with, while all the other plans that have been put forward may require from six to ten years before a drop of water can come into London, and may seriously interfere with the New River and the other existing Water Companies.

In all other schemes the engineering difficulties—the tunnels, bridges, aqueducts, retaining walls, reservoirs, collecting grounds, catchwater drains, weirs, overfalls, sluice gates, pumps, syphons and steam engines—render any estimate purely imaginary, and are absolutely enough to frighten the financial world out of its wits; while the useful, and though ornamental, still unpretending roof that I propose, has in it nothing to alarm the capitalist, and possesses attractions to make it extremely popular as the WATER, VEGETABLE, FRUIT, and FLOWER garden of the NATION.

I have the honor to be,
Sir,
Your most obedient Servant,

A. ORMSBY,
Civil Engineer.

London,
19, Parliament-street, S.W.,
May, 1867.

P.S.—The collecting grounds that I propose to form, are intended to be placed, as much as possible, out of the influence of any atmosphere that may be charged with smoke or other artificial impurities.—A. O.

APPENDIX (A).

[NOTE.—The italics are by me.—A.O.]

(From the *Times* of September 5th, 1866.)

Just at this moment London is afflicted with pestilence and India with famine for want of a good water supply. It seems almost certain, according to our present knowledge of the subject, that epidemic diseases depend for communication as much upon water as upon air, and it is quite certain that if the soil of India were irrigated as it might be such a famine as is now desolating Orissa would be a thing unknown. These facts may well impress us with the value of water in sanitary as well as social economy, and with the paramount importance of the question which for some weeks past has been discussed by correspondents in our columns. The difference, however, between India and England is this—India simply wants water; *London wants* PURE *water. Of water itself we have enough. The service is stinted in some quarters, but upon the whole the supply is not ill adjusted to the demands of even our immense population.* THE DEFECT IS IN THE PURITY OF THE ELEMENT. *Do what we will—and we have really done much—we cannot draw from the*

resources of the metropolitan district a supply of water sufficiently pure for the purposes of health. The water is a little better or a little worse according to the precautions or advantages of particular Companies, but it is nowhere so good as might be wished. The explanation of the difficulty is simple enough. The metropolitan district is too thickly peopled to allow of a pure river. The Thames and its tributaries are polluted before we can reach them, and although we escape much of the mischief by ascending the stream, we never get the element in its native purity. The result, therefore, of the late discussions has been a proposal to fetch our supplies from a distance, and to transport to London by magnificent aqueducts the water of the Cumberland lakes or the Welsh hills. As mere engineering problems, of course such works are perfectly practicable. With modern engineers all questions are questions of expense alone, and if these designs were finally approved there can be no doubt that our conduits and fountains might be fed from Windermere or Ullswater as easily as Glasgow is supplied from Loch Katrine. But these schemes, we must needs say, require very careful consideration and suggest not a few doubts.

The chief objection to the proposed undertakings was clearly stated by one of our correspondents a few weeks ago. It is this:—That for nine-tenths of our wants all this elaborate and costly mechanism of supply is totally needless. *We want pure water for drinking and for culinary purposes*, but for all the other manifold uses which enter into the aggregate of consumption

the water supplied by the present Companies is as good as need be. *It would be a splendid folly, or rather a shameful waste, to convey the water of Windermere from Cumberland to Middlesex, in order that it mght be used to flush our sewers, cleanse our streets, or extinguish our fires.* Thames water will, at any rate, do well enough for that, and we have it already at our command. IF A PURER ARTICLE IS NEEDED FOR DRINKING, WHY SHOULD IT NOT BE SUPPLIED SEPARATELY? In point of fact, it might be doubted whether any sources of supply, however prolific, would long suffice to satisfy the wants of London on a system of universal purity. Then, too, there are the claims of others to be considered. *Might not each district put forward a reasonable title to its own watershed*, and are there not, for that matter, many large towns between us and the northern lakes which might ask for a priority of service? There is something, beyond question, in this argument, and it may be added that, *if our demands for pure water were limited to those purposes for which purity is needed, we could probably find a sufficient supply in our own neighbourhood without going to the great reservoirs of Cumberland.*

The reply, however, to all this will arise spontaneously in every Londoner's mind. *It is perfectly true that drinkable water is wanted only in very small quantities, and that if we had a double service, one for pure and the other for ordinary water, the former might be supplied without resort to any prodigies either of engineering or finance.* But what would a double

service mean? It would mean a duplicate mechanism of reservoirs, mains, pipes, and taps in every street and for every house, and this in a city where the existing machinery can only be managed with infinite difficulty. What with drains, sewers, gas pipes, and water-pipes, underground London is over-crowded already, and *the daily necessity of repairs in some place or other constitutes a daily nuisance, and a formidable impediment to traffic.* To have two qualities of water would be like having two qualities of gas with a separate service for each. We do not say the difficulty would be insurmountable,—perhaps, of the two, it be less than the difficulty attending the designs proposed,—but nobody acquainted with London life would deny that it must be very serious indeed.

It is quite certain that the consumption of water in London may be divided into two branches, and that *for one of these we need no better water and no better machinery than we get at present.* But it is also equally certain that for the other we do want a supply of superior quality, though in so comparatively small a volume that it could be easily obtained if we did but see how to distribute it. Modern science teaches us that A RIVER CAN NEVER BE ABSOLUTELY PURE. It is, in fact, a natural drain, and though it need not be artificially polluted it must partake of pollution of some kind. It is formed by the descent of waters from higher ground which unite in a natural channel, but as it flows it must needs drain the country, if it does not drain a town. To get water pure we should take it

before it reaches the river and forms a running stream. The great lakes of the north are natural reservoirs, but it is easy to construct such reservoirs on a smaller scale wherever the supply may be forthcoming. The Surrey hills would probably answer all our purposes.

It is remarkable that our inquiries into this important subject should have so recent a date. In this respect England differs widely from India. For ages past the necessity of reservoirs in India has been recognised, and it is said, indeed, that *the water supply of that country was far better administered centuries ago than it is at present.* But in England we are only just beginning to examine the question, and can scarcely be said to have advanced beyond its rudiments. Our principal river, the Thames, had fallen into such a condition the other day that it was subjected to a regular Commission of Inquiry, and we may glean no small advantage from the report, but we are still in complete uncertainty about the principles of the real problem before us. We do not know how to maintain our rivers and at the same time to serve our towns. We seem to want the very water which form these rivers, and yet we also want the rivers themselves. We do not like to hear of a new Company settling down upon the sources of a noble stream, and proposing to pump it dry. The North Country people do not like to hear us talk of draining their beautiful lakes for London uses. In short, we do not yet see our way clearly in any direction. We feel that it must be wrong to turn the water of our streams into such poison as to kill the fish. We could not

endure to see the Thames apparently dying away like some famous river of antiquity now only traceable in a small brook. On the other hand, WE HAVE BEEN CONVINCED BY MOST TERRIBLE LESSONS THAT PURE WATER FOR DRINKING IS ALWAYS INDISPENSABLE TO HEALTH—often to life. *It seems, too, that we must obtain this in its original or native purity;* for when pollution has once been effected we cannot undo it. However, there is no need to despair of success in the task before us. *The drainage of the Metropolis is now a proof that neither money nor pains are spared in the promotion of the public health.* It should be remembered, too, that much, if not all our difficulty, arises from that very aggregation of industry which yields us our wealth, and that we may fairly spare something from our riches to mitigate an incidental evil. London air and London water are affected by the incidents of London's greatness, and out of London's greatness may well be devised the means of purifying these elements of life.

APPENDIX (B).

(From the *Times*, September, 1866.)

"Dr. Vacher has addressed a letter to the *Temps* on the subject of the *communiqué* received by that journal. He states that it is not the fact that his request to be permitted to analyze the water in the reservoirs of Paris was made only the day previous to the publication of his letter in the *Temps*. His application was addressed to the city engineer at least ten days previous, and, moreover, he did not express any opinion hostile to the Administration. On the contrary, he asked in respectful terms for what is the right of every taxpayer. He resolved to write to the *Temps* as a last resource, well convinced of the diarrhœa at present observed in Paris. This is the opinion entertained by all competent physicians, and especially by M. Bouchut, Professor at the College of Physicians, who, in a remarkable report addressed to the College on a microscopic examination of the Paris water, presented on the 17th of June, 1861, stated that in the neighbourhood of Sèvres, where he had long practised as a physician, diarrhœa frequently prevailed so as to become epidemic. Many physicians recommended their patients to substitute the water of the artesian well for the Seine water, and their digestive organs were immediately cured. Dr. Vacher adds that he could not count on a reply, in consequence of the deplorable habit certain officials have adopted of not replying

except to somebody bearing a decoration or holding a Government appointment. There is one allegation which he feels bound in honour to contradict. The *communiqué*, repeating the reports circulated in Paris in 1832 that the fountains were poisoned, accuses him of attributing the few cases of cholera lately reported to the water of Paris. He states that the organic matter found in large quantities in the Paris water is the cause that he went to London about a month since to make inquiries on the same subject, and that he was forthwith supplied with all the information he required without a *communiqué*. In conclusion, he renews his request to the engineer of the waterworks to give an analysis of the Paris water similar to that published monthly by Professor Hoffmann in London of the water supplied by public Companies."—*Times*, 5th Sept., 1866.

TABLE

Showing the number of Gallons obtainable from One Acre of Collecting Surface.

Rainfall.		Cubic feet of water per acre.		Gallons of water per acre.
$\frac{1}{10}$ — 0.1	equal to	363	or	2.262
$\frac{2}{10}$ — 0.2	,,	726	,,	4.524
$\frac{3}{10}$ — 0.3	,,	1.089	,,	6.787
$\frac{4}{10}$ — 0.4	,,	1.452	,,	9.049
$\frac{5}{10}$ — 0.5	,,	1.815	,,	11.312
$\frac{6}{10}$ — 0.6	,,	2.178	,,	13.574
$\frac{7}{10}$ — 0.7	,,	2.541	,,	15.837
$\frac{8}{10}$ — 0.8	,,	2.904	,,	18.099
$\frac{9}{10}$ — 0.9	,,	3.267	,,	20.362
1 — 1.0	,,	3.630	,,	22.624

Rain falls 150 days in each year. Flood rains occur 24 days in each year.

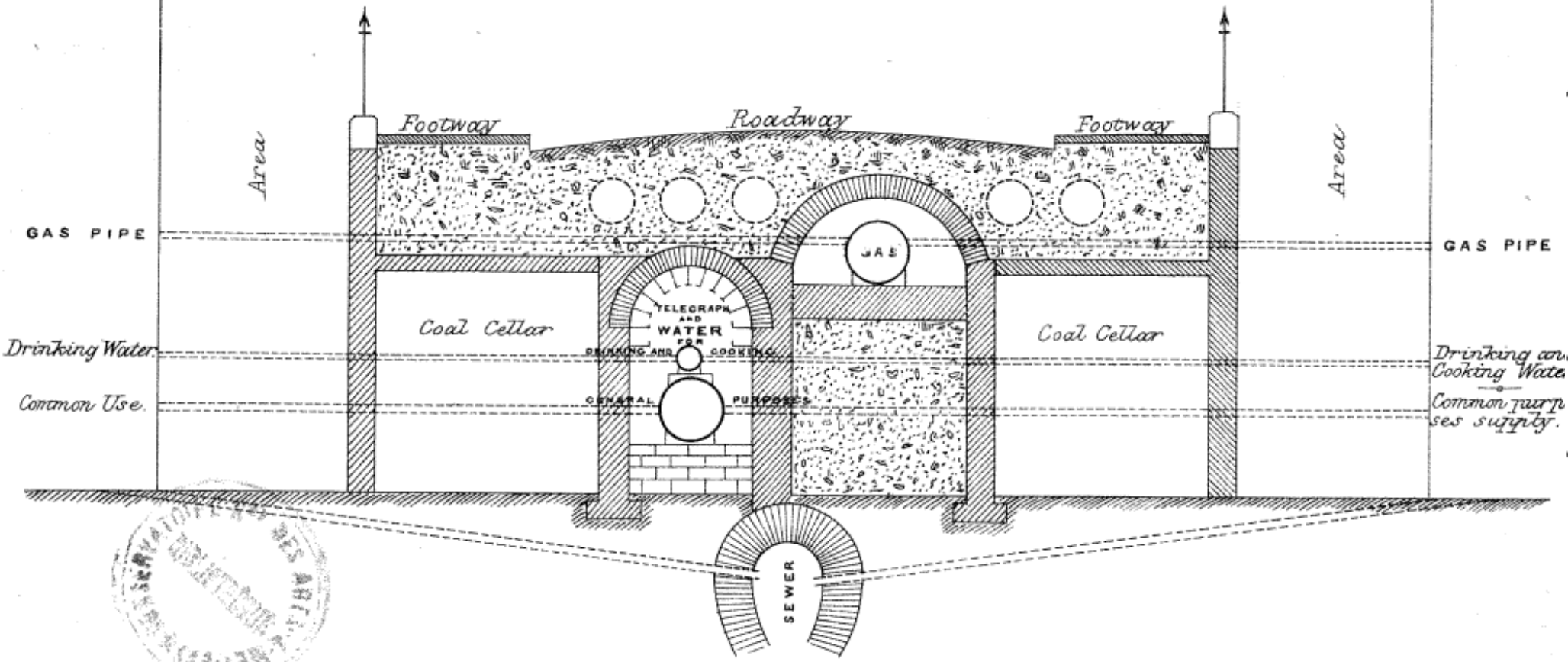
APPENDIX C.

TABLE OF PROPOSED SCHEMES FOR WATER SUPPLY.

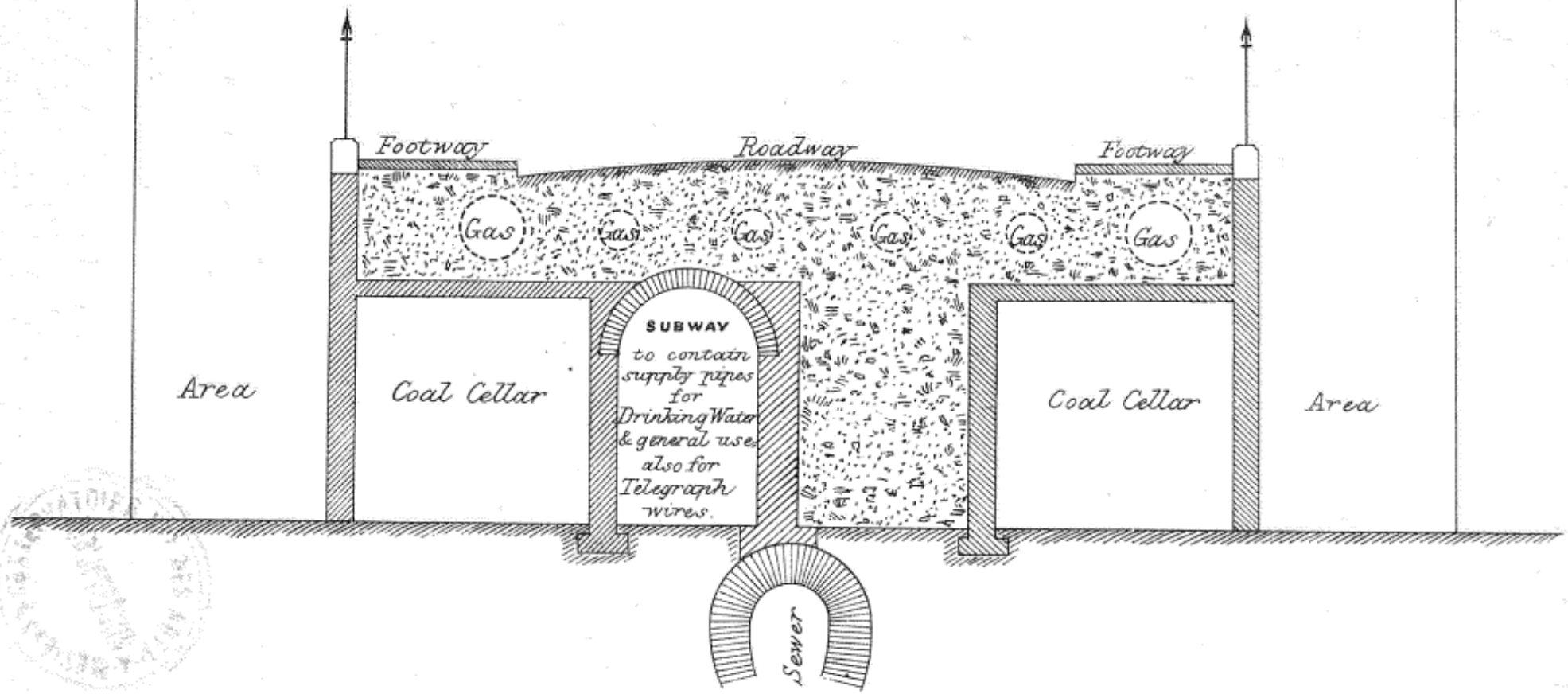
No.	Sources of Supply.	Engineers.	Date.	Assumed Estimate.	Supply in Gallons.	Observations.
	METROPOLITAN.			£		
1	From the deep springs of the chalk	S. C Homersham.	———, 1850	350,000	8 millions	See Pamphlet.
2	From the River Severn...	H. H. Fulton	September, 1865	No details	No details	Newspaper Report.
3	From North Wales ...	J. F. Bateman	November, 1865	22,100,000	220 millions	Pamphlet.
4	From Cumberland ...	G. W. Hemans	July, 1866	25,000,000	250 „	„
5	Grays, Guildford, Dorking, &c.	C. F. Gower	August, 1866	4,328,500	15 „	Engineering.
6	From Thames, filtered through Bagshot sands	Telford Macneill	October, 1866	6,700,000	400 „	Pamphlet.
7	From higher tributaries of the Thames	Bailey Denton	December, 1866	4,500,000	90 „	Pamphlet. Sir John Rennie agrees with him.
8	From Rivers Dove, Wye, and Derwent	George Remington	January, 1867	5,000,000	83 „	Engineering.
9	Non-absorbing surface and direct supply of rain water	A. Ormsby	February & May, 1867	For drinking and cooking purposes only, at one gallon per head per diem.		Pamphlet.
	PROVINCIAL.					
10	River Dee	R. Rawlinson	August, 1866	907,000	26½ „	Pamphlet. Proposes to raise Bala Lake 6 feet by embankment, and to lower it 12 feet when required.
11	Lake district of Cumberland	T. Dale	September, 1866	11,960,000	131 „	Pamphlet.
12	Haweswater Lake ...	E. Filliter	October, 1866	1,250,000	25 „	Engineering.

SKETCH Nº 1.

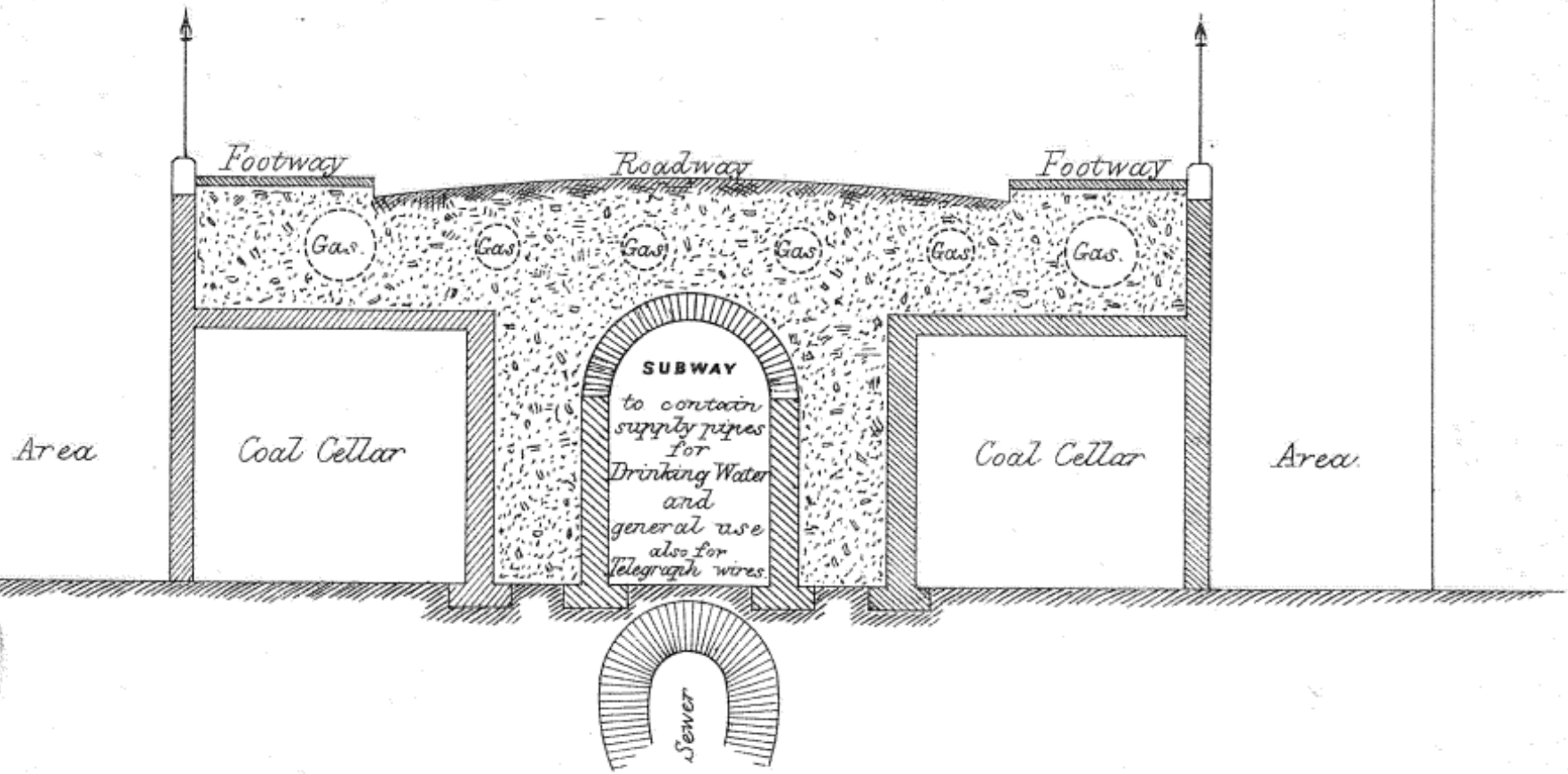
Shewing proposed manner of separating the pipes for the supply of Water, Gas, and Telegraph-wires.



SKETCH Nº 2.



SKETCH Nº 3.



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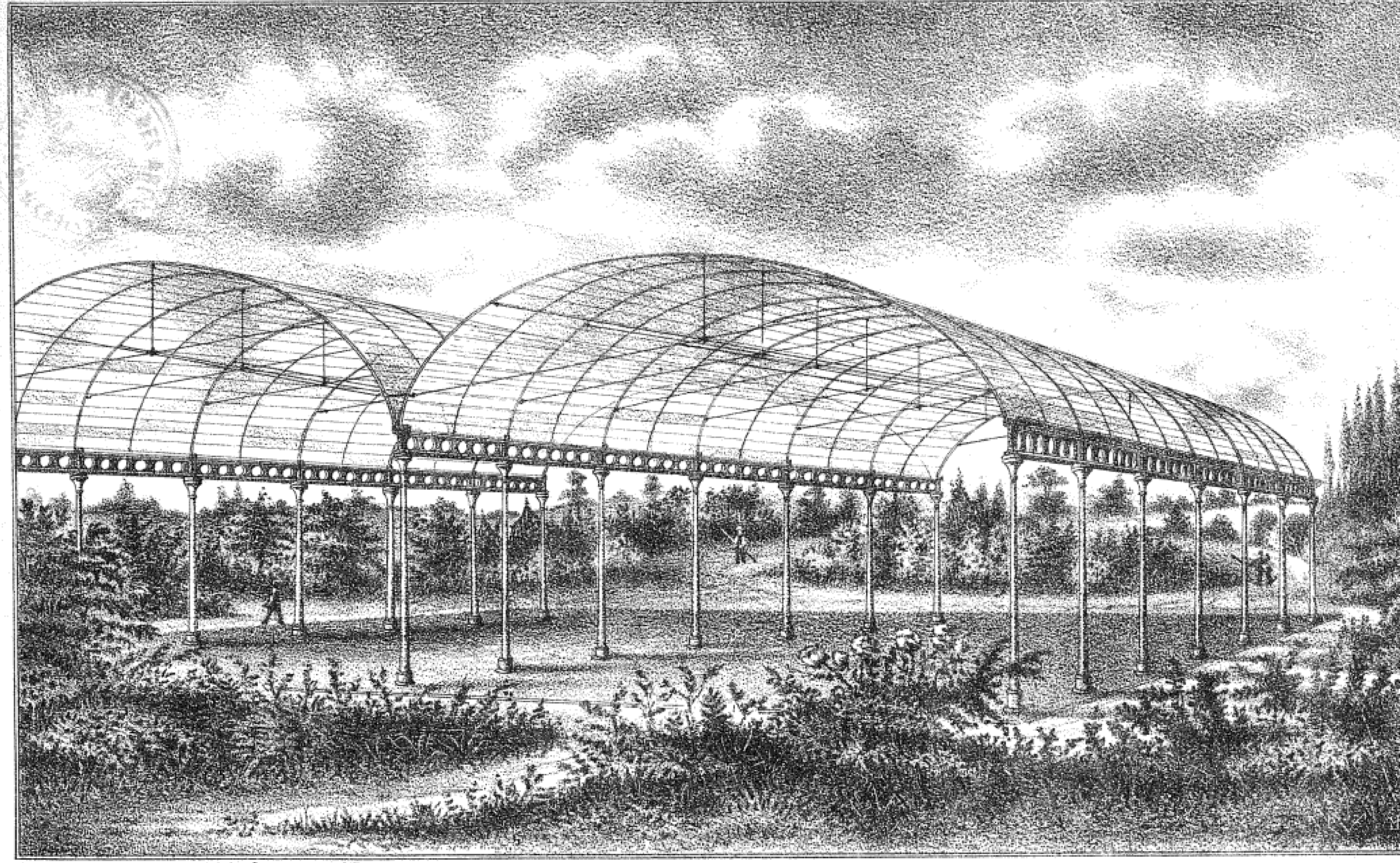

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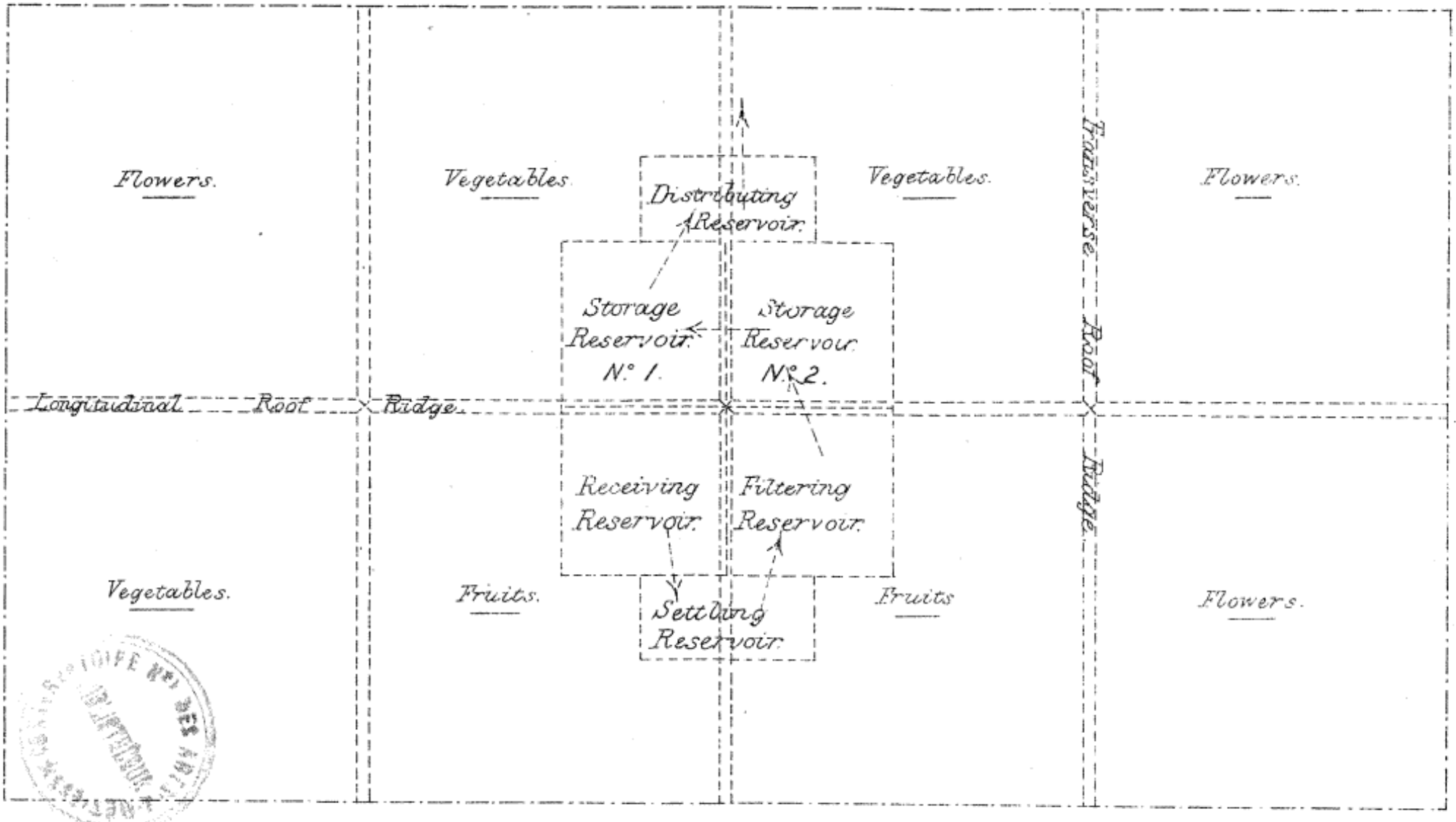
SKETCH N? 5.

GROUND PLAN SHEWING ROOF AND RESERVOIRS.



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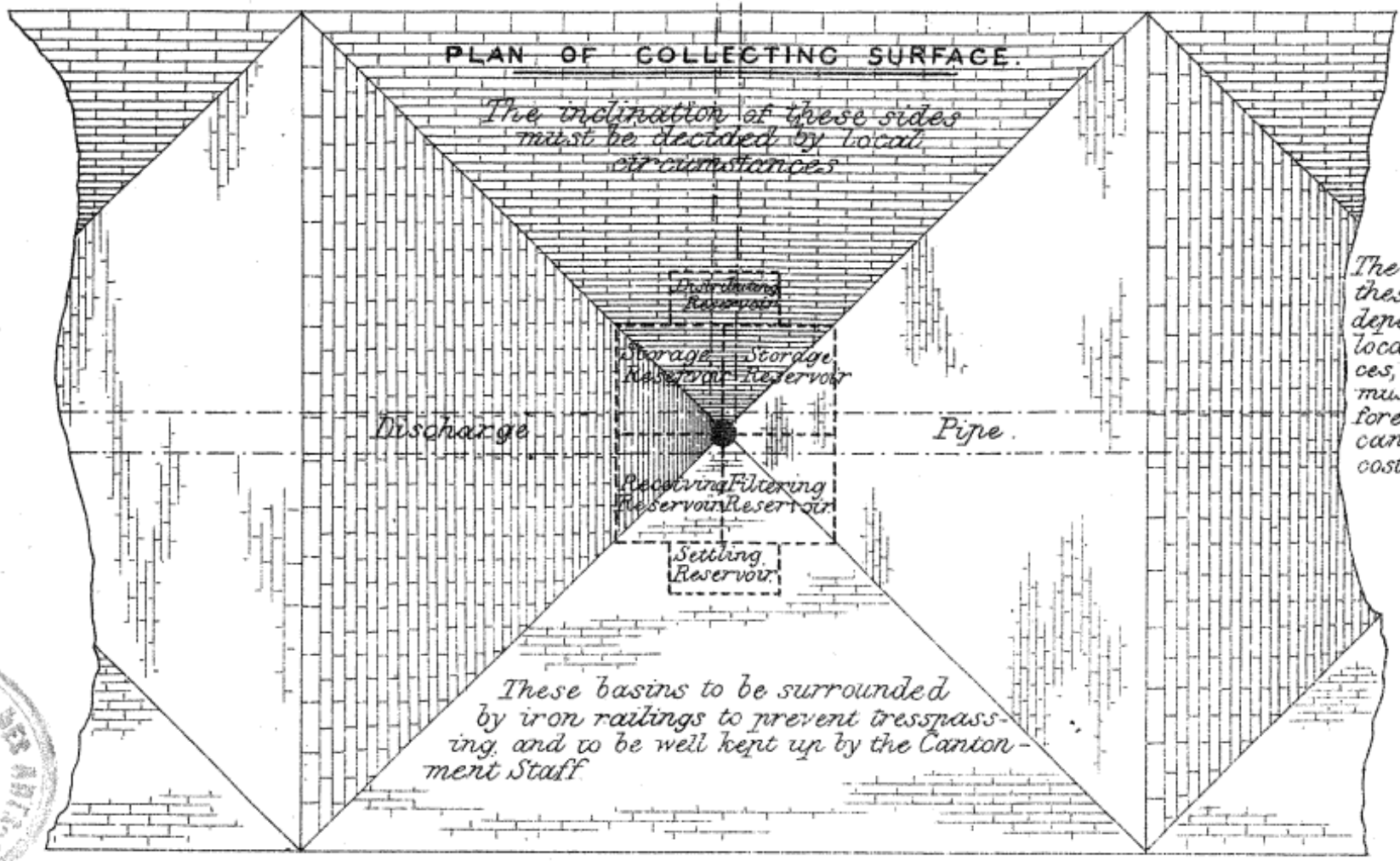
SKETCH Nº C.

SKETCH SHEWING NON-ABSORBING COLLECTING BASIN.

SECTION.

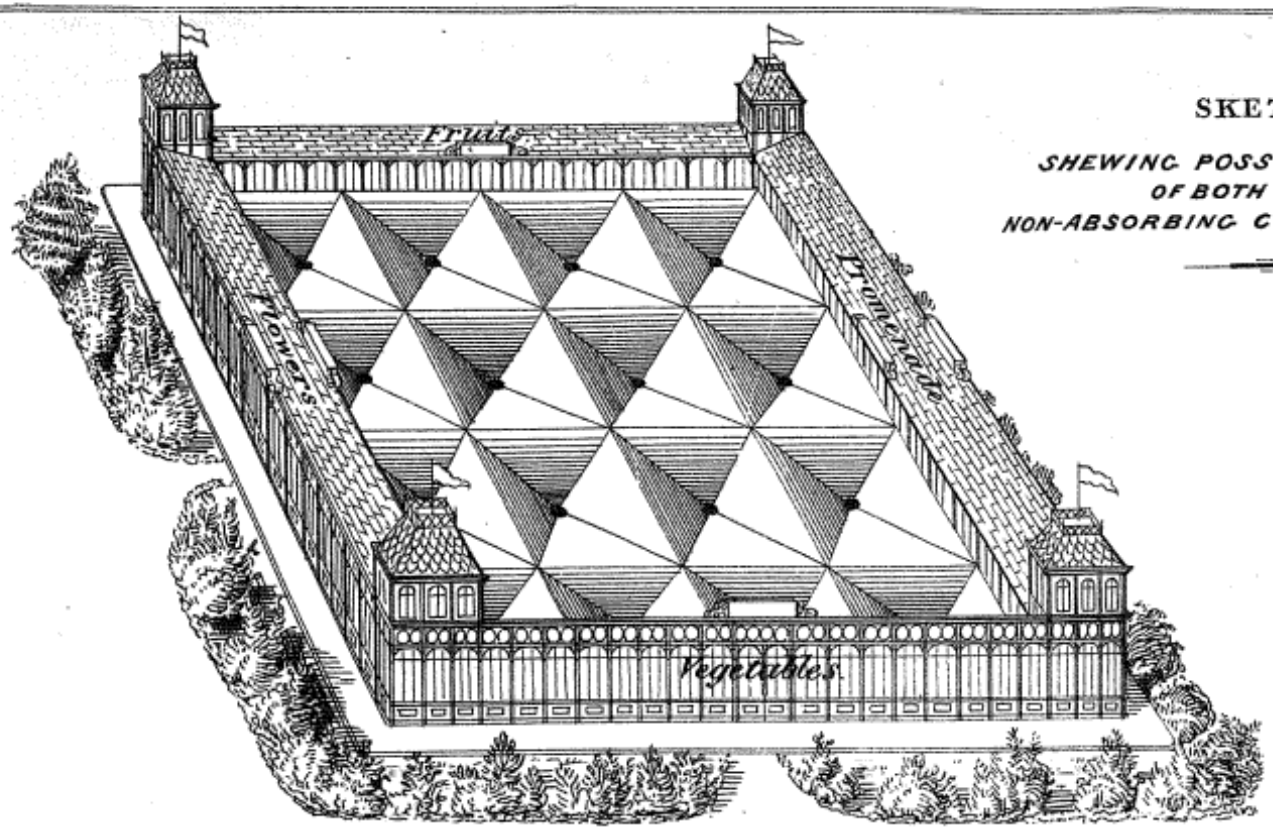
PLAN OF COLLECTING SURFACE.



NOTE.

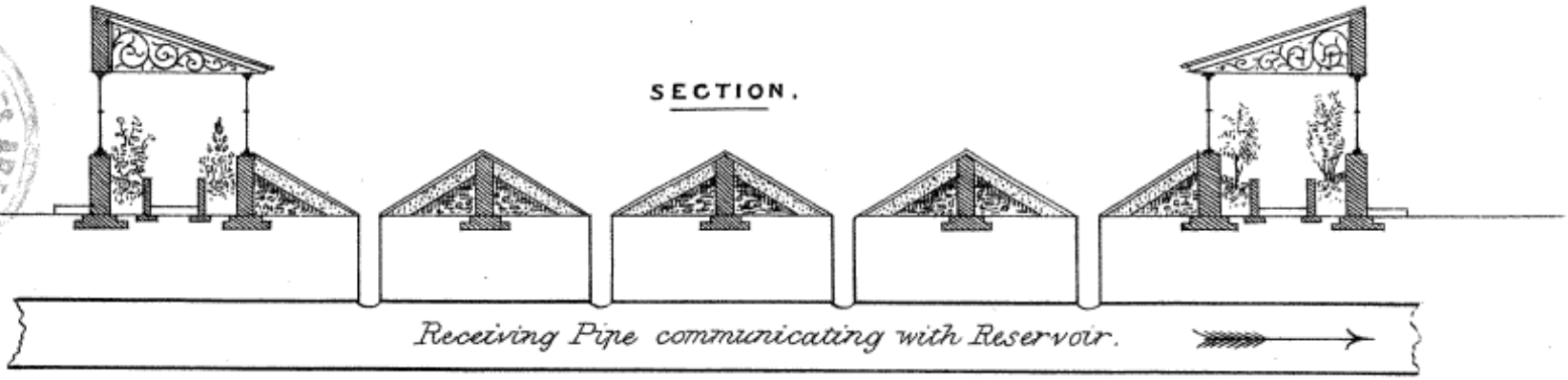
The design for these works will depend upon the local circumstances, and a survey must be made before an estimate can be given of the cost of construction

Metchim & Son, Lithrs, 20, Parliament St, S.W.



SKETCH Nº 7.,

SHEWING POSSIBLE COMBINATION OF BOTH SYSTEMS OF NON-ABSORBING COLLECTING SURFACE.



SECTION.

Receiving Pipe communicating with Reservoir.