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(1) Number of pages 140

(2) Date of repair 10/86

(3) Initials of the Referencer

AMIL NADU ARCHIVES

ERNMENT OF TAMIL NADU

P.W.D DEPARTMENT

G.O. No.
B.P. No. 4697 —W Press.
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Dated 9-12-1878 ~~197~~.

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

9th December 1878, No. 4,697 W.

Buildings and Roads.
Civil Works.

Read the following papers :—

o. 119. Endorsement of the Chief Secretary to Government, Financial Department, dated Fort St. George, 15th August 1877, No. 1,570.

rom the Hon. J. G. COLEMAN, Acting President of the Municipal Commission, Madras, to the Chief Secretary to Government, dated Madras, 13th August 1877, G. No. 548.

AGREEABLY to the instructions contained in G.O., 5th April 1877, No. 1,174, ublic Works Department, communicated in G.O., 25th April 1877, No. 1,343, inancial Department, I have the honor to forward the report of the Municipal xecutive Engineer on the present condition of the Madras Water Works with schemes r their improvement.

2. Besides lithographed plans which are appended to the report a map of Madras howing piping as laid at present with levels of bottom of pipes is forwarded.

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rom J. A. JONES, Esq., Executive Engineer, Municipal Commission, to the Acting President of the Madras Municipal Commission, dated Madras, 24th July 1877, E. No. 568.

I HAVE the honor to forward report on the Madras Water Works in connection with G.O., ,174, of 5th April last.

2. This report has been somewhat delayed by the lithographing of the plans.

3. In addition to the information in the report I have to state that I had a "bore" of 28 eet made on the proposed site for the filters as desired by Colonel Mullins, and this shows that aterite extends to that depth and it is similar to that found on the surface, though a little more ompact.

[illegible] [illegible] [illegible] available [illegible] the Govt. Office

4. Spare copies of the report are available if Government require further copies.

FORWARDED to the Public Works Department with reference to G.O. in that epartment, dated the 5th April 1877, No. 1,174.

(Signed) D. F. CARMICHAEL,
Chief Secretary.

No. 119-A.

MEMORANDUM.

THE report on the present condition of the Madras Water Works describes in more or less detail six methods of improving the supply. Four of these are for the improvement of the present system; the fifth, which is the main subject of the report, and is illustrated by plans and sections, is for raising the water from the tank by pumping, and its conveyance after filtration by iron pipes instead of the present open channel; the sixth method, briefly described in the appendix to the report, is for conveying the water by pipes all the way, but without pumping and without filtering.

2. Water is at present brought from the Red Hill Lake to Madras without filtration in an open channel and is afterwards distributed by means of iron pipes. The full tank level is 46·31 feet above mean sea level. The lowest pipe which draws off water from the tank is at 31·31, while the tank bed is at 20. The defects in the present system are considered to be—1st, that from the position of the off-take, water can only be drawn while the tank level is above 31, and is scarcely potable after it has fallen below 36; 2ndly, that it is conveyed in an open channel; 3rdly, that it is not filtered before delivery.

3. The first and fourth of the schemes for improving the supply are for conveying the water in the present open channel, and filtering it either at Madras or at some place between the tank and Madras. As these schemes involve pumping, and as the supply of water would fail, as at present, when the water in the tank had gone down 15 feet, they need not be discussed. The second and third of the schemes provide for cutting down the present channel 6 feet at the head, so that 6 feet more water could be drawn off from the tank, and filtering the water either at Madras or at some place nearer the tank. The cost of these schemes is set down at Rupees 9,88,163 and Rupees 11,22,060, respectively; about half, in each case, being for filters and reservoirs, and the rest for engine and pumps, lowering the channel, and altering masonry works at road crossings. The objection to either scheme is that the cost is not less than that of the method next to be noticed, which provides for an iron main in place of the present open channel, as well as pumping and filtering. This, the fifth method, and the one recommended by the Municipal Engineer is described at pages 7 to 23 of the report. The estimate amounts to either Rupees 13,66,334 or Rupees 10,60,480, according as brick or laterite is used for the masonry works. The estimate provides for constructing a water tower in the tank, for an iron main thence to the pumping engines, for constructing filters, settling tanks, service reservoir, &c., &c., and laying about six miles of 36-inch main to Madras. It is the intention of Government, as it is also the wish of the Municipal Engineer, that the selected estimate and plans should be submitted for the opinion of a Consulting Engineer of eminence with special knowledge of the subject of town water-supply. As this Engineer will probably not have resided at any time at Madras, or have seen the Red Hill Tank, he may take for granted that the water must be filtered before delivery and proceed to report on the best position and construction of the filters, power of the engine, size of the main, &c. But if it can be shown that filtering is not necessary, it is needless to consider the details of a scheme of which filtering is an essential part.

Five or six years ago the Red Hill Water was analyzed and found to be purer than that obtained from the Seven Wells; and at this present time the water is pronounced to be of excellent quality. The water delivered at Madras last year, during the drought, was certainly very offensive, but then owing to the short and intermittent supply the water was contaminated in its passage from the tank to the town. Ordinarily, the water is purer as it leaves the tank than the water supplied, after filtration, by some of the London Companies. The water supplied to the troops at Bangalore from the Ulsoor tank is filtered before it is sent through the pipes, but some portions of the drainage area of that tank are very foul, and the water in the tank is always muddy. This is not the case with the Red Hill water.

The sixth and last of the methods for improving the water-supply of Madras is that described in the appendix. By this method the water would be conveyed from the tank to Madras in iron pipes and be drawn from an iron cylinder 8 or 10 feet in diameter provided with valves, at different levels, to be erected inside the tank. By this method the water would always be drawn off from near the surface, where it is purest, and the pipe could be laid so as to draw off water to several feet below what is now practicable. Two of the evils of the present system—the open channel and the stoppage of the supply when the tank has fallen 15 feet—would thus be got rid of, while no provision is made for filtration, the necessity for which is at least not urgent. The cost of this method, though less than that of the others, is still considerable—upwards of seven lakhs, using the smaller of the two sizes of main suggested, but then it must be remembered that the cost of maintenance will be much less than if any scheme be adopted which involves pumping and filtering. It seems on the whole the best suited to the circumstances of Madras.

In explanation of the long time the Municipal Engineer's report has been in the hands of the Chief Engineer, he has to observe that when he received the report he had not seen the Red Hill tank, or any of the works connected with the Madras water-supply. The Municipal Engineer from whom he wished to obtain some information went on leave immediately after sending in his report, and soon after his return the tank was stated to be in imminent danger. The method of conveying water from it became then of secondary importance to the necessity for securing the safety of the tank. Repairs have been carried out by the Superintending Engineer, Chingleput, but some additional work is required to enable the tank to retain a full supply. The tank was last visited by the Chief Engineer on the 11th of March, when he was confirmed in the opinion that he, from the first, formed as to the best method of bringing the water to Madras.

(Signed) E. A. FOORD, Colonel, R.E.,
Chief Engineer, P.W.D.

6th April 1878.

No. 119-B. Endorsement of the Chief Secretary to Government, Financial Department, dated Fort St. George, 19th March 1878, No. 504.

From L. R. BURROWS, Esq., Acting President of the Municipal Commission, Madras, to the Chief Secretary to Government, dated Madras, 18th March 1878, E. No. 1,435.

IN G.O., dated 5th April 1877, No. 1,174, Public Works Department, the Government were pleased to call for information on certain points connected with the Municipal water-supply. On the 13th August Mr. Coleman, who was then acting as President, forwarded, for submission to Government, a report drawn by the Municipal Engineer on the present condition of water-works, with schemes for their improvement.

2. Since the submission of this report the circumstances of the water-supply of the city are greatly changed. At that time, or to within a short time previous, the supply was scanty, was obtained at great expense by pumping, and the quality was very inferior. At the present time the supply is abundant, no expense is incurred for pumping, and the quality is excellent.

3. The improvement of the supply is therefore no longer felt to be a pressing need. Attention is now more directed to the imperfect distribution of the water. Though my present purpose is not to propose any scheme for securing a more perfect distribution, I may mention that Mr. Jones has in readiness detailed proposals for the extension of the pipes and erection of additional fountains, the estimates for which amount in the aggregate to over Rupees 3,00,000. My present object is to call attention to the subject dealt with in Mr. Jones' report, and to hasten, so far as I am able, the solution of the question as to what is the best thing to do under the present circumstances. For I imagine that after the experience of last year every one will be ready to admit that something must be done.

4. In the report of the Water-supply Committee, in which the present system of water-works was recommended, the following passage occurs in paragraph 40:—"We have given the subject of water-supply and its distribution careful consideration, and we have arrived at the conclusion that for the present, at any rate, the class of people to whom we propose giving a water-supply are unable to pay for a street service system under high pressure, and that if we can possibly deliver the water within easy access of their dwellings from street fountain wells where the levels will admit, and keep the existing tanks and reservoirs well supplied with good, pure, wholesome water it is as much as the people most interested can afford to pay for, and as much as their real pressing necessities require." In paragraph 51 the Committee quote from a report of Dr. Wyndowe, the Chemical Examiner, in which he finds that "chemically speaking" the Red Hills water was by far the best specimen of drinking water he had yet examined at Madras, and they arrive at the conclusion that filtration would be unnecessary.

5. The object which the Committee appear to have had in view was to distribute unfiltered water, which should be "good, pure, and wholesome," under as good a pressure as was possible without pumping.

6. The history of the supply shows how far the present works have fulfilled the object of the Committee, to what extent they have failed, and the cause of their failure. And the question seems to me to resolve itself into this. Is filtration, with its inevitable adjunct pumping, necessary? Or can the object of the Water-supply Committee be attained without resorting to these expensive operations?

7. The conclusion to which I am led is briefly as follows: that before resorting to filtration and pumping it would be well to try the effect of an improved off-take at the Red Hills Lake. The means for drawing off the water might be (*mutatis mutandis*) those proposed in paragraph 6 of Appendix III to Mr. Jones' report, viz., (1) An iron cylinder 8 or 10 feet in diameter, which would be sunk, say, 10 feet below the bottom of the lake and extend to about 6 feet above full tank level. (2) The cylinder would be provided with valves at various depths below the full tank level, 46·31 feet, to the level of the sill of the municipal sluice, viz., 31·31 feet. (3) The part of the cylinder below the bottom of the tank would be excavated and filled with concrete. (4) The main would enter through the side of the cylinder at the bottom of the tank, and would be connected with the lowest pipe of the municipal sluice.

8. If the above arrangement should prove successful, the present channel would be utilized, and the expense of seven miles of iron pipe would be saved. Should it, however, prove unsatisfactory, the money expended would not have been thrown away, as the means for drawing off the water above described could be utilized in any scheme for filtering and pumping that might afterwards be resolved upon.

9. I will now explain the process by which I have arrived at the above conclusion.

10. The pressure suffices to raise the water from 8 to 20 feet above ground surface in all parts of the town when there is a full supply at the masonry shaft, or, in other words, when the draught from the taps is not greater than the channel can supply. This only happens when there is a scarcity at the Red Hills, or when the channel has become choked with weeds. It may therefore be said that the Water-supply Committee's object has been more than realized in the matter of pressure, and that no improvement in that respect is necessary. What is wanted is a better quality of water.

11. In a large reservoir like the Red Hills Lake the water varies in quality according to its position and depth. The best quality will be found remote from the margin of the land, a little below the surface and in places where the water is deep. The worst water will probably be that which lies immediately above the slimy bed of the large shallow belt of water which forms the portion of the lake nearest to the municipal sluice. It is this latter description of water which, with our present arrangements at the Red Hills, we obtain in Madras. With the appliances described above we might obtain the former description.

12. The full tank level is 46·31 feet above mean sea; the level of the sill of the lowest pipe at the municipal sluice is 31·31 feet. The bottom of the lake in the deepest portion is about 20·00 feet. The water is brought up to the sluice from the shallow portion of the lake in a channel the bottom of which is a very soft slimy sort of mud. Through the sluice it is admitted into the delivery channel, which is 6 miles 7 furlongs in length, terminating in a masonry shaft from which the head main is taken off.

13. The municipal sluice at the Red Hills consists of a number of pipes fixed in masonry at different levels, with valves for opening and closing them. The level of the sill of the lowest pipe is, as I said before, 31·31 feet (above mean sea level) and that of the pipe next above it is 35·31 feet. When the water in the lake is above 38·00 feet, it is possible to obtain a full supply through the upper pipes and of good quality, but when it has reached that level it becomes necessary to open the lowest pipe. In August 1876 pumping was commenced when the level of the water was at 34·00. The water was raised to the level of the next upper pipe. Pumping was continued up to May 1877. After the cyclone in May 1877 the water in the lake rose sufficiently high to admit of the lowest pipe being again used, but on opening the valve it was found blocked with a black and most offensive sediment, and this had to be cleared away, causing a five days' interruption of the supply to the town. So long as the lowest pipe is open the channel is kept clear by the scour which is created along its bed in the vicinity of the pipe, but the water drawn off is thus charged with sediment and is of bad quality.

14. We have seen that in a space of nine months, during which the lowest pipe of the sluice was closed for pumping, the channel had silted up so as to block the pipe, and I anticipate that when it again becomes necessary to open the lowest pipe it will again be found blocked with silt and sediment, the removal of which will be attended with considerable delay and inconvenience.

15. The most obvious remedy is to make a new and deeper channel from the lake to the sluice. If the level of the channel bed were, say, 4 or 5 feet lower than 31·31 feet at the point where it joins the municipal sluice, the bottom scour would be avoided and better water would be obtained.

16. A plan for excavating a new channel was prepared in the beginning of 1877 by the Municipal Engineer and submitted to Government for sanction as a famine work, but Government did not approve of the plan. It is clear that such a remedy would only be temporary. Before many years the same difficulty would be again experienced owing to the gradual silting up of the channel, which would continually be going on until the level of the lowest open pipe was reached.

17. It will be objected to the arrangement proposed in paragraph 7—1st, that when the lake sinks to 31·31 feet, or even to within a foot above that level, the supply to the town will cease, although there would be 10 feet of water in some parts of the lake; 2nd, that so long as the open channel is retained for conveying the water to Madras the supply will be liable to interruptions and the water to contamination.

18. In reply to the first objection I can only say that the Government have made a valuable concession to the Municipality in allowing them to take the water off at a level of 31·31 feet, and in undertaking to reserve for the Municipality as much as shall be required above that level; that it would not be wise to relinquish so valuable a concession without further trial; that we may reasonably hope that such years as 1876 and 1877 will never again be experienced, but that if such an exceptional season does again visit us, arrangements must be made for pumping as in 1876-77. The second objection is more serious. But as we have the channel we must try and make the most of it. Contamination can be and is reduced to a minimum by careful watching, and means may be devised for avoiding interruptions.

TRANSFERRED to the Public Works Department.

(Signed) D. F. CARMICHAEL,
Chief Secretary.

No. 117-C.

MEMORANDUM.

IN the letter forwarded with the above the President of the Municipal Commission brings to notice that since the date of the Executive Engineer's report on the water-supply of Madras circumstances have greatly changed; that there is now an ample supply of water of excellent quality; and that the improvement of the supply by pumping, filtering, and the substitution of iron pipes for an open channel is no longer a matter of pressing need.

2. The Chief Engineer, in returning the Executive Engineer's report which contained descriptions of several methods of improving the supply, recommended the adoption of the method described in the appendix to the report. According to this method there would be no pumping or filtering, but the water would be drawn from the tank to a lower depth than at present through an iron cylinder to be erected in the tank and conveyed through iron pipes to the town. The iron cylinder was to be provided with valves at various depths below full tank level, so that the water might always be drawn off from near the surface.

3. The cost of this scheme, though less than that of the others, still amounted to seven lakhs. As it may be difficult to provide this sum at present, the President of the Municipal Commission has now suggested a modification of the above scheme. He proposes that the iron cylinder with valves shall be erected in the tank as in the complete scheme, but the iron pipe leading from it, instead of being continued all the way to Madras, is to be connected with the lowest pipe of the municipal sluice in the tank bank, and the water conveyed thence to the town, as at present, by the existing open channel. By this method the expense of several miles of iron pipes will be saved, but on the other hand the supply will fail, as it does now, when the tank has fallen 15 feet below full tank level and the evil of an open channel is retained. Still there will be a considerable gain, as the water entering this open channel, being drawn off from near the surface of the tank, will always be purer than at present, particularly when the water in the tank has fallen to near the level of the present off-take. This is in such a position the report states that "in drawing off the water it passes over a large expanse of slimy mud, and the last 5 feet of water that can be drawn off, under the present arrangements, is pronounced to be impure. The cast-iron cylinder now proposed to be erected can be utilized in any more perfect scheme that may be adopted hereafter, so the amount now proposed to be laid out will not be lost, and, so far as it goes, will effect a real improvement in the water-supply of Madras.

FORT ST. GEORGE,
4th April 1878.

(Signed) E. A. FOORD, Colonel, R.E.,
Chief Engineer, P.W.D.

No. 119-D. Proceedings of the Madras Government, Financial Department, dated 7th June 1878, No. 1,006.

From L. R. BURROWS, Esq., Acting President of the Municipal Commission, Madras, to the Chief Secretary to Government, dated 3rd June 1878, E. No. 506.

IN connection with the subject of the Government Order marginally noted, I have the honor to append, for the information of His Grace the Governor in Council, some analyses of the Red Hills water recently made by the Chemical Examiner to Government.

No. 911, of the 23rd May 1878, Financial Department.

2. The analyses of the two samples of water taken on the 8th February from the delivery channel was for the purpose of testing the value of a filter invented by Captain Taylor; the sample marked* being water which had passed through the filter, and the other, water which had not passed through it.

3. Former analyses seem to prove that no contamination takes place in the pipes; the water taken from the most distant taps is always found to be as pure chemically as that taken from the channel.

ENCLOSURE No. 1.

ANALYSIS of Water from Red Hills Delivery Channel, dated 8th February 1878.

	Unlabelled.	Marked. *
Total solids, mgrm. per litre	0·170	0·170
Volatile " " "	0·045	6·045
Sodium chloride, " "	0·046	0·046
Total hardness	3°·5	3°·5
Permanent "	2°·2	2°·2
Free ammonia, mgrm. per litre	0·28	0·28
Albuminoid ammonia, mgrm. per litre	0·36	0·36
Nitric acid, " "	3·60	3·60

REMARKS.—The two samples of water are identical in quality. Taste and appearance good. Sediment of ferruginous clay with vegetable fibre; some water-fleas. Water from delivery channel was last examined in June. It then contained more solid and more volatile

k

matter; permanent hardness was less; free ammonia was greater, albuminoid ammonia much greater, nitric acid much less.

ENCLOSURE No. 2.

Analysis of Red Hills Water, dated 16th April 1878.

—	No. 1 Lake, 14′ below surface.	No. 2 Lake, 8′ below surface.	No. 3 Lake, 2′ below surface.	No. 4 Lake, 6′ below surface.	No. 5 Masonry Shaft, Kilpauk.
Total solids, mgrm. per litre	0·145	0·185	0·170	0·155	0·180
Volatile " " "	0·050	0·045	0·075	0·045	0·060
Sodium chloride, " "	0·056	0·059	0·067	0·056	0·056
Total hardness	4°·5	4°·8	4°·8	4°·8	4°·8
Permanent "	4°·2	4°·6	4°·6	4°·6	4°·6
Free ammonia, mgrm. per litre	0·16	0·16	0·08	0·16	0·24
Albuminoid " " "	0·38	0·36	0·52	0·36	0·36
Nitric acid, " "	1·35	1·35	0·30*	0·60	0·30*

REMARKS.—Considerable deposit of reddish clay and vegetable matter from Nos. 1 and 2. No. 3 contained much of a reddish flocculent substance when received; deposit large. Deposits from Nos. 4 and 5 small.

* Determination twice made.

Communicated to the Public Works Department, with reference to Order in that Department, dated 21st May 1878, No. 2240-W.

(True Extract.)

(Signed) D. F. CARMICHAEL,
Chief Secretary.

No. 119-E. From Surgeon-General C. A. GORDON, M.D., C.B., British Medical Service, to the Secretary to Government, Public Works Department, dated Fort St. George, 29th November 1878, No. 257-78.

ADVERTING to G.O., 19th October 1878, No. 4,071 W, I have the honor to inform you that, apparently through misapprehension, G.O. of 21st May 1878, No. 2,240, was only communicated to Surgeon-Major Nicholson, A.M.D., on the 7th November 1878.

2. I beg to annex copies of correspondence that has taken place between this office and Surgeon-Major Nicholson since the receipt by me of the G.O. of 19th October 1878.

3. With reference to the latest communication from Dr. Nicholson, viz., his No. 338, dated 25th instant, I regret that I am unable to support the application made therein regarding a money allowance to Dr. Nicholson in anticipation of a public duty he has been ordered to perform; and I regret that an officer of the Army Medical Department has thus endeavored to bargain with Government by whom he is paid for the performance of whatever public duties he is deemed eligible.

4. I regret also to observe that Dr. Nicholson indefinitely expresses the period when his chemical examination of water may be expected to be complete. Accordingly, it being necessary, as expressed in my letter to your address, No. 74-0, dated 11th October 1878, that having in view eventualities in Bengal the services of all officers of the Army Medical Department should be available for instant service if required, I trust His Grace the Governor in Council will be pleased to permit Surgeon-Major Nicholson to be relieved from the intended duties in connection with water analysis.

No. 120. ORDER THEREON, 9th December 1878, No. 4,697 W.

THE omission to issue the order to Dr. Nicholson is serious and needs further explanation from the Surgeon-General, to whom it was duly communicated.

2. Dr. Nicholson will be relieved from the duty.

3. The Superintending Engineer of the Third Circle will at once have the samples taken by some responsible officer of the Public Works Department. The analysis will be conducted by the Chemical Examiner, with whom Colonel O'Connell should put himself in communication.

(True Extract.)

(Signed) E. A. FOORD, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Surgeon-General, British Medical Department.
" Superintending Engineer, Third Circle, with G.O., No. 2,240 W, dated 21st May 1878.
" Chemical Examiner, through Surgeon-General, Indian Medical Department.
" Military Department.
" Public "

Exd C. Howarth.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of [1878] Madras.

PUBLIC WORKS

To

The SURGEON-GENERAL, BRITISH
MEDICAL DEPARTMENT,
&c., &c., &c.

Dated December 9th.

Issued

Recd. *Encl.*

G. O., 9th December 1878, No. 4,097 W.

DECEMBER.

Nos. 119-120.

Dr. Nicholson relieved from the duty of analysing the Madras water-supply; the analysis to be conducted by the Chemical Examiner.

Water Work scheme
1877

Acting President Municipal Commission.

MADRAS MUNICIPAL COMMISSION.

REPORT

ON

THE PRESENT CONDITION

OF THE

MADRAS WATER WORKS,

WITH

SCHEMES FOR THEIR IMPROVEMENT.

J. A. JONES,
EXECUTIVE ENGINEER.

MADRAS:
ALBERT MERCANTILE PRESS—S. BOWIE, PRINTER.

REPORT

ON THE PRESENT CONDITION OF THE

MADRAS MUNICIPAL WATER WORKS

WITH

SCHEMES FOR THEIR IMPROVEMENT.

L. R. BURROWS, Esq.,

Acting President Madras Municipal Commission.

Sir,

1. With reference to G. O. No. 1174, dated 5th April 1877, I have the honor to forward the following Report on the present condition of the Madras Municipal Water Works, with a Scheme accompanied by Plans for their improvement.

Surveys when commenced.

2. Since the middle of May last, having been relieved of a portion of my duties in Madras, I have been able to give a great portion of my time for acquiring the information considered necessary by the Chief Engineer for Irrigation, and in addition to this, I have been able to prepare plans for a scheme which will remedy the defects of the present supply, and which are in accordance with the views of the Chief Engineer for Irrigation as stated in his Note No. 145A contained in the G. O. above referred to.

Necessity of the improvement.

3. It is however necessary to point out to the Commissioners, firstly, why some new method of conveying the water to Madras is needed at all, and also to shew, besides the scheme to be laid before you, other methods of improving the supply and quality of water to Madras. In doing this I reply to Para 4 of G. O. under reference as to whether it is preferable to filter the water at or near the town or the Lake.

Present open Channel.

4. The Water is at present conveyed to Madras from the Red Hills Lake by means of an open Channel which was calculated to deliver about 24 gallons per head per day for a population of 545,000. When designed it was supposed that the Channel would have a good current and the growth of vegetation be thus prevented. These expectations I regret to say have not been fulfilled, and at present it is most difficult to keep the Channel clear of weeds. This may partly be caused by the intermittent system of supply which we have been of late forced to adopt, and by which method the Water is as it were dammed up and allowed to rest in the Channel for a period of 6 hours during the day and 12 during the night. There is also another evil resulting from

this, and that is that the Channel having been thus made into a Settling Tank, it is getting silted up and will in time (if allowed to) be so much so, as to be unable to deliver the necessary quantity to the town. The cleaning of the Channel either causes the water supply to be shut off from the town, or the delivery of water unfit for drinking.

What Channel was intended to do.

5. The foregoing is a description of what the Channel now is, not what it was intended to be, as it was intended that the water should continuously flow *through* the Channel and not rest in it.

Cause of intermittent supply.

6. The cause why this method of supply has been adopted is, that it has not been possible to maintain the Red Hill Tank at as high a level as was anticipated, and as will be hereafter described, the quantity which at most can be drawn off from the tank by the Channel is a depth of 15 feet, whereas the total depth of the tank at the lower contours is over 25 feet.

Levels at present off-take.

7. The level of the lowest pipe which draws off water from the tank is 31.31. The full tank level is 46.31, while the tank bottom is in some places at a level of 20.00.*

Off-take unsuitable place for drawing off water.

8. When the tank falls to 31.31, we are unable to draw off any water by our present arrangements, but this is not the only objection which can be raised against the "off-take" for the point of off-take is in such a position that in drawing off the water it passes over a large expanse of slimy mud.

At what Level potable water can be had.

9. It may be safely, I think, said, that so long as the water level of the Red Hills Tank is above 36.00, the water drawn off is in a measure potable, but below that level the water is impure. Madras can then only depend on a supply of potable water when the tank ranges from 46 to 36—impure from 36 to 31 and no water can be drawn (by present arrangements) below that level, although there still remain about 20 millions of cubic yards.

Probabilities of future supply.

10. It cannot be stated with the slightest certainty when the tank will be full again, or that it will be on an average during the year higher than a level 36.00 above which potable water can be had. Madras is therefore in the position of having no sure and certain supply of potable water all the year round, in fact the probabilities are against such a belief.

Further objections to Channel.

11. There are other objections to the present Channel independent of the height of its off-take. The Channel is eminently suited to be a breeding ground for fish and infusoria of all descriptions, and these eventually get into our pipes: did they not do so they would tend to keep the water clean, but as the pipes are not always full and as these infusoria attach themselves to the pipes, they die when the water recedes from them. They eventually get into the water which I presume accounts for the smell which sometimes arises from it when first drawn off. I have evidence of this, as the larger mains are covered on the inside with these animals much the same as a ship is covered with barnacles.

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* When any levels are given the datum is Mean Sea Level.

Pipes likely to be choked.

12. This brings us to another objection to the Channel, and that is, that it is a means of choking the pipes, and would in time considerably impede the flow of water through them.

Silt in Channel.

13. Before leaving the subject of the Channel, I think it should be noted that had not the plan been adopted of retaining the water in the Channel, and thus making it as it were a settling pond, the probability is, that the pipes would have half full of mud. I judge this from the fact that the Channel has silted up in most parts over *1 foot in depth.*

Result of impure and imperfect supply.

14. There have been many evidences of late as to what state Madras would arrive at if it were without a supply of water, and as the water must be shut off at intervals of one month or six weeks and for two or three days each time under present arrangements from the town, it must in a very great measure be prejudicial to the health of the inhabitants.

15. Having thus shewn, I hope satisfactorily, that something should be done to improve our present water supply, I now propose to consider Schemes for its improvement.

Schemes for Improvement.

16. One is naturally led to inquire if the present means of supply can be improved, and if so, in what way. There are four ways in which this can be done—

I.—To allow the water to come down the present Channel and be filtered in Madras.

II.—To cut down the present Channel to a level of say 25.00 at the head, and keep it 6 feet below its present level all the way to Madras, and then to filter as before.

III.—To cut down the Channel as in last scheme, but to filter the water near Koonoor when the Channel is about 6 feet above ground and then filter it and thence send it to Madras through pipes.

IV.—A similar scheme to No. 3, but keeping the Channel at its present level.

First and fourth schemes need not be considered.

17. The first and fourth schemes may, I think, be dismissed with the remark that we can only receive water so long as the lake is above 31.31 and that the filtration of the last 5 feet in consequence of its impurity would be more costly.* We might of course arrange to have Engines permanently at the off-take of the Channel to raise the water when it fell below the level of 31.31, but as we must employ engines at Madras, this double set of machinery would be a most expensive arrangement.

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* For reasons see page 7 para. 36.

President Municipal Commiss

Scheme No. 2 estimate.

18. Scheme No. 2 somewhat detailed would be as follows :—

	Rs.
Cutting new Channel from present Sluice to centre of lake ...	15,000
Rebuilding present Head Sluice, &c.	3,000
Lowering Channel and re-sectioning it from 0 miles to 6.4 miles—cubic yards 4,27,100 at 3 annas	78,830
Removing two Acqueducts under Channel and replacing by Syphons..	5,000
Under-pinning eight Over Bridges at 1,500	12,000
Rebuilding two under Bridges at 2,500	5,000
Rebuilding thirteen Culverts	11,700
Removing and replacing nine Wooden Bridges	900
Alteration in Main from Channel to land on opposite side of Otary Nullah	1,500
Construction of filters, tanks and compensating reservoir from which Engines would pump	5,45,000
Engines and boilers including pumps to raise to a height of 35 feet...	2,06,400
Stand pipe enclosed in tower...	4,000
Land	10,000
Total ...	8,98,330
Contingencies 10 per cent. ...	89,833
Rs...	9,88,163

Ground available for filtering.

19. The nearest available ground on which filters and settling tanks could be constructed, is that occupied by Mr. Branson and the lands adjacent to the north.

Levels of ground and details of levels of works, &c.

20. The level of this ground is about 17.00 above mean sea level. There are two methods of constructing the settling tanks and filter beds, the first being to have the settling tanks partly above ground (say at same level as the Channel would then be = 23.00) 10 feet deep and the filter beds with their highest water level at 14.00 or 3 feet below ground ; and the second being to have both filter and settling tanks below ground. By the first method, the loss of head below present arrangements would be 15 feet, and by the second method the loss would be 22 feet—but their construction in the former way would be very much greater than in the latter. The latter method is the safer and would require less land.

Pressure in town at present.

21. The water pressure in the higher parts of the town is at present very low.

Height water would require to be raised.

22. The water (taking the second method of constructing the settling tanks and filters) would then have to be raised at least 22 feet to give the same pressure as at present, but it would be expedient to raise it at least 35 feet*—(this would be 42 feet above Mean Sea Level, and is 10 feet less of head than the scheme proposed to be adopted.

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* We must calculate the loss of head at 1 foot above the bottom of the settling tank which is the same level as the water in filters, as we cannot keep filling and emptying the settling tanks at the same time without destroying their utility.

Water not regularly consumed and Engine Power required.

23. The water is not regularly drawn off, and about half the quantity is drawn off in (say) 6 hours, or 3,000,000 gallons in 6 hours, this would require Engines of 90 H. P. nominal or 115 H. P. actual ; and would be divided between two Engines and this would have to be increased by a half more as it would be requisite to have three Engines, so that any two of them could do the full work, say 172 H. P. actual. We must either have Engines to do this work or must have a compensating reservoir at a height of 18 feet above ground, able to contain at least 240,000 cubic feet, of which the cost at that height would be enormous. The cost of these engines would probably be about 1,200 Rs. per H. P. = Rs. 2,06,400.

Stand pipe tower.

24. A small tower is necessary to contain the stand pipes through which the water would have to be raised, and it would probably cost about the amount put down for it in the above Estimate.

Cost of Maintenance.

25. The total cost of this scheme would then be about Rs. 9,88,000 and the maintenance of these engines, works, &c., would be as about Rs. 646 per annum per H. P. actual at work which is 115. This annually would be Rs. 74,290 without including the depreciation of the buildings and machinery.

No allowance made for Houses.

26. It will be observed that no allowance has been made for houses for men as might be needed, or for fencing the compound as would decidedly be advisable I think from the proximity of the works to the town.

Proximity to town an objection.

27. The proximity to the town is an objection as the water is very liable to be tainted by the foul atmosphere. The reservoir into which the water goes after filtration might be covered, but this would again add to the cost.

Scheme No. 3.

28. Let us now look at scheme No. 3. It will be advisable to detail it in a similar manner to No. 2.

Estimate of Scheme No. 3.

	Rs.
To cut new Channel from present head Sluice to Centre of Lake...	15,000
Totally re-building present Head Sluice	3,000
Cutting Channel 3 miles six feet deeper than at present 197120 cubic yards at three Annas...	37,000
Pulling down nine Acqueducts and replacing by syphons... ...	5,000
Under-pinning four Over bridges	6,000
Culverts No. 9...	8,100
Removing and Replacing three Wooden Bridges...	300
Construction of filters, tanks, compensating Reservoirs, &c. ...	5,50,000
Engines including Pumps and Buildings to raise water 28 feet. ...	1,68,750
Stand pipe and tower	4,000
27" Main from Koonoor to Masonry shaft 3 miles 4 furlongs and relaying present four and half with same size of piping	2,19,450
Land	4,000
Total...	10,20,600
Contingencies 10 per cent.	1,02,060
Rs...	11,22,660

Schemes Nos. 2 and 3 compared.

29. The differences between this scheme and No. 2 are—

1st—A less length of Channel to cut down and fewer alterations in Bridges, &c.
2nd—An addition of a 27 inch Main from Koonoor to Masonry Shaft.
3rd—A less height to raise the water.
5th—Greater cost in the construction of filters, &c., on account of distance material would have to be brought.
6th—Greater cost of maintenance from a similar cause.

Site for filters.

30. The ground at Koonoor being, where the proposed site for tanks, filters, &c., under this scheme is, about 6 feet below Channel bed.

Cost of Engines.

31. The Channel at this point would be at a level of 24.00 after being cut down 6 feet, and taking a 10 feet settling tank, if we arrange to have the same head of water as in scheme No. 2, the water would require to be raised 28 feet instead of 35, and making a similar calculation the H. P. nominal required would be 70 and actual 90, but we must add ½ to this for contingencies as before making 135 H. P. required. The cost would be at 1,250 per H. P. = 1,63,750.

Cost of Main to Madras.

32. The cost of the 27" Main is the great difference, in fact we might have very nearly approximated to the cost of this scheme by deducting half the cost of the alteration on the Channel, and adding the cost of this which comes to 2,19,450 for the piping and laying, which might be done below present Channel bed. The sides of the Channel might after being cut down level with the bottom, be made available as a road to the works, or it might be filled up for this purpose.

Cost of Maintenance.

33. The cost of Maintenance in last scheme was taken at per annum Rs. 646 per H. P. actual at work, and if we take it on same rate for this, it would be Rs. 58,140 per annum. It would not however be the same rate as there is 3½ miles cartage extra, and this alone would probably cost Rs. 4,000 a year.

Objections to Schemes Nos. 2 and 3.

34. There is one great objection to both these schemes, which is, that they cannot well be executed without shutting off the water from Madras for some considerable period of time. This objection could be got over (at of course increased cost) by making a parallel Channel, the length being determinable on whether No. 1 or No. 2 scheme were adopted.

Constructing parallel Channel.

35. In making such a Channel it would be the least expensive way to make it so, that one-half of the embankment was the bank of present Channel. Such a Channel from Red Hills to Madras would probably cost Rs. 1,50,000.* The cost of a parallel Channel to Koonoor

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* I judge this from the cost of the present Channel 1,75,000. One half or 3 miles of Channel is in cutting, and the other in embankment, there would therefore be no saving in making a Channel 6 feet lower, for as the Earthwork is concerned on the first half, but there would be a saving by the earthwork and under Bridges on the second half,

would be more than half this amount as the ground is hard and the excavation would be deep. This I put down at 90,000. The scheme No. 2 with a parallel Channel would then be Rs. 10,26,740, and scheme No. 3 Rs. 11,59,790.

Water delivered from Channel impure.

36. It is necessary to point out that water delivered by a Channel will be considerably more impure when received into the settling tanks than if it were taken from a deep part of the lake by a pipe which would always draw off near the surface, and thus the cost of filtration would be considerably increased unless the settling tanks were made large in number or area so as to allow of a longer time to settle, which would increase the original cost of the works.

Schemes should be further considered.

37. Notwithstanding the objections which I have pointed out to these two schemes, I think they demand careful consideration, though I am not prepared to recommend them when compared with the scheme which I now have the honor to detail—

PROPOSED SCHEME FOR FILTERING AND CONVEYING WATER TO MADRAS.

Attached to this Report are the following Plans—

1. Small Scale plan shewing routes to Red Hills and route adopted on sheet No.
2. Large Scale plan of route adopted, shewing position of Tower, Pumping station, Filtering Beds, &c.... ... ... on sheet No.
3. Section of Route ... ... on do. No.
4. Section from off-take to Filters ... ... on do. No.
5. Plans Section and Elevations of Tower and Gangway ... ... on do. No.
6. Proposed Plan and Elevation of Pumping Well, Engine and Boiler Houses ... ... on do. No.
7. Plans and Sections of Settling Tanks, Filter Beds, Sand Washing Machines, &c .. .. on do. No.
8. Map of Madras shewing lines of Pipes at present laid and heights above mean sea level ... ... on do. No.

Off-take.

38. The first point which required to be determined was the position of the off-take, and this I have placed about 900 feet South West along the Bund from the Polal Sluice. Between this point and the Sluice, the bed of the tank on a contour parallel to the bund is practically level, and the slightly increased depth which might be had to the North East does not I think warrant the extra expenditure which would be incurred were the off-take placed North East of the Polal Sluice. Again to the South East the tank gets slightly shallower, so that we cannot move further in this direction; the point selected is I think decidedly the best place for the off-take.

Position of Filters.

39. The next point which demanded attention was the site for the tanks and filters These I have placed on high ground as shewn, though not quite the highest ground. The loss of head however is very little, and indeed the very highest land is not of sufficient area to accommodate

all the works. There is another reason however, and that the principal one, why I have placed the work here, and this was to obtain for the filters a ground of slightly less elevation than for the settling tank, as the level of the water in them must always stand about 1 foot above the bottom of the settling tanks to enable the water in the latter to be drawn off to this depth. The third reason is that the construction of the works will be cheaper, as there will have to be less excavation for the reason above stated.

Point of Junction with existing Mains.

40. Before the route to Madras could be decided on, it was necessary to fix the point of Junction with the existing pipes. I have fixed this point at the Junction of Brick Kiln, Old Lunatic Asylum and Pursewalkum High Roads. The reasons which led me to do so are—

1.—Because the pipes can be laid by a more direct route from here, avoiding obstacles such as villages, tanks, &c., than from any other place.

2.—It is near the large space of ground lately occupied by the Lunatic Asylum, and on which I propose eventually building a reservoir as will be hereafter described.

3.—This point is on the 42" Main.

4.—The route to the end of the 42" Main at the Masonry Shaft, would be longer.

Alternative routes.

41. Having thus fixed the ends of the routes, the alternative routes were next considered as shewn in sheet No.

Route decided on.

42. I decided on the route marked No. 1 through Perambore for the following reasons.

The other routes.

43. The route by the road is too long, and that marked No. 2 though slightly shorter than No. 1 passes away from Roads.

Reasons for selecting route.

44. The route marked No. 1, is altogether the most favorable. It is the nearest road along which the piping can be easily carted, and I think this is a great desideratum. It passes near the Perambore Works of the Madras Railway, where there are a large number of people who will gladly use the water, and the Company itself I think will be glad to take advantage of it. The route avoids all tanks through which piping could not be laid in the wet season. It avoids passing near houses or through any property which might be injured in laying the piping, and it, as far as possible, avoids topes through which it is costly to lay piping, and which might probably injure the pipes in future or render it difficult to get at them in case it were required to do so. It was impossible without increasing the length of the piping considerably to avoid these topes altogether. The route also passes near the Lunatic Asylum which may also be provided with a branch.

Further reason.

46. Again, nowhere does the ground rise suddenly so as to cause deep excavation in order to avoid raising the piping above the line of virtual declivity. The principal reason however for the selection of the route is as stated before its proximity to roads.

Why piping should not be laid along road.

47. It would be expensive on account of the small culverts under them to lay the piping along the roads and all severe bends have been avoided.

Depth at which piping will be laid.

48. I propose to lay the top of the piping on an average 3 feet below the ground which is far below the depth of any ploughing operations.

Filtration should not be done at Madras.

49. Before proceeding to describe each detail of the scheme, I think it proper to point out why in this scheme filtration should not be done at Madras.*

Giving reasons for the above.

50. In the first place we should require engines to raise the water from the lake; if raised high enough we might reduce the size and therefore the cost of the Main to Madras below what it is in the scheme I propose.† But this advantage is more than counterbalanced by this, that unless at Madras we have a compensating reservoir at a high elevation, we must have engines of double the power we would otherwise need, and still a compensating reservoir at a low level from which they would pump, so as to allow of filtration proceeding regularly, and we must also have engines at the Red Hills—and that of very little less power than the *only* engines in the scheme I am proposing. Indeed there is no advantage to be had, even the cost of construction will be more, if laterite be the material selected at Red Hills, in having the water filtered near Madras, and as I have before stated, it is on many grounds objectionable. There is no ground higher than about 10.00 and this is below many parts of the town.

WATER TOWER.

Position and levels.

51. This I have placed at the point previously described and at a distance of 74 feet from the top of the inner slope of the bund. It is not quite at the lowest level of the bed of the tank, but a small Channel will be constructed as shewn, so that water can be obtained down to the full depth required. The lowest level from which I propose to draw off is 22.00. The tower I propose to found at a level of 14.00 on concrete made of Morgan's cement which could be lowered through water if necessary, should a difficulty be

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* See note by Secretary to Government Department Public Works Irrigation.

† It would not require to be raised quite to the level of the proposed filter beds, to do this as the size of the Main in the scheme proposed is increased on account of the water not being drawn regularly all day, and in this alternative proposal, the compensatory reservoir would be in Madras.

Acting President Municipal Commission

Description of Tower.

Machinery in Tower.

Girders for supporting Machinery.

found in laying the foundations. The level of the bottom of this concrete is 8.00 or 12 feet below the lowest level of bed of tank, and from what I have seen in late excavations I believe that this depth will probably be found sufficient. Its internal dimensions are 8 feet at level of girder at top and 9 feet at bottom. It is hexagonal and divided by a central wall. In one-half of the tower thus divided, a stand pipe is placed with branches through the water into the other half which is in direct communication with the waters of the lake. In the former part are the valves which are always thus free from water and able to be put in repair and to be inspected at any time. The mouths of the pipes of the latter division are closed when necessary by balls which are moved by a crab up or down on iron rods as shewn on drawings. The lowest pipe of all has not this arrangement as it will only be required to be in use when the water is very low and when it is therefore accessible in either division of the tower. As this pipe will only be used when the water is very low and when the head at the pumping well is very little, it is of greater diameter than the other off take pipes. On girders in the upper part of the tower rests the machinery for regulating the valves, and these are covered by small tower. Gratings will be fixed in entrances through the tower to the pipes. The tower I propose to be in brickwork pointed with cement.

CULVERT.

Culvert shewn on plans.

52. I have shewn a culvert for conveying the pumping main from the tower through the embankment, and this has an entrance placed as shewn beyond the outer face of the bund.

Culvert may possibly not be required.

53. I have shewn this in deference to the views of the Chief Engineer for Irrigation, but I beg to submit for consideration whether such is needed, and whether a large amount of clay puddle round the pipe and two or three collars of brickwork at intervals might not prevent any flow of water from the tank through the bund. The present bund has no clay puddle wall as far as I am aware, and this may be a reason against the alternative proposal, I however record such for consideration.

Support for piping.

54. If the culvert be constructed, the piping will be supported on cross walls each nine feet apart as shewn.

Entrance to Culvert.

55. The entrance to the culvert will be covered over, and a trap door placed in the cover with a ladder underneath for admission.

GANGWAY.

Construction.

Two spans.

56. The Gangway consists of two lattice girders, their top and bottom booms formed of T irons, and their bracings of flat iron. The flooring will be supported on cross angle irons as shewn. The top of the girders will be cased in wood to form a hand-railing. The gangway is divided into two spans each of 33 feet by a pier, and one end of one span rests on the tower built to receive it as shewn, and the opposite end of the other on the bund where a block of masonry will support it. The gangway will be 5 feet in width—detail drawings sheet No. are given which fully explain the design.

Estimating cost of Tower culvet.

57. It is somewhat difficult to estimate the cost of the tower and culvert as it will greatly depend on the state of the tank at the time of construction, I have thought it therefore proper to allot a considerable sum for dams, pumping water, &c., &c., and think that Rs. 3,000 will probably cover all expenses of this kind.

POSITION OF ENGINES AND PUMPS.

Positions proposed.

Foundations unsafe at back of bund.

Probable injury to Bund.

58. It is hardly necessary to point out that the pumps must be so placed and so constructed that they can be able to draw from the bottom of the lake; but by making the pumps atmospheric and forcing, we can place them say at any level between 22.00 and 42.00 above mean sea level. I have made this remark as I do not consider that the pumps should be placed immediately behind the bund. The foundations would in all probability be very soft and after examination of this site, I am led to believe that there is a leakage through from the tank underneath the bund. The foundations for the Engines and pumps at this site would be most expensive, and as the ground is also liable to flooding, they would require to be raised considerably above its level. There is again the risk that the operations in excavation might tend to create a rush of water through the bund and the continual vibration of large pumping Engines would not I think be favorable to its safety. On the plan I have marked two sites, Nos. 1 and 2 where I think they would be favorably placed.

Force pumps

Atmospheric Pumps.

59. I am not sufficiently acquainted with the construction of the force pumps used in water works to state the following positively, but I believe that at whatever level they are placed they will require to pump from that level whether the tank be at a higher level or not; with however an atmospheric pump, we can always draw safely 20 feet, and on this account I prefer site No. 2 which is at a higher level, because we would be able with an atmospheric and force pump to take the full advantage of the level of water in the Lake and only have to draw from that level. Thus suppose the inlet valve of the pump were at a level of 42.00, if the tank were at 42.00 we should only have to force from 42.00 up to the level of the filters and at most only have to draw between 42.00 and at whatever level the tank stood. If this same advantage is to be gained by a force pump, then there

is no advantage in site No. 2, except perhaps that is on more accessible ground, and not so liable to floods as site No. 1. There is, however, an objection to site No. 2, and it is this that we must draw atmospherically through 3,000 feet of iron piping. There is no doubt that the pipes could originally be made air-tight, but it is difficult to say how long they might remain so, or what it would cost to keep them so. This is a point I leave for consideration. It would be expensive to put a force or lift pump at site No. 2, and therefore if the objection as to atmospheric pumping is thought too great, site No. 1 should be adopted—when we would not need air-tight pipes. The pipe from the collecting tower should have a slight fall towards the pumping well at site No. 1, so that the level of the bottom of the well at that site would probably be about 20.00, the ground level is about 32.00.

Drawings of pumps, &c. not given in detail.

60. I have not given detail drawings of the well and pumps, but only a plan of the Engine House, Boiler House, &c. with the pump well, which are sufficient to shew the arrangements I propose—(sheet No. .)

ENGINES.

61. The amount of water required to be raised from a level of 20 feet to a level of 70 above mean sea level is 6,000,000 gallons per day.

62. The Power required for this is found by the following calculation.

Calculations for Engines.

$$\frac{\overset{\text{gallons.}}{6{,}000{,}000}, \times \overset{\text{lbs.}}{10} \times 50 \text{ feet.}}{33{,}000 \times \underset{}{\overset{\text{hrs.}}{24}} \times \overset{\text{min.}}{60}} = \text{say } 64 \text{ H. P.}$$

this, however, is only the nominal H. P. required. It is necessary to have reserve power in case of accident, and I therefore propose three Engines, any two of which can do the work, so that we require three Engines each 32 H. P. nominal.

Actual H. P. required.

63. For Engines of this H. P. (nominal) about 7″ of area for each H. P., is allowed by the makers, and taking the steam at 30 lbs. pressure over six inches, and the speed of the piston 200 feet a minute, we have the actual H. P., for which amount we must estimate, viz. :—

$$\frac{\overset{\text{H. P.}}{32} \times \overset{\text{inch.}}{7} \times \overset{\text{lbs.}}{30} \times \overset{\text{feet}}{200}}{33{,}000} = 41^{*} \text{ H. P. actual.}$$

This is the amount for which I have allowed in the estimate (3 Engines of 41 H. P. each.) We have already seen that the area of the cylinders is 224″ therefore the diameter $= \sqrt{\frac{224}{7854}} = 17$ inches.

Stroke of Engine.

64. The stroke is usually twice the diameter this gives 34″ = 2.83 feet.

This brings us to the calculations for the size of the pumps.

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* It is supposed that this amount will also cover the extra head due to friction in the pumping main.

PUMPS.

No. of pumps.

65. Let there be 3 pumps, any two of which can do half the work, therefore each pump must rise $\frac{6,000,000}{2}$ per day or $\frac{668}{2}$ cubic feet per minute = 334 cubic feet. The length of stroke I propose to be the same as the piston of the cylinder viz. 2.83 feet so that $\frac{200}{2{\cdot}83} = 70 =$ strokes per minute. The capacity of the pump must therefore be $\frac{334}{70} = 4.8$ cubic feet and as the length of stroke is 2·83 the area of the pump will be $\frac{4.8}{2.83} = 2$ feet area or say 1-8, diameter for each pump.

Engines proposed.

66. I propose to make the Engines direct acting and place them over the pumps—which are in a well 20 feet diameter.

Engines how supported.

The Engine framing will be supported on girders laid across the well, and disposed above the pumps as shewn in drawings of Engine House. The pumping main will divide into three and join each pump. Each pump will have its own air vessel into which the pipes from the pumps will be led, and after leaving the air vessel they will join again into one main. This plan of placing the Engines over the pump well and using it for their foundations leads to economy not only in them, but also in allowing of the reduction of the size of the Engine House.

Economy in foundations.

A similar plan has been adopted at the Eastbourne Water Works with success. The air vessels should be of about 38 cubic feet in capacity.

Cost of Engines—Cost at other places.

67. The cost of pumping Engines varies very considerably. The cost of the Engines at Cork Water Works (Sir J. Benson) was £55 per H. P. and at the London Sewage Works the Engines we estimated at £70 per H. P. Both the above included Engine and Boiler houses, Chimneys, &c. The Board of Health have adopted a standard of £50 per H. P. and Mr. Neville in his work on Hydraulics says that the cost per H. P. will vary from £50 to £100. I have taken the extreme limit and put the cost per *H. P. nominal* at Rupees 1,200 allowing for contingencies and carriage, exchange, &c. this amount will I think cover all probable expenses, and I include the Engine House and Buildings in this sum.

PUMPING MAIN.

Size of Pumping Main.

68. I propose that the pumping Main be 18″ in diameter. The amount of water raised per minute by the Engines is 666 cubic feet and this would equal a velocity through one pipe of 6.0 feet per second which is not excessive. This main should be furnished with two or three intermediate slop valves to prevent the water returning in case of accident and a loaded blow off valve will also be necessary for each pump.

FILTER BEDS AND SETTLING TANKS.

Details in drawings.

Filter Beds on lower ground than tanks.

Compactness in design desirable.

69. These are fully detailed in the drawings attached to this report, see sheets Nos.   and   . In designing them, economy and convenience has been strictly studied. By the plan adopted the filter beds are placed as far as possible on ground lower than the settling tanks and the compensating Reservoir is placed on the lowest ground of all. Though ground in this locality is not valuable compactness in the design is advisable for other reasons. The filters and tanks can be more easily supervised, the length of connecting piping between them is of less length, and the regulating valves are placed together as far as possible for easy access and for speedy and convenient working.

No. of Settling tanks and filter beds.

70. There are six settling tanks, five filter beds, and one compensating and service reservoir. Each settling tank has an area of 45,000 square feet. They are nine feet deep, but only 8 feet will be available for drawing off into the filter beds, the remaining foot in depth being available for impurities which will be deposited. These six tanks are therefore able to contain.

cubic feet   gals.

45,000 × 8 × 6 = 2,160,000 = 13,500,000.

Time of filling and emptying tanks.

As however one tank will always be out of use for the purpose of cleaning, we can only calculate on 11,250,000 gallons; as each tank holds 2¼ million gallons, it will take 9 hours to empty itself—so that it will take 45 hours to empty the five tanks as however it will also take 9 hours to fill each of them, we must deduct this amount and thus the water will be allowed 36 hours for settling, when only five tanks are in use, but 45 hours when all the six are in use. This time I think will be sufficient for whatever state in which the Red Hills Tank may be. When the tanks require to be cleaned, the remaining water in them will be let off by a drain which is sunk below the level of the tank, and towards which the beds of the tanks slope. The drain is on a gradient of 1 in 500. The beds of the tanks being a smooth surface, they will be readily cleaned, first by washing them with remaining water 12″ deep, and by then attaching a hose to the supply pipe of the tank. These drains will be led into tanks which are around the base of the hill—the water may therefore be made available for irrigation or other purposes to a small extent. These drains will be partly tile drains, and partly open cuts or Channels.

FILTER BEDS.

Rate of filtration.

71. There are five filter beds, one of which will always be out of use for cleansing purposes. They have each an area of 2,336 square yards, or with 4 filters 9,344 square yards. The rate of filtration will be 642 gals. per square yard in 24 hours—which this gives 6,000,000 which is

the quantity required. This would be about 5.5 inches per hour. The rate of filtration to be efficient should never exceed 6 inches per hour.

Rate of Thames Company.

This rate has however sometimes been exceeded, and the following table exhibits the rates at a few of the English Water Companies filter beds.

	Inches per hour.
Chelsea	6·4
East London...	2·5
New River	4·5
Southwark and Vauxhall	3·0
Lambeth	10·7

Red Hills water is not so foul as Thames water.

Supply to the filter Beds

72. Each filter bed can be supplied with water from any of the six settling tanks.

Distribution how effected.

73. In leading the water from the settling tanks, the pipes leading it from a pair of tanks unite and pass into a collecting well, and from this well, pipes lead to all the five filter beds. These pipes enter the filter beds at a slightly higher level than the top of the sand, the regulating valves are placed at the various collecting wells.

Filtering Media.

74. The filter beds as designed shew three feet of water above the filtering media, which are—

2 feet fine sand.
1 foot sand size of shot.
1 foot gravel size of walnuts.
1 foot gravel large size.*

Drains for conveying away filtered water.

75. In the lower layer are the drains 6″ and 9″ in breadth according to their position in the filter bed. I propose that they be of 4½″ brick walls and flat tiles laid over them. The bricks will be perforated as also the horizontal tiles—these it is probable can be made in this country.

Formation of sides and floors of Filter Beds.

76. There are two available methods of forming the sides and floors of the settling tanks and filter beds. They are—1st of Brickwork laid in Chunam and pointed with Cement, and 2nd Laterite similar to that used in the Red Hills Tank Bund and plastered with Morgan's or Portland cement. I have estimated for executing the works in either way—in either case I propose to lay the masonry on puddle one foot thick.

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* The supply of filtering material is an important point. Sand can be had best I fancy from the Cortilliar River. Small gravel may be got at the Red Hills, their upper strata are composed of it. It would however require extensive washing. Larger gravel might probably be had from the Cortilliar, but there can be little difficulty in procuring this. The lower layers of the filter beds seldom if ever acquire renewal.

Collection of Filtered Water.

77. After filtration the water is carried by drains and pipes into the main collecting well—the pipes from Nos. 1 and 2 filter will be carried under filter No. 3, and the pipe brought to the same level at the well as the pipes from the other three filters. From this collecting well the water is led into the compensating and service reservoir.

Clearing out filters.

78. When the water is required to be completely led out of any filter in order to clean it, this will be performed by closing the valve leading to the Main collecting well and opening the valves on the pipes in connection with the lower part of this well, which has a double bottom—(see drawing No. sheet No.) the water is discharged from the under part of this well by a 12' stoneware pipe as shewn on drawing. It will therefore be noted that the arrangements for regulating the flow of all the filters is at this well, in addition to the appliances for completely exhausting the water from the filters.

SERVICE AND COMPENSATING RESERVOIR.

Extent required.

79. Were the water drawn off in the city at a regular rate, this would not be needed, but as the water is not so, we require, so as to allow of filtration proceeding regularly, to keep a certain quantity of water in reserve. The quantity required in 24 hours is 6,000,000 gals. Of this, however, one half or 3,000,000 gals. is drawn off in 6 hours, but as the filters only pass 1,500,000 gals. in this time, we require to make up for this difference of rate in receipt and supply. It is also necessary to keep always a head of water above the pipe. I have allowed for a reservoir able to contain 2,000,000 gals. if necessary, but except in exceptional circumstances, all this quantity would not be needed. The following shews approximately the varying rate at which water is taken in Madras.

				Gallons.	
3 hours	Filtered from	A.M. A.M. 6 to 9	Let	1,500,000	be the amount in tank at 6 A. M.
			...	750,000	
				2,250,000	
	Drawn from	6 to 9.........		1,500,000	
6 hours	Filtered	A.M. P.M. 9 to 3...........		750,000	This will be the amount in tank 9 A.M.
				1,500,000	
	Drawn	P.M. P.M. 9 to 3...........		2,250,000	
				1,000,000	
3 hours	Filtered	3 to 6...........		1,250,000	do. do. at 3 P.M.
				1,750,000	
	Drawn	3 to 6.........		2,000,000	
				1,500,000	
				500,000	do. do. at 6 P.M.
12 hours	Filtered	P.M. A.M. 6 to 6...........		3,000,000	
	Drawn	6 to 6...........		3,500,000	
				2,000,000	
Total 24 hours				1,500,000	do. do. at 6 A.M.

It will be observed that half the quantity is drawn 6 hours, viz., from 6 to 9 A. M. and 3 to 6 P. M.

The lowest at which the tank stands is 500,000 gallons and the height of the water when the tank holds 2,000,000 gallons is 10 feet, there will therefore never be less than 2½ feet in the tank, or perhaps rather more (say 3 feet), as the tank has sloping sides. As designed, the level of the water is to stand at 69.00 in the settling tanks above mean sea level, and in filters 8 feet lower or 61.00, and when the compensation reservoir is full with 2,000,000 gallons it will stand at same level of 61.00.

80. The general plan of tanks and filter beds also shews the following—

Turncocks' quarters.
Valve Houses.
Stores.
Offices.
Sand washing Box.

With the exception of the latter, these do not need to be described in detail; they are included in the estimate.

81. The sand washing box Sheet No. may however be briefly described. It is a large box formed of brick work having two floors with 9 inches space between. The upper floor is formed of perforated cast iron plates, and on this the sand to be cleaned is laid; between the floors the water is admitted at some pressure from the pumping Main. It enters between the floors and passing up through the sand which is being vigorously stirred by men with peculiar spades, carries off any earthy substance with it. The box is divided into three tubs, so that a large or small quantity can be washed. Two of these boxes are shewn on the general plan of the filter beds, &c. and have attached sheds for storing sand cleaned and that not so.

PIPES, VALVES, &c.

82. On the pumping main reaching the main valve house, it is divided into three branches to the three pairs of tanks, and in this house are the valves for cutting off the supply of water from any pair of tanks. On approaching the settling tanks, each branch is again divided into two, with valves to each tank. From the valve house just referred to, there will be an electric communication with the Engine House regulating the supply from the pumps to the settling tanks, or a self-acting communication could be made by allowing the water when it gets high enough in the tanks to run back through a small pipe to the Engine House and blow a whistle. This valve house should be erected with an upper story so as to allow of the levels of the water in the filter beds and tanks being carefully watched. The next most important valves are these at the main collecting well, (see drawing No. sheet), there will also be a valve on the Main from the Reservoir to the Town and valves will also be placed on the other pipes where necessary.

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MAIN FROM RESERVOIR TO MADRAS.

Size of Main.

Quantity it must be able to carry.

83. The size of the Main depends on the quantity to be supplied, the rate at which it must be supplied and the head of water obtainable.—The quantity to be supplied is 6,000,000 gallons per day, but at some hours of the day the demand will exceed this, we must allow in calculating the diameter of the pipe for the greatest possible demand and this will be about double the average demand so that the main must be able to supply at the rate of 12,000,000 gallons per day—this quantity equals—

Gallons.		c. ft.		
12,000,000	=	1,925,544	in	24 hours.
500,000	=	80,230	in	1 hour.
8,333	=	1,336	in	1 minute.
140	=	22	in	1 second.

The bottom of the service reservoir at Red Hills is 51.00 but the lowest level of the water in it will be 54·00 above mean sea level as before shown. The point at which the present Main is met in this scheme is at a level of 2·00 and this gives 52 feet of head, I calculate only however for 50 feet head. The 42 inch main towards the town is about the same level; at some points the branches are higher. This will not however to a great extent influence the calculation for the main.

84. I have calculated the diameter of the main by the two following formula which give the results set against them—

	inches.
* Beardmore's which gives the diameter as	34·40
† Hawkesley's do do as	37·33

By Neville's tables the velocity of discharge from a 36 inch pipe under same conditions is 38.8 inches per second, and this would give 22.2 cubic feet per minute which is the amount we require.

Calcutta Main.

85. In Calcutta the size of the pipes was determined by *Hawkesley's* formula and calculated to supply 6,150,000 gallons per diem at an average rate, (the compensating resevoir is in this case at end of the main next Calcutta), but by experiments made in 1870, it was found that the actual discharge was at least 8 million gallons an increase of 30 per cent. I think I am therefore warranted in estimating for a 36 inch main and this is what I have done.

Present Madras Main.

86. The present main (42″) is of course larger than this, because it has less head (23 feet less); but as this head is obtained only half a mile distant from the point of junction, the pipe is on that account less in diameter than it would be were this head obtained at Red Hills or a similar distance away.

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* Beardmore's formula is $D = \cdot 235 \sqrt[5]{\frac{l \times q^2}{h}}$ in which, D = diameter in feet. l and h the length of pipes and head in feet and q the quantity to be discharged in cubic feet per second.

† Hawkesley's formula is $D = \frac{1}{15}\sqrt[5]{\frac{g^2 l}{h}}$ in which g = No. of gallons to be discharged per hour, l the length of pipe in yards, and h the height in feet and D the diameter of the pipe in inches.

87. I think it will be expedient to replace the part of this main between the point of junction and the masonry shaft by smaller pipes suited to the consumption of the few houses it supplies. The part between the junction of the new main and town end of the old main should also be removed and replaced by 36 inch pipes. The question mooted in G. O. No. 1,174 of 5th April 1877 as to the advisability of moving these 42 inch pipes to part of the route between the Red Hills and Kilpauk demands a reference. It would evidently not be proper or expedient to place the pipes directly next the reservoir as on this part of the route we have a greater inclination than on any other and a less size of pipe than 36 inch in diameter should probably be used here, so as to keep up a proper train and a pipe of greater diameter than 36″ between this part and Madras. There can be no doubt that these 42 inch pipes cannot be laid on this latter portion of the route without continuing them all the way to Madras, and the expense of such a proceeding debars us from it. I do not at present see where these pipes can be used at all.

Valves, &c., for Main.

88. The main should be furnished with scour cocks and self-closing valves which would close on any burst taking place and causing a great increase in the velocity of flow. Air valves will also be needed, and a few stop valves should be provided to divide the main into short districts to enable it to be readily repaired if need be.

89. I have now described the works which I propose, I think fully enough to shew their main points, and to enable it to be said whether they can be executed for the amount set down in the estimate.

Storage Reservoir.

90. There is however another point to be referred to, and that is the construction of a storage reservoir in the old Lunatic Asylum compound, the cost of which I have not included in the scheme. The level of the ground is about 12.00 and its area is about 11½ acres. The highest points which we need to supply are at a level of 20·00. It is therefore evident that any reservoir must be above the level of the ground. I propose that if it is thought absolutely necessary to have a storage reservoir, to construct it so that its highest water level may be 10 feet above ground level, or a level of 22.00; if the reservoir were made of an area equal to about 384,000 square feet for which there is an ample space, the reservoir would hold four days supply, and this is a much greater time than the main if properly laid would ever take to repair. Two days might be taken as the extent I think, and if so, the reservoir would only fall 5 feet and be at a level [illegible] 17.00 which would still supply Black Town and other low parts of the town* in which are the greater parts of the population. The cost of such a reservoir of masonry may be approximately stated at Rs. 2,00,000, and if covered as it should be, it would cost considerably more. It would be unsafe I think to put a earthen revetted embankment so near the town.

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* If this plan is adopted the pipes over the Elephant Gate and Hospital Bridges must be relaid under the Canal instead of over the Bridge as they will be too high when this reservoir falls.

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91. I think it necessary to institute a comparison between the areas of the works allowed in this scheme for settling and filtration—and those at Calcutta and it is as follows :—

Comparison between this scheme and Calcutta.

	Scheme for Madras Square feet	Calcutta. Square feet.
* Settling Tanks ...	270,000	750,000
Filter Beds ...	105,120	160,000

92. This needs some explanation, and I think it is to be found in this, that the water is so foul above Calcutta where drawn from the Hooghly, that it takes one month to clean a tank, and that the deposit of mud is one cubic inch to the cubic foot or 1 in 728 in bulk *when dried.* As this however has to be removed from the settling Tanks in the fluid state of soft mud three or four times daily the above proportion of bulk amounts to 4,000 to 5,000 cubic feet of mud daily from 6 million gallons of water.† Again in the filter beds two are always available for cleaning at Calcutta, this however I think, necessary, looking to the very different quality of water which will be received upon them in this scheme. I have already shewn that the area I have allowed is perfectly sufficient, and Calcutta can be no guide in this respect.

Why area of tanks and filter beds less than at Calcutta.

93. To give however other evidence. Take the five "Thames Companies" viz., The West Middlesex ; Grand Junction ; Southwark and Vauxhall ; Lambeth and Chelsea. The average area allowed by these Companies for subsiding reservoirs is 4.22 square yards and for filters 2.34 square yards per 1000 gallons in 24 hours, this for the scheme under consideration would be

$$\text{Settling Tanks} \quad \frac{6{,}000{,}000 \times 4.22}{1{,}000} = \overset{\text{Sq. yds.}}{25{,}320} = \overset{\text{Sq. feet.}}{227{,}880}$$

$$\text{Filter Beds} \quad \frac{6{,}000{,}000 \times 2.34}{1{,}000} = 14{,}040 = 126{,}360$$

94. It will be seen that the Calcutta area is greatly in excess in both cases. The settling tanks I propose are slightly larger in proportion while the filter beds are slightly less—it will, however, I think be admitted that Thames Water is never so clear as water from the Red Hills Lake taken from near the surface.

Calcutta in Excess.

ESTIMATE.

95. In making the estimate I have not gone fully into detail, only sufficiently so to get at a close approximation to the cost. I have allowed ample rates, and having been guided by prices lately paid in the district.

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* The depths in this scheme and at Calcutta are the same.

† See Jackson on Calcutta Water Works.

96. The following is my Estimate for the works, such as I have detailed in the foregoing reports and on the drawings attached :—

Particulars.	If of Brickwork.			If of Laterite.		
	Rs.	A.	P.	Rs.	A.	P.
Construction of Tower, including forming dam for it and for culvert	8,000	0	0	8,000	0	0
Machinery in Tower	3,500	0	0	3,500	0	0
Pier to support Gangway......	1,422	0	0	1,422	0	0
Culvert through Bund	1,200	0	0	1,200	0	0
Three Engines of 32 H. P. nominal including Pumps, Well, Buildings, &c., &c., at 1,200 per H. P....	1,15,200	0	0	1,15,200	0	0
Pumping Main between Tower and Filters, including laying and carting	30,815	0	0	30,815	0	0
Excavation, Masonry, Drains, Puddle, &c., &c., in Filters, Settling Tanks, Service Reservoir, &c., &c.	5,40,126	0	0	2,65,578	0	0
Turncocks Quarters	3,000	0	0	2,000	0	0
Valve Houses at Filters, (2)	2,000	0	0	1,500	0	0
Offices, Stores, &c	3,000	0	0	2,000	0	0
Gateway	2,000	0	0	1,500	0	0
Sand washing Boxes, (2) &c., including Piping to do ...	1,660	0	0	1,158	0	0
Drains, Pipe and Tile, &c	2,000	0	0	2,000	0	0
6·28 miles of 36" Main to Madras, including laying and carting an average of 6 miles	4,97,635	0	0	4,97,635	0	0
Stop, Self-acting, and Air Valves, on do.	13,920	0	0	13,920	0	0
Valves, Piping, Branches, Junctions, &c., and Machinery at Filters	16,644	0	0	16,644	0	0
Total...	12,42,122	0	0	9,64,072	0	0
Add for contingencies, &c., 10 per cent...	1,24,212	0	0	96,408	0	0
Grand Total...	13,66,334	0	0	10,60,480	0	0

The above estimate shews the cost of the several works in Brickwork and in Laterite. The tower which I have shewn to be of Brickwork in each estimate might perhaps be also of laterite, but I fear that the latter material is too porus to make satisfactory work in the tower. The difference of the cost of Laterite and Brickwork is very great. I have estimated that good Brickwork can be done at Rs. 12 per cubic yard, which is a moderate allowance. Laterite Pitching which I propose should be used in settling tanks and filter is said to have cost at Red Hills Tank Annas 8 per cubic yard. I am unable to see how it can have been done for this amount. The price I have estimated these works at is Rs. 4 per cubic yard, and this includes plastering with MORGAN's cement :—and I think there is little doubt that the work can be executed for this amount. It may then be safely considered that the cost of these works will not exceed 10½ Lacs—were they to be carried out in full.

97. The consumption in Madras at present however is only 7½ gallons per head instead of 15 gallons for which these works are designed. Therefore the full Engine power would not be at first required. As the three Engines estimated for can do one and a half times the work, one Engine will do half the work, and if two Engines are ordered at present we have one for the contingency of the other breaking down. We may then deduct the cost of one

Present consumption in Madras.

Acting President Municipal Commission

Engine less the cost of Buildings, say this is Rupees 1,000 per H. P. nominal and this decreases the estimate by
H. P. Rs. Rs.
32 × 1,000 = 32,000.

98. Again the filter beds will be more than sufficient, and we may do without one of these and one pair of tanks, and this would be about Rs. 1,15,000, so that probably the amount required to be at first expended would not be more than Rs. 9,00,000.

99. In an Appendix I give the rates at which I have estimated the various classes of work which will in a measure shew whether the estimate is likely to be sufficient or not.

100. There is one method to be noted by which part of the cost of the cartage of piping, engines, &c. might be saved, which is, that most of the material might be landed at the Madras Railway Company's Wharf and trucked to Perambore—and thence carted back towards Madras for some distance, and also to the Red Hills—by this means a large saving in the cost of cartage would result.

MAINTENANCE.

101. The cost of Maintenance will depend greatly on the cost of coal which I have put down at Rs. 25 per ton delivered at the Red Hills. The monthly cost would probably be as follows :—

		Rs.
1	Superintendent at Rs. 250	250
3	Drivers at Rs. 60	180
3	Firemen at Rs. 20	60
112	Tons Coal (4½ lbs. per actual H. P. (32) per hour at work ...	2,800
12	Coolies at Rs. 6	72
10	Turncocks Rs. 20	200
	Sand for filters and cleaning*	550
	Oil contingencies, &c.	300
	Total...	4,412

This is equal to Rs. 53,044 per annum. As before shewn the present consumption is only 7½ gallons instead of 15 gallons per head per diem, and the above is for pumping the whole 15 gallons. The cost for the 7½ gallons per head per diem would amount to not more than 30,000 or 36,000 per annum, and this latter amount capitalized at 5 per cent. = Rs. 720,000. If we add this amount to the estimate of 9,00,000 it gives us Rupees 9,720,000 which will be the *first total cost.*

102. In concluding this report, I wish to remark that it includes with the accompanying plans, sections, &c., all the information desired by Government. If the estimate be adopted and the design for the Tower Culvert &c., be approved of by the Chief Engineer for Irrigation these works may be started at once as pointed

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* The cleaning of filters has been taken at Rs. 2-8 per million gallons filtered in 24 hours. In England it cost about 10s. or 5 Rs.

out by Colonel Mullins in G. O. under reference. Probably every day now lost will increase their cost.

103. I cannot venture to hope that Government will accept the whole scheme as proposed by me without further professional advice, but I venture to ask, that unless some practical objections can be urged against my proposals that they be submitted on any doubtful points for the consideration of some consulting Engineer of eminence, who might amend the scheme as he considered necessary.

104. No doubt the scheme might be made more complete, but most probably at increased cost, and if so, I fear that it would be beyond the means of the Municipality to carry out.

105. There is no doubt that the works could be carried out by the Municipality departmentally as far as regards the excavation and masonry works at less cost, and in much less time, and much more satisfactorily than could be done by any contractor, and of this I have had some experience in other places—and I venture respectfully to ask that His Grace the Governor in Council will reconsider his views as to the placing of the works in the hands of an English contractor.

106. I beg that any omissions in this report, these plans, &c., may be criticized as leniently as possible. I have had little or no assistance in their preparation, and it was necessary for me on account of other duties to spend as short a time on this work as possible.

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

J. A. JONES, Assoc : Inst. c. e.

Executive Engineer,
Madras Municipal Commission.

Madras, *June 1877.*

APPENDIX No. I.

Table Shewing rates used to form Estimate.

Nos.	Particulars		Rates.		
			Rs.	A.	P.
1	Brickwork per	Cubic yard.	12	0	0
2	Laterite built in Chunam and plastered with Morgan's cement...	"	4	0	0
3	Clay Puddling	"	0	8	0
4	36" Piping delivered in Madras	Ton	80	0	0
5	Laying do per	Lineal yard.	3	8	0
6	18" Piping delivered in Madras	Ton	80	0	0
7	Laying do	Lineal yard.	2	12	0
8	Cartage of Piping per	Ton mile.	0	3	0
9	Excavation at site of Filters &c....	Cubic yard.	0	4	0
10	Cost of Valves, Bends, Sluices, &c. taken at same rates as Madras W. W. contract.				

APPENDIX II.

The following Statement shews the cost of "Gravitation and Pumping" works constructed in England for a supply of 20 gallons per head per day.—

Town.	Population.	Maximum daily supply.	Total Cost.	Cost for a supply of 20 gallons per head per diem.
		Gallons.	£	£
Gosport ...	22,000	222,000	21,000	1·75
Hartlepool ...	30,000	20,00,000	75,000	·75
Kendal ...	13,000	300,000	15,500	1·03
Liverpool ...	6,20,000	16,500,000	2,000,000	2·42
The Potteries ...	1,30,000	3,000,000	215,157	1·43
Merthyr ...	55,000	1,500,000	84,000	1·12
Newport ...	30,000	15,000,000	52,000	0·07

The cost of the scheme now proposed for Madras is, say Rs. 10,50,000 say ... £1,05,000
It has cost already ... ... Rs. 12,80,000 ... £1,28,000
Total... £2,33,000

This amount for a population of 400,000 = £ 0·58 for 15 gallons per head or say
for 20 gallons ... ... 0·77

The average of the above towns is ... 1·37 for 20 gallons per head,

The cost of Calcutta Works was
£570,596 for 429,535 people = per head... ... £ 1.33 for 15 gallons nearly
(say) 1.77 for 20 gallons per head.

It will be noted therefore that Madras even after this scheme has been carried out will be supplied with water at almost half the rate of the English towns noted and at considerably less than half what the Calcutta works cost.

J. A. J.

APPENDIX III.

Memorandum on a method of supplying Madras direct through a pipe without pumping, and by which the water may be able to be drawn when the Lake stands at any level—

I.—The bottom of Red Hills Lake at lowest point is 20·00.

II.—The fall between this level and the point at which the main is joined in the scheme to which this memorandum is attached is 20 feet.

III.—If a continuous pipe be laid to deliver water while the Lake is at any level not lower than 22·00, no part of the pipe can be above this level, and none of it should be higher than the line of vertical declevity.

IV.—The distance from the centre of the Red Hills Lake to the point previously described is about 40,820 feet—on a line of country near the present channel, but slightly lower than the level of its bed.

V.—The average depth of cutting required to lay this piping as above described would be 12 feet.

VI.—The means I would provide for drawing off the water would be as follows—

1. An Iron Cylinder 8 or 10 feet in diameter, which would be sunk, say 10 feet below the bottom of the Lake, and extend to about 6 feet above Full Tank level. The total length of this Cylinder would be 42 feet.

2. The Cylinder would be provided with valves at various depths below the Full Tank level.

3. The part of the Cylinder below the bottom of the Tank would be excavated and filled with concrete.

4. The main to Madras would enter through the side of the Cylinder, and be turned up through the concrete to the level of the bottom of the tank.

5. There would also be a valve on the main inside the Cylinder.

6. The Cylinder would be approached by a boat from the banks of the tank.

7. The main must be able to supply at least 6,000,000 gallons per day, but as half of this is drawn off in 6 hours, the main should be large enough to supply 12,000,000 gallons per day, and should be able to do this when the tank is as low as (say) 22·00.

8. The diameter of such a main would be 44 inches.

9. At times when the tank is at a higher level than (22·00) the quantity able to be delivered through such a main would be much increased.

10. The cost of such a scheme as the above is detailed below.

11. I have also shewn in a table what a 44 inch and 36 inch diameter main would supply at varying levels in of the tank, and the cost of a scheme with a 36 inch main.

12. In starting from the tank it would perhaps be the least expensive method to lay the piping along the Channel leading to the Soorapadu Sluice.

13. The iron Cylinder would be floated out by means of pontoons, only so much of it being put together at first as would enable it to be lowered to the bottom of the lake without its higher end being covered.*

14. The following are estimates for the above scheme with a 44 inches and a 36 inch main

	44 inch Main.	36 inch Main.
Cylinder and Tower in Tank	3,000	3,000
Erecting do	2,000	2,000
Machinery in do	2,000	2,000
Cost of Main Lineal yards 13,606	7,61,920	5,71,440
Laying do	68,030	37,416
Excavation	36,284	31,750
Cartage of Main	10,714	8,035
Valves in Main	8,400	5,760
	890,348	661,401
Contingencies	89,052	66,149
Total...	9,79,400	7,27,550

15. The amount of expenditure in Maintenance would be very little, certainly not more than what it costs to maintain the present Channel.

16. It will be observed that with this scheme there is no filtration, but its advantages over present arrangements would be that water would always be drawn from near the surface of the lake and that it could be drawn off to a depth of 11 feet below the level of present delivery Channel.

17. So long as the water remained above the level of the present Channel, the Head of water in Madras would be *at least* 2 feet greater than it now is, as there is about 2 feet fall in the length of the Channel.

18. A rise in the level of the water in the Lake above 31·31 does not practically increase the head to any extent in Madras at present, though it increases the quantity of water which can be delivered by the present Channel in a certain time.

19. By means of this scheme the head of water will vary, and when the lake is full the head in Madras will be about 44 feet at the point previously described.

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* Such a tower as this composed of iron cylinders might probably be cheaper for the scheme with filtration than a brick tower if the tank stood at a high level.

TABLE SHEWING the quantity of Water which would be delivered in 24 hours by pipes of 44 inches and 36 inches in diameter, at varying levels of the Red Hills Lake.

Tank Level.		Head taken as	Delivered by pipes of	
			44 in. diameter.	36 in. diameter.
Above mean sea	22.00	20	$\underline{1340}$ 12,060,000	$\underline{804}$ 7,236,000
	27.00	25	$\underline{1500}$ 13,500,000	$\underline{900}$ 8,100,000
	32.00	30	$\underline{1640}$ 14,760,000	$\underline{984}$ 8,856,000
	37.00	35	$\underline{1784}$ 16,056,000	$\underline{1070}$ 9,630,000
	42.00	40	$\underline{1900}$ 17,100,000	$\underline{1140}$ 10,260,000
	46.00	44	$\underline{2022}$ 18,198,000	$\underline{1213}$ 10,917,000

NOTE.—The smaller quantities underlined thus —— are cubic feet per minute.

The larger quantities are gallons per day.

In reading the above table it should be remembered that Madras requires 6,000,000 gallons per day or 666 cubic feet per minute, but that during certain hours the consumption is double this quantity.

J. A. JONES.

APPENDIX IV.

RED HILLS TANK.

Table showing Cubical Contents at half foot vertical intervals.

Height above mean sea level.	Contents at level in column 1.	Difference of cubical contents at each half foot.	Height above mean sea level.	Contents at level in column 1.	Difference of cubical contents at each half foot.
1	2	3	1	2	3
FEET.	CUBIC YARDS.	CUBIC YARDS.	FEET.	CUBIC YARDS.	CUBIC YARDS.
22·31	944,514		34·81	33,646,893	2,103,979
22·81	1,485,647	541,133	35·31	35,826,419	2,179,526
23·31	2,099,961	614,314	35·81	38,080,312	2,253,893
23·81	2,787,152	687,191	36·31	40,406,379	2,326,067
24·31	3,546,648	759,496	36·81	42,809,544	2,403,165
24·81	4,379,655	833,007	37·31	45,318,050	2,509,506
25·31	5,285,442	905,787	37·81	47,899,712	2,581,662
25·81	6,248,189	962,747	38·31	50,544,433	2,644,721
26·31	7,266,081	1,017,892	38·81	53,248,891	2,704,458
26·81	8,339,998	1,073,917	39·31	56,013,395	2,764,504
27·31	9,467,808	1,127,810	39·81	58,840.739	2,827,344
27·81	10,651,052	1,183,244	40·31	61,767,999	2,927,260
28·31	11,889,957	1,238,905	40·81	64,667,822	2,900,823
28·81	13,141,584	1,251,627	41·31	67,651,247	2,983,425
29·31	14,475,912	1,334,328	41·81	70,716,557	3,065,310
29·81	15,874,637	1,397,725	42·31	73,861,778	3,145,221
30·31	17,338,013	1,464,376	42·81	77,090,852	3,229,074
30·81	18,873,401	1,535,388	43·31	80,401,616	3,310,764
31·31	20,477,034	1,603,633	43·81	83,800,897	3,399,281
31·81	22,132,523	1,655,489	44·31	87,280,564	3,479,667
32·31	23,864,963	1,732,440	44·81	90,838,735	3,558,171
32·81	25,671,308	1,806,345	45·31	94,473,127	3,634,392
33·31	27,552,497	1,881,189	45·81	98,188,189	3,715,062
33·81	29,510,484	1,957,987	46·31	101,981,815	3,793,626
34·31	31,542,914	2,032,430			

P.W. Pros. 9-12-77
No 4697 W.

For reading

P1

Municipal Commissioners' Office,

G. No. 548

Madras, 13th August 1877.

From

The Hon^ble^ J.G. Coleman
~~L. R. BURROWS~~,

Acting President Municipal Commission.

To

The Hon^ble^ D. F. Carmichael
Chief Secretary to Government
Fort St George

Sir,

Agreeably to the instructions contained in G.O. 5th April 1877, No. 1174, Public Works Department, communicated in G.O. 25th April 1877 No. 1343, Financial Department, I have the honor to forward the Report of the Municipal Executive Engineer on the present condition of the Madras Water Works with Schemes for their improvement.

2. Besides lithographed plans which are appended to the Report a Map of Madras shewing piping as laid at present with levels of bottom of pipes is forwarded.

I have the honor to be,
Sir,
Your most obedient Servant,
J.G. Coleman
Acting President Municipal Commission.

No 1570

82

Forwarded to the Public Works Department with reference to G.O. in that department dated the 5. April /77. No 1174.

D. Carmichael
Chief Secretary

Hutson Sengr
15th September /77
to the Public Works Department.

with 1 Cover 1 Plan & Book*
* not recd in Record Office 22/11

No 4787

Judl 1877 Sept

From
The Actg President
Municipal Commission
Madras

To
The Chief Secretary
to Government
Fort St George.

Dated 13th August
Recd 14th Do

No 548
Enc. 3.

Forwards the Report of the Municipal Executive Engineer on the present condition of the Madras Water Works. —

Forwarded

5 Apl 1877 No 1174
10 Aug 1876 " 2066—

Cir 17.4.78. Retd 25.4.78.
O.L. Ackd 8 Apl
Cir 8/4.

Municipal Commissioners' Office,

E. No. 568

EX-ENGINEER'S DEPARTMENT,

Madras, 24th July 1877.

No 3

From

J. A. JONES, Esq.,

Executive Engineer, Municipal Commission.

To

The Hon. J. G. Coleman
Ag. President M. M. C.

SIR,

I have the honor to forward Report on the Madras Water works in connection with G. O. 1174 of 5th April last.

This report has been somewhat delayed by the lithographing of the plans.

In addition to the information in the report I have to state that I had a "bore" of 28 feet made on the proposed site for the filters as desired by Col Mullins and this shews that Laterite extends to that depth and is similar to that found on the surface though a little more compact.

Spare copies of the report are

are available if Govt require further Copies.

I have the honor to be
Sir
Your Most Obed. servant
(Signed) J. A. Jones
Ex. Engineer In C.

(True Copy) W. Colman
Acting President

11/1867 7/1/7

P. W. D.

P 6

Memorandum.

Endorsement of the Chief Secretary
No. 504 dated 19th March 1878.

In the letter forwarded with the above the President of the Municipal Commission brings to notice that since the date of the Executive Engineer's report on the Water Supply of Madras circumstances have greatly changed, that there is now an ample supply of water of excellent quality and that the improvement of the Supply by pumping filtering and the substitution of iron pipes for an open Channel is no longer a matter of pressing need.

2. The Chief Engineer in returning the Executive Engineer's report which contained descriptions of several methods of improving the supply recommended the adoption of the method described in the appendix to the report. According to this method there would be no pumping or filtering but the water would be drawn from the tank to a lower depth than at present through an iron Cylinder to be erected in the tank and conveyed through iron pipes to the town. The iron Cylinder was to be provided with valves at various depths below full

tank level, so that the water might always be drawn off from near the surface.

3. The cost of this scheme though less than that of the others still amounted to seven lacs. As it may be difficult to provide this sum at present the President of the Municipal Commission has now suggested a modification of the above scheme. He proposes that the iron Cylinder with valves shall be erected in the tank as in the complete scheme, but the iron pipe leading from it instead of being continued all the way to Madras is to be connected with the lowest pipe of the Municipal sluice in the tank bank, and the water conveyed thence to the town, as at present, by the existing open Channel. By this method the expence of several miles of iron pipes will be saved but on the other hand, the supply will fail, as it does now, when the tank has fallen fifteen feet below full tank level and the evil of an open Channel is retained. Still there will be a considerable gain, as the water entering this open Channel, being drawn off from near the surface of the tank, will always be purer than at present, particularly when the water in the tank has fallen to near the level of the present off take. This is in such a position the report states that "in drawing off the water it passes over a large expanse of slimy mud" and the last five feet of water that can be drawn off, under the present arrangements ~~the water~~ is pronounced to be impure. The cast iron cylinder now proposed to be erected can be utilized in any more perfect scheme that may be adopted hereafter, so the amount now proposed to be laid out will not be lost, and so far as it goes will effect a real improvement in the water supply of Madras.

E A Trevor Colonel R. E.
Chief Engineer, P.W.D.

Fort St George
4th April 1878.

Cir. 1794.78 Retd 25.4.78
T.L. Sheel 8 Apl
Cir 6-4-78

No

Memorandum

Endorsement of the Chief Secretary No. 1570 dated 15th August 1877.

—

The report on the present condition of the Madras Water Works describes in more or less detail six methods of improving the supply. Four of these are for the improvement of the present system the fifth, which is the main subject of the report, and is illustrated by plans and sections, is for raising the water from the tank by pumping, and its conveyance after filtration by iron pipes instead of the present open channel. The sixth method, briefly described in the appendix to the report, is for conveying the water by pipes all the way, but without pumping and without filtering.

2. Water is at present brought from the Red Hill Lake to Madras, without filtration in an open channel and is afterwards distributed by means of iron pipes. The full tank level is 46.31 feet above mean sea level. The lowest pipe which draws off water from the tank is at 31.31 while the tank bed is at 20. The defects in the present system are considered to be 1st that from the position of the Off-take, water can only be drawn while the tank level is above 31. and is scarcely potable after it has fallen below 36. 2nd that it is conveyed in an open channel. 3rd that it is not filtered before delivery.

3. The first and fourth of the schemes for improving the supply are for conveying the water in the present open channel, and filtering it either at Madras or at some place between the tank and Madras. As these schemes involve pumping, and as the supply of water would fail, as at present, when the water in the tank had gone down fifteen feet, they need not be discussed. The second and third of the schemes provide for cutting down the present channel six feet at the head, so that six feet more water could be drawn off from the tank, and filtering the water either at Madras or at some place nearer the tank. The cost of these schemes is set down at Rupees 988163 and Rupees 1122060 respectively. About half, in each case, being for filters and reservoirs, and the rest for engine and pumps, lower the channel and altering masonry

works at road crossings. The objection to either scheme is that the cost is not less than that of the method next to be noticed which provides for an iron main in place of the present open channel, as well as pumping and filtering. This, the fifth method, and the one recommended by the Municipal Engineer, is described at pages 7 to 23 of the report. The estimate amounts to either Rupees 1366334 or Rupees 1060480, according as brick or laterite is used for the masonry works. The estimate provides for constructing a water tower in the tank, for an iron main thence to the pumping engines, for constructing filters, settling tanks, service reservoirs &c &c and laying about six miles of 36 inch main to Madras. It is the intention of Government, as it is also the wish of the Municipal Engineer, that the selected estimate and plans should be submitted for the opinion of a Consulting Engineer of eminence with special knowledge of the subject of Town Water supply. As this Engineer will probably not have resided, at any time at Madras, or have seen the Red Hill Tank, he may take for granted that the water must be filtered before delivery and proceed to report on the best position and construction of the filters, power of the engine, size of the main &c. But if it can be shown that filtering is not necessary, it is needless to consider the details of a scheme of which filtering is an essential part.

Five or six years ago the Red Hill -

water was analyzed and found to be purer than that obtained from the Seven Wells; and at this present time, the water is pronounced to be of excellent quality. The water delivered at Madras, last year, during the drought, was certainly very offensive, but then owing to the so short and intermittent supply the water was contaminated in its passage from the tank to the town. Ordinarily, the water is purer as it leaves the tank, than the water supplied, after filtration, by some of the London companies. The water supplied to the troops at Bangalore from the Ulsoor tank is filtered before it is sent through the pipes, but some portions of the drainage area of that tank are very foul, and the water in the tank is always muddy. This is not the case with the Red Hill water.

The sixth and last of the methods for improving the water supply of Madras is that described in the appendix. By this method, the water would be conveyed from the tank to Madras in iron pipes and be drawn from an iron cylinder 8 or ten feet in diameter, provided with valves, at different levels, to be erected inside the tank. By this method the water would always be drawn off from near the surface, where it is purest, and the pipe could be laid so as to draw off water to several feet below what is now practicable. Two of the evils of the present system – the open channel and the stoppage of the supply when the tank has fallen 15 feet – would thus be got rid of while no provision is made for filtration the necessity for which, is at least not urgent. The cost of this method, though less than that of the others, is still considerable - upwards of seven lacs, using the smaller of the two sizes of main suggested, but then it must be remembered that the cost of maintenance will be much less than if any scheme be adopted which involves pumping and filtering. It seems on the whole the best suited to the circumstances of Madras.

In explanation of the long time the Municipal Engineer's report has been in the hands of the Chief Engineer, he has to observe that when he received the report he had not seen the Red Hill tank, or any of the works connected with the Madras Water supply. The Municipal Engineer from whom he wished to obtain some information went on leave immediately after sending in his report, and soon after his return, the tank was stated to be in imminent danger. The method of conveying water from it became then of secondary importance to the necessity for securing the safety of the tank. Repairs have been carried out by the Superintending Engineer Chingleput, but some additional work is required to enable the tank to retain a full supply. The tank was last visited by the Chief Engineer on the 11th of March when he was confirmed in the opinion that he, from the first, formed as to the best method of bringing the water to

? No 6.
above

Madras.

E A Bird Colonel R.E.

Chief Engineer P.W.D.

6th April 1878.

2

~~The Chief Secretary to Government~~

~~with the papers returned~~

Cir - 1708-78 Rptd 25.4.78
O.L. Shut 8 Apl
Cd. 8.4

Madras Municipality,

E. No. 1435

EXECUTIVE ENGINEER'S DEPARTMENT,
Madras, 18th March 1878.

From
L. R. BURROWS, Esq.,
Acting President Municipal Commission.

To
The Hon'ble D. F. Carmichael
Chief Secretary to Government
Fort St George.

Sir,

In G. O. dated 5th April 1877 No. 1174 c Public Works Department the Government were pleased to call for information on certain points connected with the Municipal Water Supply. On the 13th August Mr Coleman who was then Acting as President forwarded for submission to Government a report drawn by the Municipal Engineer on the present condition of Water Works with schemes for their improvement.

2. Since the submission of this report the circumstances of the Water supply of the city are greatly changed. At that time or to within a short time previous the supply was scanty, was obtained at great expense by pumping, and the quality was very inferior. At the present time the supply is abundant, no expense is incurred for pumping, and the quality is excellent.

3. The improvement of the supply is therefore

no longer felt to be a pressing need. Attention is now more directed to the imperfect distribution of the water. Though my present purpose is not to propose any scheme for securing a more perfect distribution, I may mention that Mr. Jones has in readiness detailed proposals for the extension of the pipes and erection of additional fountains the estimates for which amount in the aggregate to over Rs 3,00,000. My present object is to call attention to the subject dealt with in Mr. Jones' report and to hasten so far as I am able the solution of the question as to what is the best thing to do under the present circumstances. For I imagine that after the experience of last year every one will be ready to admit that something must be done.

4. In the report of the Water Supply Committee in which the present system of water works was recommended the following passage occurs in para 40. "We have given the subject of Water Supply and its distribution careful consideration and we have arrived at the conclusion that for the present, at any rate, the class of people to whom we propose giving a water supply are unable to pay for a street service system under high

pressure

pressure, and that if we can possibly deliver the water within easy access of their dwellings from street fountain wells where the levels will admit and keep the existing tanks and reservoirs well supplied with good, pure, wholesome water it is as much as the people most interested can afford to pay for, and as much as their real pressing necessities require." In para 51 the Committee quote from a report of Dr. Wyndowe the Chemical Examiner in which he finds that "chemically speaking" the Red Hills water was by far the best specimen of drinking water he had yet examined at Madras, and they arrive at the conclusion that filtration would be unnecessary.

5. The object which the Committee appears to have had in view was to distribute unfiltered water, which should be "good pure and wholesome", under as good a pressure as was possible without pumping.

6. The history of the supply shows how far the present works have fulfilled the object of the Committee, to what extent they have failed, and the cause of their failure. And the question seems to me to resolve itself into this:— Is filtration, with its inevitable adjunct pumping, necessary?

On

Or can the object of the Water Supply Committee be attained without resorting to these expensive operations?

7 The conclusion to which I am led is briefly as follows:— that before resorting to filtration and pumping, it would be well to try the effect of an improved off-take at the Red Hills Lake. The means for drawing off the water might be (*mutatis mutandis*) those proposed in para 6 of Appendix III to Mr Jones' report, viz: 1 An Iron Cylinder 8 or 10 feet in diameter, which would be sunk say 10 feet below the bottom of the lake and extend to about 6 feet above Full Tank level. 2 The Cylinder would be provided with valves at various depths below the full Tank level 46·31' to the level of the sill of the Municipal Sluice viz: 31·31'. 3 The part of the Cylinder below the bottom of the Tank would be excavated and filled with concrete. 4 The Main would enter through the side of the Cylinder at the bottom of the Tank and would be connected with the lowest pipe of the Municipal Sluice.

8 If the above arrangement should prove successful the present channel would be utilized, and the expense of seven miles of iron pipe would be saved. Should it however prove unsatisfactory the

the money expended would not have been thrown away; as the means for drawing off the water above described could be utilized in any scheme for filtering and pumping that might afterwards be resolved upon.

9. I will now explain the process by which I have arrived at the above conclusion.

10. The pressure suffices to raise the water from 8 to 20 feet above ground surface in all parts of the town when there is a full supply at the Masonry Shaft, or in other words when the draught from the taps is not greater than the channel can supply. This only happens when there is a scarcity at the Red Hills or when the channel has become choked with weeds. It may therefore be said that the Water Supply Committee's object has been more than realized in the matter of pressure and that no improvement in that respect is necessary. What is wanted, is a better quality of water.

11. In a large Reservoir like the Red Hills Lake, the water varies in quality according to its position and depth. The best quality will be found remote from the margin of the land, a little below the surface and in places where the water is deep.

The

The worst water will probably be that which lies immediately above the slimy bed of the large shallow belt of water which forms the portion of the lake nearest to the Municipal Sluice. It is this latter description of water which, with our present arrangements at the Red Hills, we obtain in Madras. With the appliances described above we might obtain the former description.

12. The full tank level is 46·31′ above mean-sea. the level of the sill of the lowest pipe at the Municipal Sluice is 31·31′. The bottom of the lake in the deepest portion is about 20·00′ The water is brought up to the sluice from the shallow portion of the lake in a channel the bottom of which is a very soft slimy sort of mud. Through the sluice it is admitted into the Delivery channel which is 6 miles 7 furlongs in length terminating in a Masonry Shaft from which the head main is taken off.

13 The Municipal Sluice at the Red Hills consists of a number of pipes fixed in masonry at different levels, with valves for opening and closing them. The level of the sill of the lowest pipe is, as I said before, 31·31′ (above mean sea level) and that of the pipe next above it is 35·31′. When the water in the lake is above 38·00′ it is possible to obtain a full supply through the upper pipes and of good quality, but when it has reached that level it becomes necessary to open the lowest pipe. In August 1876 pumping was commenced when the level of the water was at 34·00 The water was raised to the level of the next upper pipe. Pumping was continued up to May '77. After the cyclone in May 1877 the water in the lake rose sufficiently high to admit of the lowest pipe being again used, but on opening the valve it was found blocked with a black and most offensive sediment, and this had to be cleared away causing a five days' interruption of the supply to the town. So long as the lowest pipe is open, the channel is kept clear by the scour which is created along its bed in the vicinity of the pipe, but the water drawn off is thus charged with sediment and is of bad quality

14. We have seen that in a space of nine months during which the lowest pipe of the sluice was closed (for pumping), the channel had silted up so as to block the pipe, and I anticipate that when it again becomes necessary to open the lowest pipe it will again be found blocked with silt and sediment, the removal of

of which will be attended with considerable delay and inconvenience.

15. The most obvious remedy is to make a new and deeper channel from the lake to the sluice. If the level of the channel bed were say 4 or 5 feet lower than 31·31' at the point where it joins the Municipal Sluice the bottom scour would be avoided and better water would be obtained.

16. A plan for excavating a new channel was prepared in the beginning of 1877 by the Municipal Engineer and submitted to Government for sanction as a famine work, but Government did not approve of the plan. It is clear that such a remedy would only be temporary. Before many years the same difficulty would be again experienced owing to the gradual silting up of the channel, which would continually be going on until the level of the lowest open pipe was reached.

17. It will be objected to the arrangement proposed in para 7. 1st that when the lake sinks to 31·31' or even to within a foot above that level, the supply to the town will cease, although there would be ten feet of water in some part of the lake. 2nd that so long as the open channel is retained for conveying the water to Madras the supply will be liable to interruptions & the water to contamination.

18. In reply to the first objection I can only say that the Government have made a valuable concession to the Municipality in allowing them to take the water off at a level of 31·31' and in undertaking to reserve for the Municipality as much as sha be required above that level; that it would not be wise to relinquish so valuable concession without further trial: that we may reasonably hope that such years as 1876 & 1877 will never again be experienced, but that if such an exceptional season does again visit us, arrangements must be made for pumping as in 1876-77. The second objection is more serious. But as we have the channel we must try and make the most of it. Contamination can be and is reduced to a minimum by careful watching, and means may be devised for avoiding interruptions.

I have the honor to be
Sir,
Your Most Obedt. Servant
L. R. Burrows.
Acting President Muncl. Comn.

No 504

p16

Transferred to the Public Works Department.

Fort St. George
19th March /78.

Chief Secretary

To the Public Works Department.

Finl. 1878 Departt.
Municl. Water supply
From
The Acting President
Municipal Commn
Madras
To
The Chief Secretary
to Government
Fort St. George
Dated 18th March 1878
Recd 19th — do —
No 1435
No 1227
Reports on the circumstances of the water supply of the City since the submission of the Municipal Engineer's Report asked in G.O. 5th April 1877 No 1174 P.W.
Transferred

G.O. 10-8-76 No 2066
11-10-76 - 63 Mis
5-4-77 - 1174

Cir 17-4-78 Pd 25-4-78
O.L. Encl. 8 Apl
Cir 6-4-78

p17

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

7th June 1878, No. 1006.

Municipal—Water-supply.

Read the following paper:—

No. 26. *From L. R. BURROWS, Esq., Acting President of the Municipal Commission, Madras, to the Chief Secretary to Government, dated 3rd June 1878,* 506.

No. 911, of the 23rd May 1878, Financial Department.

In connection with the subject of the Government Order marginally noted, I have the honor to append, for the information of His Grace the Governor in Council, some analyses of the Red Hills water recently made by the Chemical Examiner to Government.

2. The analyses of the two samples of water taken on the 8th February from the delivery channel was for the purpose of testing the value of a filter invented by Captain Taylor; the sample marked * being water which had passed through the filter, and the other, water which had not passed through it.

3. Former analyses seem to prove that no contamination takes place in the pipes; the water taken from the most distant taps is always found to be as pure chemically as that taken from the channel.

ENCLOSURE No. 1.

ANALYSIS of Water from Red Hills Delivery Channel, dated 8th February 1878.

	Unlabelled.	Marked *.
Total solids, mgrm. per litre	0·170	0·170
Volatile " " "	0·045	0·045
Sodium chloride, " "	0·046	0·046
Total hardness	3°·5	3°·5
Permanent "	2°·2	2°·2
Free ammonia, mgrm. per litre	0·28	0·28
Albuminoid ammonia, mgrm. per litre	0·36	0·36
Nitric acid, " "	3·60	3·60

REMARKS.—The two samples of water are identical in quality. Taste and appearance good. Sediment of ferruginous clay with vegetable fibre; some water-fleas. Water from delivery channel was last examined in June. It then contained more solid and more volatile matter; permanent hardness was less; free ammonia was greater, albuminoid ammonia much greater, nitric acid much less.

ENCLOSURE No. 2.

ANALYSIS of Red Hills Water, dated 16th April 1878.

—	No. 1 Lake, 14′ below surface.	No. 2 Lake, 8′ below surface.	No. 3 Lake, 2′ below surface.	No. 4 Lake, 6′ below surface.	No. 5 Masonry Shaft, Kilpauk.
Total solids, mgrm. per litre ..	0·145	0·185	0·170	0·155	0·180
Volatile " " " ..	0·030	0·045	0·073	0·045	0·060
Sodium chloride, " " ..	0·056	0·059	0·067	0·056	0·056
Total hardness	4°·5	4°·8	4°·8	4°·8	4°·8
Permanent "	4°·2	4°·6	4°·6	4°·6	4°·6
Free ammonia, mgrm. per litre ..	0·16	0·16	0·08	0·16	0·24
Albuminoid " " " ..	0·38	0·36	0·52	0·36	0·36
Nitric acid, " " ..	1·35	1·35	0·30*	0·60	0·30*

REMARKS.—Considerable deposit of reddish clay and vegetable matter from Nos. 1 and 2. No. 3 contained much of a reddish flocculent substance when received; deposit large. Deposits from Nos. 4 and 5 small.

* Determination twice made.

No. 27.

ORDER THEREON, 7th June 1878, No. 1006.

Communicated to the Public Works Department, with reference to Order in that Department, dated 21st May 1878, No. 2240-W.

(True Extract.)

Chief Secretary.

To the Public Works Department.
" Military Department.
" Surgeon-General, Indian Medical Department.
" Sanitary Commissioner.
" President of the Municipal Commission, Madras.

Exd. A. F. Goodall.

No 71

Adjt Genl's office
No Dn Ooty
30th May/78

No 98

Memorandum

Forwarded to the Surgeon General British Medical Service for information and return.

By order
sd/ G. W. Jebb
Brig Genl
Adjt Genl

To,
The Surgeon Genl
BMS

1878
No 202 Vol. I P. 99

Secy to Govt
M. D.

Directing Surgeon Major Nicholson Medl charge Rly [illegible] to analyse the Red Hills water & submit the Report.

No 22/6

Medl Deptt. Brit. Force
Surgn Genl's Office
Ootacamund, 31st May/78

Memo.

Returned as requested

sd/ C. A. Gordon
Surgeon Genl
P. M. O. B. F.

To,
The Adjt Genl
Ootacamund

No 124/78

Surgn Genl's office
BMS
Fort St George, 4th June/78

Memo.

Returned as requested

sd/ G. B. Mouat
Surgeon Maj
for Surgeon Genl
P. M. O. B.

To,
The Adjt Genl
Fort St George

No 3244/78

Surgeon General's office
BMS
Fort St George, 28th Octr/78

Sir,

I am directed to request you will be so good as to call upon Surgeon Major Nicholson, M.D. for a report of the results of his investigations with regard to the analysis of certain samples of water, he is now engaged on, in compliance with P.M.G. No 2240 W, dated 21st May 1878, Public Works Department.

2. In the event of this duty not yet being completed, you will be so good as to ascertain when it is likely to be so.

I have &c
sd/ G. B. Mouat
Surgeon Major
Secy to Surgeon Genl
BMS

To,
The Depy Surgeon Genl
BMS
Presidency Circle

(Copy)

No 307

Royal Artys Hospl
St Thomas Mount
31st Octr/78

45

From

The Medl officer in ch.
R. Ay

To.

The Depy Surgeon Genl
B.M.D
Presy circle

Sir,

In reply to Letter* from Secy to Surgeon Genl B.M.D, I have the honor to state that this is the first intimation I have received on the subject of any chemical duty being confided to me by Govt.

When I am favored with instructions I shall be able to state how long the investigation will take.

* No 3244/78 herewith returned

I have &c
Sd/ E. Nicholson
Surgn Major
A.M.D
In Medl ch. R.A.

No 997

Madras
1st Novr/78

No. 109/4

Ref

Surgn Genl's No. 3244 of the 8th Ult.

Forwarded

sd/ A. H. Fraser
Depy Surgn Genl B.M.S.
Presy Circle

From
The Medl Officer
in ch. R.A.

To, The Dy Surgn Genl
B.M.S.
P.C.

No. 307

St Thomas Mount
31st Octr 1878

Relative
to chemical
duty.

No. 3334/78

Surgeon Genl's office
B.M.S.
Fort St George, 7th Novr/78

From,
The Secy to Surgeon Genl
B.M.S.

To,
Surgeon Major Nicholson
in Medl ch. R.A.
Saint Thos Mount

Sir,

Adverting to your letter No. 307 dated 31st Octr/78, I am directed to forward for your information copies of the documents marginally noted and to state that in performing the duties connected with the chemical examination of the Madras water supply, you must be prepared for any emergency such as a sudden move in the event of the exigencies of the service rendering it necessary.

1. P. M. G. No. 2610 dated 27th May/78 Sanity Departt.
2. Letter No. 74/0 dated 11th Octr/78 from Surgn Genl Gordon.
3. P. M. G. No. 4071 W. D/ 19th Octr/78 P. W. Departt.

I am further directed to point out that the chemical duties are not to interfere with your immediate duties connected with the charge of the Royal Artillery at Saint Thomas Mount.

I have &c
sd/ G. B. Mount. Bnd
Surgeon Major
Secy to Surgn Genl
B.M.S.

N/C
Deputy Surgn Genl
B.M.S.
Presidency circle

Sanitary – Potable Waters No 71

Mily Depart

No 2610

Proceedings of the Madras
Government
27 May/78

Read the following paper:—

Public Works Depart

No 2240 W.

Proceedings of the Madras
Government
Under date the 21st May/78

Proposals recently made for the improvement of the Madras water supply render it necessary that an examination and analysis should be made of the water at certain places in the system with a view to ascertain the sources of any impurity and contamination. The object in view will be best attained by analysis of specimens taken respectively from the Red Hill tank, from the Madras end of the open supply channel, and from one of the drinking fountains as at Triplicane.

His Grace the Governor in Council with the permission of His Excellency the

the Commander in Chief directs that the obtaining of the samples and their analysis be conducted by Surgeon Major Nicholson, Medical charge, Royal Arty Saint Thomas Mount, without prejudice to his present duties, who on completion of the analysis and submission of his report shall receive such remuneration as shall be determined by the Govt in communication with the Surgeon General, British Medical Department.

"True Extract"

Sd/ N. Fennell Col
Under Secy to Govt

To
Pd

The Military Deptt
order - Communicated
to His Excellency the
Commander-in-Chief.

"True Extract"

Sd/ J. Michael Col
Secy to Govt

To

The Adjutant General

GO No 2240 W 21-5-78 Orig

No. 6874

Govt. of (1878) Madras.

FINANCIAL.

To
The PUBLIC WORKS DEPARTMENT,
&c., &c., &c.

Recd 18 June

Dated June, 7th.
Issued 17
Recd. Encl.

G.O., 7th June 1878, No. 1006.

JUNE.
Nos. 26-27.

*Municipal Water-supply.—Letter from President, Madras Municipality, forwarding two analyses by the Chemical Examiner of Red Hills water, communicated.

To Actg 19-6-78

"Copy"

No. 74/0 Ooty 11th Octr 1878

From
The Surgeon General
British Forces

To
The Secy to Govt
P. W. Department
Ootacamund

Sir,

Adverting to Proceedings of the Madras Govt No. 2240 W, Public Works Department under date 21st May/78, I have the honor to observe that sufficient time appears to have elapsed for the analysis of the Madras water therein alluded to to have been completed by Surgn Major Nicholson, M.D. and in view to eventualities in Bengal, I am anxious to have this medical officer like others of the Army Medical Department at my disposal.

I have &c
sd C. A. Gordon
Surgn Genl
P. M. O. B. F.

Public Works Department

Proceedings of the Madras Government

Under date the

Read the following: —

From the Surgeon General British Forces } H. E. No 74/0 d/11th Octr/78.

Order thereon 19th Octr 1878, No 4071 W

The Surgeon General will call on Surgeon Major Nicholson for report of the result of his investigations.

"True Extract"

sd/ W. Farewell Col.
Under Secy to Govt.
P. W. D

To.
The Surgeon General
B. M. Service }

(Copy)

No. 3560/78

Surgeon Genl's office
B. M. S.
Fort St George, 25th Novr/78

From

The Secy to Surgeon General
B. M. S.
Fort St George

To,

The Depy Surgeon General
B. M. S.
Presidency Circle

Sir,

Adverting to the correspondence marginally noted, I am directed to request you will be so good as to ascertain from Surgeon Major Nicholson how far the water analysis referred to has proceeded and when it is likely to be completed.

This office Memo Nos. 3244/78 d/ 28th Octr/78 to Depy S.G. B.M.S. P.C. & 3334/78 d/ 7th Novr/78 to Surgn Major Nicholson through Depy S.G. P.C.

I have &c
Sd/ G. B. Mowat, M.D.
Surgeon Major
Secy to Surgeon Genl
B. M. S.

(Copy)

No. 338

Royal Arty Hospl
St Thomas Mount
25th Novr 1878

From
The Medl Offr in charge
R. Ay

To
The Secy to Surgeon Genl
Mds

Sir,

I have the honor to state that I shall be glad to undertake the analysis of water required by Government as communicated in your letter* of the 7th ctoor especially as I have, by me, a treatise on the Chemistry and Hygiene of water, the result of long Indian experience, which requires finishing by the light of some concluding experiments, in a laboratory. The duty would be a pleasure to me; but I require apparatus; the laboratory I had formed for the analysis of water and cement experiments in 1871–74 is dispersed, but I can from another; and at the conclusion of the analysis of water, the apparatus would be available for any independent researches.

I require such chemical apparatus and drugs as can be supplied by the medical

stores

* Recd under Docket No. 151/4 of 9th Novr from Dept Mds P.C.

stores. For apparatus to be privately procured and laboratory expenses, I require a contingent allowance not exceeding Rs 150/ per mensem until completion of the duty.

I have &c
(Sd) E. Nicholson
Surgeon Major
A.M.D.
In Medl. ch. R.A.

(True copies)

Surgeon Major
Secy to Surgn. Genl. I.M.D.

No 1067

No 186/4

Madras
28th Novr/78

Ref

Surgn Genl's No 3550 of
the 25th inst.

Forwarded

by F. Pent
Surgn Major A.M.D.
43rd Lt Infy
for Dy Surgn Genl
B.M.S.
Presy circle
absent on duty

From

The Medl Officer
in ch. R.A.

To

The Secy to Surgn
Genl
B.M.S.

No 338

St Thomas Mount
25th November/78

Relative to
the analysis
of water

1119

No. 257/78

Medical Department, British Troops,
Surgeon General's Office,
Fort Saint George 29th Novr 1878

From

The ~~SECRETARY to~~ SURGEON GENERAL,
British Medical Service,

To

The Secretary to Government
Public Works Department
Fort Saint George

Sir,

Adverting to G.O. 19th October/78, No 4071W. I have the honor to inform you that apparently through misapprehension G.O of 21st May 1878. No 2240 was only communicated to Surgeon Major Nicholson. A.M.D. on the 7th November 1878.

2. I beg to annex copies of correspondence that has taken place between this office

office and Surgeon Major
Nicholson since the receipt
by me of the O. G. of 19th Octr /78.

3. With reference to the
latest communication from
Dr Nicholson viz, his No 338
dated 26th Instant, I regret
that I am unable to support
the application made
therein regarding a money
allowance to Dr Nicholson
in anticipation of a public
duty he has been ordered to
perform; and I regret that
an officer of the Army
Medical Department has

thus

thus endeavoured to bargain
with Government by whom
he is paid for the performance
of whatever public duties he
is deemed eligible.

4. I regret also to observe
that Dr Nicholson indefinitely
expresses the period when his
chemical examination of water
may be expected to be complete.
Accordingly, it being necessary
as expressed in my letter to
your address No 74/0 dated 11th
October /78, that having in view
eventualities in Bengal the services
of all officers of the Army

Medical

G.O. 19-10-78 No 4071-W
" 1-8-78 " 3053 W.
" 10-7-78 " 2824 W.
" 21-5-78 " 2240 W

No 1344 C.

8

From
The Secretary to the
Surgeon General,
British Medical Service,

To
The Secy to Government
Municipal
[illegible]

Fort Saint George, 2nd [illegible] 78.
No. 257

Endorsement in the Financial Dept.
No 504 dated 19 March 1878 - 8/5

Memorandum by the Chief Engineer P.W.D dated 4 April/78

FOR ORDERS.

G A Mill Colonel R.E.
Secy to Govt. P.W.D

I am myself strongly opposed to any ~~[illegible]~~ small expedients & little niggling experiments in regard to the Madras water works — I think that what is to be done sh'd be carefully considered & decided on & then undertaken firmly & consistently thereafter —

for sand filtration & protection let us provide well [illegible]

6 April 1878

I am disposed to let the Municipy try the experiment but I sh'd like to know whether Col. Mullins sees any objection from the point of view of his Sanitary Dept.

[illegible]

FOR ORDERS.

Mr W. [illegible]
Hon Sir W. R[illegible] DCL
Mr [illegible] to [illegible]

with C. No 7907/77

Ld 10-8-76 No 2066
" 11-11-76 - 63 Mis:
" 5-4-77. 1174-

Cir 7 17-4-78. Rld 25.4.78

C. No 7907/77
C. No 3579/78

Madras water

I have read the report of last June of Mr Jones and the subsequent letter of the Madras Municipal Com-

2 questions are involved - 1st certainty of supply in all seasons 2nd purity of the supply -

The 1st raises the question of the depth at which the water shall be drawn off from the tank - and the probability of the tank level ~~ere~~ again falling below the outlet

or so near as to render
supply insufficient by
the present means

From the contents given
in the Appendix table -
it would seem ~~that~~
if the tank be filled
once in the year
the contents should
suffice allowing for
a considerable wastage
+ evaporation - and
that the scarcity in
1877. was the combined
effect of scanty supply
and of a large consumption
for irrigation -
If the latter be
treated as subordinate
to the Town supply then

the supply seems ample

The Govt. are unable certainly
to give Municipality
+ therefore to reserve for
them a certain quantity
of water above Municipal
outlet -
The Govt. therefore cannot
allow water to be drawn
for irrigation which will
reduce the above quantity -
altho - as regards irrigation
only - the water is equally
available at 25 feet
as at 40 -
The irrigation therefore ~~to~~
must be secondary to
the Town supply unless
Govt. make any different
arrangements by dividing
the tank - or otherwise to

Small supply to be
apportioned —

If the supply then
is sufficient at present
outlet in [illegible] any years
it seems unnecessary to
incur the heavy cost at
the moment of a new
main & lower outlet
if the purity of the
water can be attained
without it —

This brings me to the
consideration of the 2nd
head —

It is possible that there
may be times when
with a nearly full tank
without disturbance by strong
winds or storms — the
water may be fairly pure

but experience has
shown that these conditions
if they exist are very
few — and common
sense indicates that
water so favourable
to animal & vegetable
growth as the Red Hills
is shown to be — and
so charged with silt
cannot be relied on to
be pure without filtration

I cannot agree to
dispense with filtration
therefore —

The question is the
mode & the cost —

These are engineering
questions — but the Engineers
to decide them
require to be told what

is needed –
I cannot think the
filtration of the whole
quantity needed –

The water is largely
used in Madras for
filling tanks – at
Temples – & for
bathing & washing
clothes – for watering
streets – road making –
flushing drains
and for drinking –

Now for all but the
last no filtration is
required or necessary

Cannot then the
Drinking supply be
taken off at the
pumping shaft or
near it: be there
filtered & pumped
through a stand pipe
of sufficient elevation
for delivery into
compensation reservoirs
at suitable parts of
the town –

Compensation & storage
reservoirs are an absolute
necessity – in case of
accident to pipes –
channel clearing &c –

Without more accurate
data than are before
me – it is not possible
to estimate the
cost of such arrangements
but assuming population
as 400,000 and

filtered water needed
5 gallons per head
only 2,000.000 need
filtration —

taking the estimate
No. 2 or 3 — in the former
Report - which are based
on filtration of 6,000.000
there is no very great differ
in the estimated cost of filtration

Taking Estimate No. 2 —
the 4 last items are those
connected with filtering - &
would be ~~[illegible]~~ divided by 3 -

5.45,000 ÷ 3 = 1.81,666
2.06 400 = 68,800
4,000 contingencies = 4,000
10,000 say = 4.000
.65400 R 2,58,466

The engines in this are
calculated as doing the
full maximum delivery

without compensation &
storage reservoirs — but
as the cost of working
steam machinery - its
maintenance &c is much
increased with additional
size - and as engines capable
of delivering half the
supply in 6 hours - would
be working only at 1/3 of
their power during 18 hours
# while their consumption
of fuel wear & tear &c
will not be proportionally reduced
it will probably be found
economical to reduce the
power - and provide
storage reservoirs in different
parts — probably cast
iron tanks about 6 feet
deep on masonry supports
would not be found

so expensive in cost — and could be fixed at suitable levels for the district they supply. so that the engines would not be called on to lift water for the lowest parts to an unnecessary height

---

There will of course have to be added the cost of supply main to the reservoirs — & pipes for delivery therefrom or if existing pipes are retained therefor the alternative pipes needed in places to

supply the unfiltered water — but the pipes ~~[illegible]~~ would be but of comparatively small size — nothing probably in excess of 6 inch — & much probably of 3 inch — the cost would not be very heavy —

Now as to dividing the supply. so as to enable the people readily to distinguish & economise the supply —

The ~~[illegible]~~ outlets for all except drinking & household water. should be on the ground except the high stand pipes for street watering

The Fountains should be
all supplied with the
drinking water – but if
so arranged that people
could not wash their
legs. by merely turning
the tap much economy
would result –

If the figures I have
then arrived at – 2.51,000
~~other~~ or including
additional pipes say
3½ lacs – would
suffice – filtered water
might be supplied at
a very reduced cost
~~without~~ in any way
interfering with supply
during work – or

doing any thing which
would prejudice or
be wasted in any
future extension of
plan –

The ~~main~~ working
of engines &c will be
materially less at
Madras than at Red
Hills – by the reduced
cartage non occupancy
of same building &c

I think the whole
question should be
fully discussed in
Council – & possibly
with advantage in
meeting with Revenu

& engineer of Municipality
would be advantageous—

The works indicated
here might be
undertaken in
division — without
waste of money —
as for instance the
whole arrangements
for Black-town — for
Triplicane &c —
might be completed
singly — The cost of land for
filter — & the pumping
engines only being
however necessarily
incurred at once

B A 25/4

Madras Water Supply

(62)

(63)

Endorsement of the Chief Secretary No. 1570 dated 15th August 1877.

Memorandum by the Chief Engineer dated 6th April 1878.

FOR ORDERS.

E A Wood Colonel R.E.
Secretary to Govt. P.W.D.

8th April 1878.

I have already read the latest papers & recorded my opinion in favor of the R.G. scheme. It seems to be approved by the Ch. Engr. the Presidt. M.C. & the San. Engineer & is the only one wh. from its cost seems really practicable.
L.H.

I think that this ought to be most carefully discussed in Council. I confess to [illegible] to adopt a scheme of which filtration does not constitute a factor.

Kindly let me have a spare copy of the Report

Supplied [illegible] [illegible]

FOR ORDERS.

[illegible]

[illegible] C. No. 3075/78

Recd. 17.4.78 Rptd. 25.4.78.
O.L. Sheet 8 Apl.
Cir. D.4 [illegible]

PUBLIC WORKS DEPARTMENT.

Letters from the Surgeon General, British Medical Service, No. 257/70 of 29 Nov/78.

FOR ORDERS.

E A [illegible]
Secy to Govt. P.W.D.

2nd Decr 1878.

The omission to give the order is serious & needs full explanation.

Dr K. must be released as requested — and the [illegible] to be taken by some responsible officer of P.W. and R.A. [illegible] [illegible]

Letter [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] officer

No. 4697 W.

Public Works Department.

FOR ORDERS.

Hon W. [illegible]
Hon D. F. [illegible]
H. [illegible]

5

Some time ago an order was passed directing Surgeon Nicholson to make an analysis of the water of the Red Hill tank. I have been informed that nothing has been done and that Surgeon Nicholson has not received any orders on the subject

EAF
8/11 80

No 4697W.

Public Works Department

FOR ORDERS.

Hon W. H[illegible]
Hon S. F. Carmichael
His Excy the Governor

[illegible]

Mr L.

C. to. { 7907 : 77 print
C.E. memo. d/6 April 78 print

C. to { 3579 : 78 print
C.E. memo. d/4 April 78 print

C. to. 6874 : 78 print without enclosures

The papers should be printed in the above order, & should issue on Saturday at the latest.

HS 12/12

FOR ORDERS.

Hon W. Huddleston
Hon D. F. Carmichael
H. E. the Governor

№ 4697 W.

Public Works Department.

65

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Under date the 9th Dec/78.

Read the following :—

From the Civil Department (H. E. No. 1570 of 15 Aug/77
~~To the Surgeon General Memorandum~~
~~From the Civil Department~~ — " — [illegible] of [illegible] April/78
~~To the Surgeon General~~ — " — 506 of 16 May/78
From the Surgeon General — " — [illegible] & [illegible]/78
British Med. Service (H. E. No. $\frac{257}{78}$ of 29th Nov/78)

K 21

The omission to issue the order to Dr. Nicholson is serious and needs further explanation from the Surgeon General, to whom it was duly communicated.

Dr. Nicholson will be released from the duty.

The Supdg. Engr. of the third Circle will at once have the samples taken by some responsible officer of the Public Works Dept. The analysis will be conducted by the

N.J.C. 9/12

Chemical Examiner,
with whom Col McConnell
should put himself
in communication.

EAF 9.12.78

Surgeon Genl. | B. M. D.° n/s
S. Surgn Third Circle with G.O. no 2240 | ✓ 21 May n/s.
Chemical Exr thro' Surgeon Genl. | ✓ B. M. D. n/s
Mily. Department
Public Dept
+ Mil. S. Copy despd 7-12-78

Le. desp 11-12-78

1-9-90

Cr 13440

GOVT. OF (1878) MADRAS.

PUBLIC WORKS.

12

To The Surgeon General Br
Medical Dt

Dated

Issued

Recd. Encl.

G. O. 9 Decr 1878, No. 469/1

NOS.

Dr Nicholson reli
from the duty of Analy
the Madras water Sup
the analysis to be co
ducted by the Chemic
Examiner

Rep