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TAMIL NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

PUBLIC WORKS DEPARTMENT

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Military Works.

READ—the following papers:—

From Brigade-Surgeon G. BIDIE, M.B., C.I.E., Officiating Sanitary Commissioner for Madras, to the Chief Secretary to Government, dated Ootacamund, 5th May 1883, No. C-1.

Having learned that the water-supply of the cantonment of Bangalore was running short, I lately paid a visit to the station, so as to ascertain the actual state of affairs, and have now the honor to submit the following remarks on the subject to the Right Honorable the Governor in Council.

2. Being situated on the crest of the water-shed between the basins of the Arkavati and South Pennér rivers, the water-supply from local sources must always be limited, and more or less precarious, being entirely dependent on the rainfall * in the immediate neighbourhood of the station; and it is greatly to be regretted that a civil community has been gradually allowed to settle down in and around the cantonment in numbers much beyond the resources of the existing tanks and wells.

* About 36 inches per annum.

3. A still more deplorable fact is the imprudence which here, as elsewhere, has allowed followers and a civil population to house themselves in the valley above the principal tank of the station, so that its gathering grounds lie to a great extent in crowded native bazaars. In other words, by the neglect of our predecessors, the chief water-supply of the station is contaminated to such an extent that it is now necessary to maintain, at great expense, pumping machinery and filtering beds to render the fluid fit for the use of the troops.

4. The water-supply of Bangalore is got partly from tanks and partly from wells. The European garrison receives its supply from the Ulsoor tank and the Dhobies' wells close behind its *bund*, while native troops and the civil population draw water from three small reservoirs known as Miller's tanks and from various wells. Miller's tanks are situated in the same valley, but higher up than the Ulsoor tank. The wells in the bazaar are all of great depth, running down through a variable thickness of decayed gneissic strata to the live rock, on the surface of which, in favorable sites, there is a limited and capricious percolation of potable water which frequently dries up in the hotter months of the year.

5. In addition to the above, a large impounding reservoir was recently constructed, at a cost of over five lakhs of rupees, in a valley near the 3rd milestone on the Bellary road. The gathering grounds of this tank consist chiefly of low rounded uncultivated hills covered largely with a tufted grass, an *Andropogon*, and are clean and all that could be desired. This scheme was to provide ten gallons of filtered water per diem to each person in a population of 90,000, but unfortunately it has never been completed, and is therefore practically useless.

6. As already stated, the gathering grounds of the Ulsoor reservoir consist largely of the inhabited area within cantonment limits; but, in addition to the water collected there, it formerly received supplies from the north side of Muntapum hill, an eminence some miles north of the station. These, it appears, have been, to some extent, diverted into the new tank referred to in the preceding paragraph, so that for some time they have been partly lost to Ulsoor and its sister tank, the Sumpanjee, which used to receive any surplus flow and act as a safety valve to Ulsoor. At the same time, it further appears that, in the northern outskirts of Bangalore, the old channel leading from this distant collecting area to Ulsoor and Sampanjee has been interfered with in passing through private grounds, so that practically, by these measures, nearly all supplies from the north have been cut off from the station tanks.

7. At the time of my visit to Bangalore there was only a very small supply of water remaining in Miller's tank and in the various wells on which the native troops and the civil community chiefly depend. As regards the wells, the small quantity of water that accumulates in them during the night, when drawing is purposely stopped, is rapidly exhausted, and then numbers of people may be seen waiting till enough has again percolated to allow of its being scooped up with a special tin which they have invented for the purpose. In the Ulsoor tank, at the date of my visit, the average depth of the water was under five feet, representing a supply which ought to be sufficient till rain comes. In the present strait, however, in addition to the troops, large numbers of the civil population also draw water from the Ulsoor lake, so that its reduction, when we further take into account the great amount of evaporation, must, failing timely rain, be very rapid.

8. It will thus be seen that the civil population of the cantonment of Bangalore are now suffering greatly from a deficient and impure water-supply. Hitherto it appears to have been too much the custom to treat the matter as if the military and civil populations had conflicting interests in the water-supply; but, I am of opinion that, from a sanitary point of view, these must, as matters now stand, be regarded as identical. It is no doubt to be regretted that the civil population of the cantonment were allowed to outgrow the available water-supply and to pollute its sources, but the evils have been accomplished, and the most that we can now do is to mitigate their effects. An insufficient and bad water-supply must tell rapidly on the health of the civil population; and if they suffer from epidemic disease, we can hardly hope to restrict its ravages to the limits of the bazaar. Hitherto the station has been a fairly healthy one for troops, and it enjoys climatic and other advantages quite exceptional in the tropics, but we must face the possibility of a defective water-supply, rendering it, in course of time, untenable as a military position, if some remedy be not provided.

9. The arrangements made for the separation of sewage from storm-water in the channel leading to the Ulsoor tank from the cantonment bazaar are very ingenious and as efficient as practicable, and so are those in connection with the north tank or settling basin, but we cannot shut our eyes to the fact that this reservoir must always be liable to dangerous pollution. No doubt the supply of water formerly received from the north beyond cantonment limits and from clean gathering grounds tended to reduce this risk by dilution, and I am therefore disposed to regard the loss of the northern feeder as one of very serious consequence, not only with reference to pollution, but also with regard to possible failure of supply.

10. The lake itself is fairly conserved, but still there is room for improvement, as I observed a good deal of human ordure in the lower end of the cantonment bazaar channel and also in the upper tank or settling basin. On two occasions also, in a small inlet below the cantonment bazaar, I found people engaged in washing piles of dirty clothing and puckallies complacently filling their bags from the same source. On inquiry, I was told that this water was being collected for sale in the bazaar. Surely, when water is *so scarce* and *so precious*, a little more care might be exercised in its protection. The shallow margins of the tank are fringed with *Cyperus articulatus* (and two other species), *Panicum paludosum* (and two other species), *Jussiæa repens*, *Herpestes monniera*, *Polygonum glabrum*, *Marsilea quadrifolia*, &c. The body of the tank is now teeming with *Vallisneria spiralis*, *Potamogeton*, and *Hydrilla verticillatæ*; and

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Ceratiastratiotes and *Trapa bispinosa* have been introduced. These are all beneficial when kept within moderate bounds, and their presence seems to have almost entirely banished the objectionable *Confervöideæ*, once so plentiful. The waters are also tenanted by one or two species of *Carp*, several *Siluridæ* and an *Ophiocephalus*; and the *Gourami* has lately been introduced. In 1882-83, filtered water was supplied to the European troops from the tank and Dhobies' wells to the extent of 53,445 gallons per diem, at a cost of 1,796 gallons per rupee.

11. As regards the quality, the water has, under the order of the Surgeon-General, Her Majesty's Forces, been periodically analysed and declared potable on filtration. The pumping and filtering arrangements are all most carefully attended to by the Engineer in charge, Mr. Smith, and the instructions given in paragraph 4 of G.O., No. 3578, * of 13th July 1882, have been punctually carried out. I was therefore surprised to find that, notwithstanding such injunctions regarding the conservancy of the rock on which the filter bed and pumping machinery are located, a pathway was being constructed up the back of the declivity from near the boat-house. This is intended, I understand, to allow the people of the station to view the boat races from the summit of the rock, and, of course, there will be the usual refreshment arrangements and congregation of native servants. I have to recommend, therefore, that the pathway under construction be at once stopped, and that no one, except on business, be allowed to enter the enclosure containing the pumping and filtering apparatus. I am also of opinion that the boat-pier and boat-house are too near the feeding pipe of the filter bed. Indeed, I was told, on good authority, that both men and dogs sometimes bathe here, within a few feet of the great feeding pipe through which the water is raised from the lake. Clearly we should scrupulously avoid everything likely to impair the quality of the water, and exercise a most fastidious cleanliness in a matter of such vital importance.

* Military Department.

12. It now remains to say a few words regarding the future water-supply of the station. The demands on the existing tanks and wells are more likely to increase than diminish, while, on the other hand, their normal yield will doubtless be reduced by the withdrawal of the supply which used to be delivered at a high level by the channel coming in from the north, referred to in paragraph 6. Not only did this channel aid in feeding Miller's tanks and the Ulsoor lake, but also helped to keep up the supply in various wells in the lower parts of the cantonment. This, therefore, is a matter that requires early attention, although its remedy will only give partial and temporary relief. It is further most desirable that the works connected with the new tank on the Bellary road be completed as early as possible. This project, as already stated, was calculated to supply ten gallons of water per diem per head for a population of 90,000. It is possible that the yield may fall short of this estimate; but, on the other hand, if completed, it is apparently capable of delivering in the station a liberal supply of water of unexceptionable quality.

No. 890, Public

Transferred to Military Department, with the Hon'ble Colonel Sankey's demi-official note of 7th May.

OOTACAMUND,
7th May 1883.

(Signed) C. G. MASTER,
Chief Secretary.

No. 2641, Military.

Transferred to the Chief Engineer, Public Works Department, for favor of the necessary action.

OOTACAMUND,
8th May 1883.

(Signed) E. L. HANKIN, Colonel,
Secretary to Government.

Proceedings of Government, Military Department, dated 19th September 1883, No. 5092.

Read—the following letter from Brigadier-General R. C. STEWART, Quartermaster-General, to the Secretary to Government, Military Department, dated Ootacamund, 29th August 1883, No. 699 :—

The impurity of the Ulsoor tank as a source of water-supply to the troops at Bangalore has been realized by the Commander-in-Chief since his first visit to that station in December 1881, and the recent outbreak of enteric fever, of which there have been no less than forty-eight cases amongst the British troops between 1st January 1882 and 31st July 1883, of which eighteen have terminated fatally, seems to His Excellency to show that early measures should be adopted for remedying matters.

2. I am accordingly desired to forward, for submission to Government, the proceedings (A) of a special committee which assembled last year under the Commander-in-Chief's orders to report on the present source of supply, with a strong recommendation that early and earnest consideration may be given to the subject.

3. Sir Frederick Roberts is satisfied that the present supply is impure and dangerous to the health of troops and civil population, for it is impossible, in his opinion, that water taken from a reservoir, the gathering ground of a large part of one of the main feeders of which is covered by a dense bazaar, can be made safely drinkable.

4. The normal condition of the feeder referred to, and of the drains leading into it, is described in letter, copy attached (B), of a medical officer who recently inspected them, and so long as water liable to be thus contaminated is permitted to find its way into the tank, His Excellency the Commander-in-Chief feels sure that nothing will be gained by attempting to improve the supply from that source.

5. Sir Frederick Roberts has lately caused three different samples of the water distributed to the troops from the Ulsoor Tank to be analysed, as under :—

I. Water direct from the Ulsoor tank.
II. Water taken after passing through the filter bed.
III. Water taken from the Dhobies' wells.

The result of the analyses of these samples is that "all three contain a very large amount of organic impurity."

6. With reference to the above analyses, I am desired to remark that Sir Frederick Roberts has lately perused a paper in a scientific journal on this subject of analyses of water, from which it seems clear that, though organic impurities can, by analysis, be detected when present in water, science has not yet succeeded in demonstrating what portion of that organic matter is injurious to health.

7. For this purpose—to decide, in fact, as to the wholesomeness or otherwise of any particular water—it is necessary to be acquainted with the physical surroundings of its source, and no better proof of the dangerous quality of the Ulsoor tank water could, in His Excellency's opinion, be adduced than the personal experience of Dr. Waters, gained by his visit to the main feeder of the tank, the state of which is graphically illustrated in his report attached to this letter.

8. Government will observe, from the above-mentioned analyses, that one of the samples was taken after it had passed through the filter bed, and another from the Dhobies' wells. Both these samples were found to contain organic matter, and it would seem, therefore, that no amount of filtration can free water of impurity which may or may not be injurious to health in accordance with the condition of the source from whence the supply emanates.

9. It seems unnecessary to Sir Frederick Roberts to enter into discussion as to how a project for supplying the European garrison of Bangalore with water from so foul a source as the Ulsoor tank was ever originally contemplated or approved. What now concerns His Excellency is the best and most economical mode of supplying the troops with pure water, and in this he earnestly hopes to receive the support of Government.

10. The Government will perceive that in the proceedings of the committee which accompany this letter, and in the various reports which have been from time to time

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written on the Ulsoor water works, the matter is well nigh exhausted. None of the recommendations for the improvement of the water of the tank commend themselves to His Excellency, believing as he does that the only true course to pursue is to obtain water for the troops from another source.

11. The Commander-in-Chief thinks there are three courses open to the Government, which he now begs to submit :—

First.—To extend the scheme originated by Major-General Sankey, C.B., R.E., when Chief Engineer in Mysore, for supplying the town of Bangalore with water, and to apply it to the use of the garrison. It is understood that two or three lakhs of rupees have already been expended on this project. With what result His Excellency is not in a position to judge, but it seems to Sir Frederick Roberts that it is a work which, if successful, would be of such enormous benefit to the garrison that it is worthy of the closest examination and the most earnest consideration.

Second.—By the construction of a channel along the south margin of the tank into which the drainage of the town would be diverted and ultimately discharged alongside the waste weir.

Third.—To undertake the construction of a series of wells in the vicinity of the European barracks from which the garrison would be supplied with drinking water.

12. His Excellency would deprecate the assembly of any further committees, but he would advocate the appointment of a specially selected officer to confer with the Government of Mysore as to the possibility of elaborating Major-General Sankey's scheme, as well as of considering the other two propositions herein mentioned.

13. The second of these would commend itself to Sir Frederick Roberts, were it possible to divert the whole of the drainage of the town from the tank, but His Excellency very much fears that a large portion of the drainage from the polluted ground to the west and north-west would still find its way into the tank, and that this scheme would not have the effect of cleansing the water of all impurity.

14. The third proposal seems to Sir Frederick Roberts to hold out the best hope of affording to the garrison a satisfactory supply of drinking water, for the wells would be under regimental supervision and free from all possible contamination.

ENCLOSURE.

PROCEEDINGS of a Committee assembled at Bangalore on the 8th August 1882, *et seq.*, by order of Lieutenant-General W. PAYN, C.B., for the purpose of making replies to certain questions regarding the Ulsoor Military Water Works :—

President :

Lieutenant-Colonel W. H. BURTON, R.E.

Members :

Surgeon-Major WATERS, A.M.D.
Mr. SMITH, Engineer, Ulsoor Water Works.

The committee having assembled, pursuant to order, on the 8th instant, read the paper placed before it, viz., the memorandum marked "A," hereto annexed. On the 9th, 10th and 11th and 15th the committee again met and inspected the following localities and works connected with the Ulsoor water-supply :—The Ulsoor tank, cantonment bazaar supply channel, and bazaar street surface drains, the three Miller's tanks, Ooperhally village, Muntapum hill and gathering ground near the railway station. The tanneries, the Dhobies' wells, the Cavalry, Royal Artillery, and Royal Horse Artillery lines and wells mentioned in appendix "B":—

1. The committee find that, during the 12 months immediately preceding 1st August 1882, the quantity of water actually used (as stated by Mr. Smith) was as follows in column VIII, the strength of the garrison entitled to the use of the Ulsoor water during that time being as shown opposite each month, columns I—VI, the quantities and strength being the daily average of the months named :—

Period.	European. Officers and Men.	European. Women.	European. Children.	Native Followers.	Horses.	Average quantity required at 16 per man, woman and child, 12 per horse, 2 per Native follower.	Average quantity actually used daily.	Quantity unaccounted for, daily gallons.	
I	II	III	IV	V	VI	VII	VIII	IX	
							As stated by Mr. Smith.	Weather	
1881.									
July	..	..	..	..	..	..	..	..	..
August	1,332	167	301	772	466	35,936	53,268	Dry ..	17,332
September	1,332	202	322	774	465	36,664	62,851	½ Dry ..	26,187
October	1,336	209	328	796	494	37,488	50,829	Wet ..	13,341
November	1,296	206	326	713	425	35,774	46,280	Dry ..	10,506
December	1,286	199	326	714	422	35,468	46,003	Dry ..	10,535
1882.									
January	1,291	200	330	714	419	35,592	41,536	Dry ..	5,944
February	972	144	279	404	232	25,912	55,750	Dry ..	29,838
March	1,104	154	283	404	232	28,248	53,955	Dry ..	25,707
April	1,856	164	310	718	774	48,004	57,601	Dry ..	9,597
May	1,870	169	310	718	778	48,356	54,126	Wet ..	5,770
June	1,860	166	303	718	772	47,964	60,849	Wet ..	12,885
July	1,869	164	301	717	769	48,006	48,516	Wet ..	510
						463,412	631,564	..	168,152
Daily average throughout the year ..						38,617	52,630	..	..
Unaccounted for, stolen or wasted daily ..						..	..	..	14,013

We wish to point out that, whilst the quantities in column VIII are the quantities noted in the records of the Ulsoor water works engine-house, they bear no relation either with the strength of the garrison or the season of the year against which they are noted. It is therefore doubtful if column IX really represents the quantity of water wasted or unnecessarily used. Again, it is purely a matter of opinion whether the quantities stated in column VII as "required," are less or more than sufficient for legitimate requirements of the troops. Still it is a matter of fact that we saw this expensively steam-pumped water running to waste through the horse foot bath in Royal Artillery lines, and evidences of its being used elsewhere also for irrigation purposes as well as by the inhabitants of the populous village called Grass-cutters' lines.

The increase of this village, which may be seen by a comparison of the maps of 1870, with its present area, is very rapid and must have a prejudicial effect on the proper water-supply of the troops.

2. If the horses were watered at the wells hereafter mentioned, and the 750 native followers entitled to water (the number of followers is from the present extent of the Grass-cutters' lines, &c., population of which probably approximates to 7,000) were only allowed to use well water, as is feasible, the quantity of Ulsoor water necessary would be under 30,000 gallons per diem and if annual strength of garrison be as it was last year. The details of these calculations are in appendix C.

Plan. Mounted Parade.

3. The existing wells in or near the lines are shown in appendix B.

Wells,* if provided with bullock ramps and watering troughs, will be suitable for the horses of I/3, R.A.—these are distant from the lines 600 yards: the wells No. 29[a] and No. 28[b] would similarly be sufficient for the horses Q/1, R.A., the lines of which are distant 610 and 860 yards, respectively; an encroachment at present exists round the well 29[a], which should, in any case, be removed at an early date: that well No. 29[b] would similarly be sufficient for British cavalry horses, the stables of which are nearer to this well than to the existing Ulsoor water watering trough. It is very doubtful during which months in the dry season these wells would supply water, if constantly used as above, by the troop horses. There are no wells conveniently near which could be similarly used by Royal Horse Artillery, the nearest being 2,223, Dumboor tank, distant 1,600 yards.

* Nos. 25 and 26.

4. The only well actually "in the lines" which could be made use of is No. 29[b]

viz., in the British cavalry lines. The Dhobies' wells water has been analysed by Surgeon Pedlow, A.M.D. This is clear, palatable, and of good quality and contains only a small amount of organic matter which could, in a great measure, be accounted for by surface washings running into the wells direct from the surface of ground.

5. Owing to these wells not being in constant use, the water being stagnant, a fair sample, for analysis could not be obtained; but we have reason to believe it is of good quality.

6. The existing quantities now in each of these wells is shown in appendix B, column of remarks.

7. On account of these wells being pumped under varying conditions and circumstances and at uncertain periods, it is not possible to give reliable and useful answers to this question. The quantity tested by us on the 9th, 10th, 11th August 1882, averaged 18,300 gallons daily.

8. The Dhobies' wells were last thoroughly cleansed of all silt, &c., in November 1876. From the wells being constantly pumped dry, viz., on three or four days a week, the height of water in them is a variable one. The wells having been constantly pumped for seven years last past, it is impossible to say how high the water will stand if not pumped in wet or dry season. The yield is greatly affected by height of water in tank and the local rainfall. The wells would dry three or four weeks before the tank dried.

9. It is desirable to surround each well with a 12-inch parapet wall to prevent contamination by surface washings.

10. About 32,000 gallons per diem can be filtered artificially at the Dhobies' wells filter. During the last six months ending 31st July 1882, the supply from the Dhobies' wells has been almost daily supplemented by means of this filter; it is more convenient to use this filter in preference to the rock filter on account of economy of fuel.

11. The water in the Dhobies' wells filter has been analysed by Surgeons Pedlow and McLaughlin, A.M.D. The water is clear after filteration and no traces of nitric or nitrous acids are shown by the ordinary tests, and only a small quantity of chlorine and oxidisable organic matter.

It is usable at present after filtration, but its composition varies, the organic matters being now in a state of extreme dilution in the tank in consequence of the late rains.

12. If the Government would acquire the plot of municipal land near the road marked B, there would be ample room in the laterite bed for five new wells which, together with the three existing ones in this plot and with three new wells which might usefully be added to the system in the Government tope adjacent, there is reasonable hope of adding 6,000 gallons per diem to the supply; but this would not suffice for the use of the garrison.

Vide plan II, shown in yellow.

13. The bed of laterite within and without the Government land is insufficient to supply, by means of wells, the total quantity required for the daily use of the troops.

But if, in lieu of sinking more wells in this laterite, a longitudinal tank or cistern were constructed (as shown in plan II attached), its inner side made of dry stone walling, and its outer side of stone in lime mortar and cement plastered, there is every reason to believe, from the nature of the soil and surrounding circumstances, that a largely increased supply of laterite filtered water over and above what new wells would supply, will be obtained after the municipal tract of ground (B) has been acquired by Government. We would strongly recommend this in preference to sinking any more wells.

It is to be considered that the cistern will not only yield an additional supply of water over and above what a few wells could give, but it could be extended, as shown in dotted lines, so as to enclose the whole of the laterite bed, when enough laterite filtered water would, in all probability, be obtained, sufficient in fact to supply the whole garrison.

14. Eight wells and the necessary underground galleries or channels between them, will cost about Rs. 3,000. The, in our opinion, more effective cistern method would cost about Rs. 4,000, viz., if built on plot B only.

15. The Engineer's establishment, which works the steam machinery and supervises the distribution of the water in barracks, cost Rs. 537 per mensem.

The cost of fuel, all wood, for the twelve months ending 31st July 1882, was Rs. 3,463.

16. The quantities range between 30 to 35,000 gallons per diem.

17. In order to keep as much of the surface filth of the catchment basin as possible out of the tank, it will be necessary and practicable to—

(*a*) Surround the tanneries by an open ditch and bank, the ditch inside the bank, and made so as to discharge its contents into an underground masonry sewer to below the tank at a cost approximating to Rs. 25,000.

Large plan.

(*b*) Surround the Muhammadan burial ground N.N.W. of the railway station by the completion of existing bund and ditch, to ensure, by military inspection (viz., by means of a sanitary inspector acting under the orders of the Lieutenant-General), that all burials in it and other adjacent burial grounds, take place six feet below

the surface as well as to prevent bazaar sweepings being deposited, as is now the case, anywhere within the catchment basin.

(*e*) Stop all the drain holes in the side walls of the main or paved feeding channel; this will prevent the greater part of the sweepings and filth of the adjacent side streets from passing directly into the channel, as is now the case, and to cause the channel to be daily cleaned.

To cut off the whole of the streets, bazaars, &c., of the cantonment bazaar and sites of houses of European population by an intercepting storm-water channel will too much reduce the natural or legitimate drainage area of the Ulsoor tank, which has already been considerably diminished (without the contemplated beneficial result to the garrison anticipated at the time) by the Bangalore new water works and by the raising of the weir of the lower Miller's tank one foot.

The reduction of legitimate drainage area here alluded to is indicated on the map hatched and tinted blue.

This reduction is the more to be regretted by the military authorities, as the gathering ground taken thereby from the Ulsoor tank was the only gathering ground it had, which was untainted by any impurity.

A perusal of appendix C, an extract from the memorandum of the Chief Engineer, dated 9th September 1868, on Mr. Humphrey's project, will show that it was the intention to fully supply the garrison with water from this tank upon its completion: this may now be said to be found impossible, and, therefore, we are of opinion that the drainage area thus taken from the Ulsoor tank should be restored to it, more especially as it is the supposed intention of the Mysore Government to divert the water of this tract from Mr. Humphrey's to the Damanbaddy or Petta tank.

(*d*) The parapet walls of the paved channel in many parts are too low to prevent filth and surface washings of the adjacent roads being swept, &c., into it.

(*e*) Two silting traps are very necessary, one at the end of the west feeder (paved channel) and one at the end of the south feeder.

(*f*) If the silt trap, proposed for safeguarding the tank from impurities coming into it by the south feeder, is made, the angle of the tank can thereby be cut off by a bund and waste weir built over the existing filth channel: this filth channel will then be wholly without the tank, and this bund would obviate any engineering difficulty of rebuilding the filth channel outside the tank.

(*g*) We think the sanitary supervision of the cantonment bazaar is conducted without due regard to the purity of the water in the Ulsoor tank. Some of the feeding channels are publicly resorted to by the natives and used as latrines; filth of all description is frequently seen in them, and, during the rainfall, washed into the tank even in the main or paved channel; old cloths, dead animals, human excreta, and filth of all description are to be seen at all times, except, of course, immediately after the heavy rain-storm.

18. The completion of a suitable paling round the lower tank and a cactus or aloe hedge round the upper tank, will be both practicable and very essential in order to preserve the water and beds of the tanks from constant direct contamination in all seasons; convenient arrangements, at certain places, being, at the same time, made to enable the native population to freely draw water into their hand vessels. Such places to be flagged and approached by a flight of steps and always kept in a proper sanitary state.

19.

			GALLONS.
(*a*) The Agram or Cavalry cistern should contain	... ...	...	
(*b*) The Ulsoor or R.H.A.	do. ...	...	280,000
(*c*) The parade or B. Infantry	do. ...	...	179,000
(*d*) The hospital iron cistern	do. ...	...	112,500
	... ...	...	11,495

But the Agram cistern will now contain only 184,000 gallons, and the Ulsoor only 148,000 gallons, both owing to constructive errors.

The parade and hospital cisterns contain their proper quantities respectively.

(Signed) W. H. BURTON, Lieut.-Col., R.E., President.
(„) R. WATERS, M.D., Surgeon-Major, A.M.D., } Members.
CHEPAUK, 31st August 1882. („) J. SMITH, Engineer in Charge, "Ulsoor Water Works." }

No. 430.

BANGALORE, 29th September 1882.

(Signed) W. PAYN, Lieut.-General, Commanding Bangalore Division.

APPENDIX "A."

Ulsoor Tank Water-supply.

What quantity of water is required daily for the troops at Bangalore, who are supplied with water from the Ulsoor tank?

2. What quantity would suffice, supposing that water was supplied to human beings only, and that horses and other animals were watered from other sources?

3. What other sources are there, and that what distance from the several lines?

4. Are there any wells in the lines which receive water from the Ulsoor tank which could be made use of to assist the supply?

5. Has the water in the wells been analysed and with what results?

6. What quantity of water could be drawn from them daily on an average?

7. What quantity of water can the Dhobies' wells supply on an average throughout the year, without any assistance from the water in the filter tank near them?

8. Have the Dhobies' wells ever been pumped out, deepened and thoroughly cleaned? If so, give the last date. At what height does the water stand in the wells in the dry and in the rainy season, and does the height correspond with the height of the water in the tank? When the tank is dry or low, do the Dhobies' wells continue to yield a fair supply of water?

9. Is it not desirable on sanitary grounds to have each of the Dhobies' wells surrounded by a low parapet wall to prevent contamination by surface washings, and to have the covers ventilated?

10. What quantity of water can the filter tank supply, and how often during the last six months has it been found necessary to resort to it to supplement the supply drawn from the Dhobies' wells?

11. Has the water in the filter tank been analysed, by whom, and with what result?

12. If the wells in the municipal tract of ground immediately adjoining the Dhobies' wells belonging to Government were made over for the use of the station, would the total quantity of water then available suffice for the use of the garrison?

13. If not, how many more wells would be required, and could room be found for them in proper soil, where the Dhobies' wells now are, or in the municipal tract of ground immediately adjoining?

14. What would be the approximate cost of sinking the number of wells required?

15. What is the cost to Government of the establishment now employed in arranging for the water-supply, and what is the average annual expenditure of fuel?

16. What amount of water is drawn on an average from the Ulsoor tank to supplement the supply from the Dhobies' wells?

17. As the impurity of the water in the Ulsoor tank is chiefly due to surface filth of every description being washed into the tank during the rains, could the tank be supplied from higher tanks or higher ground than is the case to a considerable extent at present, and the surface filth and washings of the streets, bazaars, &c., intercepted by a circular storm water channel?

18. Is there any engineering difficulty in carrying the filth channel outside the tank instead of under it as at present?

19. Would it be practicable to have the tank completely surrounded by a low wall or suitable paling, in order to preserve the water from contamination by natives directly resorting to it, and to make convenient places on a lower level with delivery taps? These places to be flagged and approached by a flight of steps.

20. What amount of water in gallons can be stored in the several reservoirs in the lines, and are these all water-tight?

(Signed) W. H. BURTON, Lieut.-Colonel, R.E., President.

31st August 1882.

APPENDIX B.

LIST of Military Wells which can assist the Water-supply from Ulsoor Tank throughout the Year.

No. of military wells marked on map.	Situation of well.	Distance from Royal Horse Artillery stables as walked by horses.	Distance from Cavalry stables as walked by horses.	Distance from 2/1st Royal Artillery stables as walked by horses.	Distance from Q/3rd stables as walked by horses.	Diameter of well.	Total depth from surface of ground.	Depth of water in hot weather.	Depth of water, 9th August 1882.	Quantity of water now in the wells.	Remarks.
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
		YDS.	YDS.	YDS.	YDS.	FEET.	FEET.	FEET.	FEET.	C. FT.	GALLONS.
1	Cavalry barracks, family quarters ..	..	600	..	..	..	..	..	..	..	
2a	Lime-kiln, south of	..	1,760	1,500	1,260	12	33	Not known.	16	1,809	
2b	Agram hospital ..	..	1,760	1,500	1,260	6½ × 5½	24½	Do.	7½	268	
3a			2,050	1,780	1,550	4½	15½	Do.	11	174	
3b			2,050	1,780	1,550	4½	15½	Do.	11	174	
3c	Dumloor tank, west	1,600	2,050	1,780	1,550	4½	15½	Do.	11	174	
22	margin.		2,290	2,020	1,790	12	16	Do.	13	1,470	9,187½
22d			2,200	1,900	1,700	12	18	Do.	16	1,809	
23			2,130	1,860	1,630	12	31	Do.	24½	2,770	17,312½
24	Gopaul Moodellier's chattram near Dumloor tank ..	..	2,230	1,960	1,730	9½	23	Do.	18½	1,311	
25	East of road on Lower Agram road,	..	1,200	930	600	12	25	Do.	20	2,261	14,131½
26	south of Agram barracks ..	..	1,200	930	600	12	34	Do.	28	3,166	19,787½
27	Slaughter-house, in-	..	1,260	1,000	760	4	13½	Do.	9½	1,193	
28a	side	..	1,260	930	700	4	13½	Do.	9½	1,193	
28b	Do. outside ..	..	1,130	860	600	12	23	Do.	16	1,809	11,306½
29a	Near Dhobies' village behind the Cavalry followers' lines near Neelasundrum road	..	880	610	380	12	29	Do.	9	1,017	6,356½
29b	Between Cavalry stables and Cavalry forge	..	..	..	..	12	46	6	7½	1,979	2,368¾
10	South-west corner of Ulsoor tank ..	For British Infantry, 400 yards from single men's barracks.				9½	25	1 to 2	3	212	
11	Do. ..					13	23	Do.	IN.. 6	796	
12	Do. ..					14	19	Do.	FEET. 3	461	
13	Do. ..					15	19	Do.	3	530	

CHEPAUK,
31st August 1882.

(Signed) W. H. BURTON, Lieut.-Colonel, R.E.,
President.

APPENDIX C.

Period.	EUROPEANS. Men.	Women.	Children × 16.	Natives × 2.	Gallons.	Horses × 12.	Gallons.	Grand Total.
I	II	III	IV	V	VI	VII	VIII	IX
1881.								
August	1,332	167	301	772	..	466	..	..
			1,800					
	Gallons ..		28,800	..	1,544	..	5,592	35,936
September	1,322	202	322	774	..	465	..	..
			1,846					
	Gallons ..		29,536	..	1,548	..	5,580	36,664
October	1,336	209	328	796	..	494	..	..
			1,873					
	Gallons ..		29,968	..	1,592	..	5,928	37,488
November	1,296	206	326	713	..	425	..	..
			1,828					
	Gallons ..		29,248	..	1,426	..	5,100	35,774
December	1,286	199	326	714	..	422	..	..
			1,811					
	Gallons ..		28,976	..	1,428	..	5,064	35,468
1882.								
January	1,291	200	330	714	..	419	..	..
			1,821					
	Gallons ..		29,136	..	1,428	..	5,028	35,592
February	972	144	279	404	..	232	..	..
			1,395					
	Gallons ..		22,320	..	808	..	2,784	25,912
March	1,104	154	283	404	..	232	..	..
			1,541					
	Gallons ..		24,656	..	808	..	2,784	28,248
April	1,856	164	310	718	..	774	..	..
			2,330					
	Gallons ..		37,280	..	1,436	..	9,288	48,004
May	1,870	169	310	718	..	778	..	..
			2,349					
	Gallons ..		37,584	..	1,436	..	9,336	48,356
June	1,860	166	303	718	..	772	..	..
			2,329					
	Gallons ..		37,264	..	1,436	..	9,264	47,964
July	1,869	164	301	717	..	769	..	..
			2,334					
	Gallons ..		37,344	..	1,434	..	9,228	48,006

CHEPAUK,
31st August 1882.

(Signed) W. H. BURTON, Lieut.-Colonel, R.E.,
President.

APPENDIX D.

Extract from Chief Engineer's memorandum on Mr. Humphreys' project for Bangalore Water-supply, dated 9th September 1868.

* * * * *

56. The President of the Board does not consider the census of 1863 to be reliable, and probably it is not so; but that of 1862, to any one acquainted with Bangalore, exaggerates the population absurdly.

57. My own opinion is that, including European troops, followers, &c., the total will not be found to exeed 80,000 in all.

58. It will never in any case be necessary to provide a water-supply for the whole of the residents at the station, as even now along the lowest points of the several drainage lines, and below the different reservoirs, well water is always obtainable by the inhabitants in the imm[illegible] neighbourhood, and the facilities in this respect will be very much increased the moment a supply is brought in, for the use of the residents on the upper grounds. Nothing can [illegible] exceed the purity of the well water below the Ulsoor, Shoolay and Sumpenjee tanks, and quently, taking all the circumstances into consideration, we may fairly strike 20,000 out of the above enumeration, leaving 60,000 who may now be said absolutely to require an extraneous supply, and who will at least be able to pay a small cess for having it brought within their reach.

59. To meet all reasonable demands of the future, it will, I think, be sufficient if we add 50 per cent. to the above, and say that the scheme shall provide 10 gallons of filtered water per diem for a population of 90,000 souls. This Mr. Humphreys' project will do.

Number of souls to be provided for.

* * * * *

69. A glance at the topographical features of the ground will at once show that the general parade ground occupies a distinct ridge, with population on either side of it, while Mootcherry and St. John's Hill lie along high ground to the north. To command, therefore, all the ground, as also to pass on supplies, if necessary, to the new Cavalry barracks and Artillery, and further allow the Sumpenjee, Shoolay and Ulsoor tanks to pick up all the tail or waste weir (which, if desired, may be employed for flooding the parade grounds occasionally or upon any other useful object), two distinct sets of iron mains will be needed (one along each of the ridges above mentioned), and from these delivery may take place in any way deemed most suitable hereafter. As the water flowing simply by gravitation will be delivered at a summit level of 80 feet above the waste weir of Ulsoor tank, it will easily command all the ground mentioned, leaving only a very few residents on the "High Ground" unprovided for. Any slight lift by pumping would give even these an ample supply.

Arrangement of the delivery mains.

* * * * *

74. Had the Ulsoor water-works, now being carried out, not been commenced, it would have been a simple corollary to the above proposition that the Madras Government should bear a proportion of prime cost for the benefit of the European and Native troops and followers; and even now it is much to be hoped that, in case the scheme now working out does not prove as successful as was originally anticipated, some joint action on that which I venture to put forward may yet be found practicable.

* * * * *

From Surgeon-Major R. WATERS, A.M.D., Senior Medical Officer, North Station Hospital, to the Deputy Surgeon-General, Her Majesty's Forces, dated Bangalore, 8th August 1883, No. 447-83.

Amongst the causes which contribute to the pollution of the water-supply at this station, I desire to bring to your notice the foul condition of the main channel or principal feeder of the Ulsoor tank, from which is derived, in conjunction which the Dhobies' wells, all the water used by the British troops.

2. This main channel, about 30 feet wide, runs through the bazaars and receives the surface water therefrom, the overflow of the tanks on the higher ground, and the water from the collecting grounds beyond; it is flagged throughout, and has a wall on each side, so that there need not be the slightest difficulty in keeping it clean. But to all appearances there has been no attempt made in respect to its cleanliness. Yesterday I examined it carefully and found the bottom of the channel covered with accumulation of filth of every description, putrid mud, human hair (thrown in by the barbers who sit and carry on their trade at the side of the

channel), dead animals, baskets, chatties, old shoes, hats, straw, rags, vegetable debris, and refuse of every description; whilst throughout, from end to end, I found excreta of men, horses, cattle and goats. I also found the top of the walls covered in numerous places with human excreta; the channel being used as a latrine, the people sitting, for this purpose, on the low parapet walls. The roads alongside the channel are almost equally polluted, excrement and filth being deposited there and washed through the openings in the walls into the channel on the occurrence of rain.

3. On the floor of this channel, at its very commencement, at the end next the Ulsoor tank, I found yesterday within the space of a few yards sixteen deposits of fresh human excrement; one had a close resemblance to the pea-soupy character of enteric fever excreta.

4. The channel is perpetually polluted, and the filth is washed into the tank on the occurrence of every shower. I have repeatedly examined it and walked from end to end as I did yesterday, and never found it otherwise than in the condition above described.

As respects the Ulsoor tank itself, the same foul practices continue that were formerly

Sept Yesterday I saw it used for *bathing* and ablution purposes, for watering and washing nd cattle, washing of clothing, &c. I also saw during the short time I was there twelve , *bathing* in it, and others without number performing their ablutions with all their attendant filthy practices; of these latter, I saw one urinating at the edge of the water, and on a former occasion I saw a man urinating whilst standing up to his knees in the water washing himself.

6. I wish to bring this to your notice, as such a condition of the main channel and tank is not only horrible and repulsive, but is attended with great danger to the lives of the troops.

From W. S. MURRAY, Esq., Deputy Surgeon-General, Her Majesty's Force, Bangalore Division, to the Assistant Quartermaster-General, Bangalore Division, dated 8th August 1883, No. 1043.

Forwarded for submission to the Lieutenant-General Commanding.

I am able from my own observations to corroborate the general statements brought forward by Surgeon-Major Waters, and consider it of essential consequence to the health of the troops that effectual steps should be taken to obviate the evil conditions represented.

P.S.—Requests favor of information as to the result of steps taken.

Order—dated 19th September 1883, No. 5092, Military.

The Right Honorable the Governor in Council entirely concurs in opinion with His Excellency the Commander-in-Chief that the question of the water-supply to the troops at Bangalore imperatively demands immediate and most careful consideration and the earliest possible action, in view either to the removal of the causes that now so largely contribute to the contamination of the water of the Ulsoor tank, or to the adoption of such other measures as may be deemed desirable for securing an adequate supply of pure drinking water to the troops at Bangalore.

2. The question is, however, essentially a professional one, and will be referred for early consideration in the Public Works Department, in continuation of Military Department No. 2641, dated 8th May 1883, with the suggestion that a specially selected officer be deputed to the duty indicated in paragraph 12 of the Quarter-master-General's letter; as also to consider and report, without avoidable delay, which of the measures proposed by His Excellency the Commander-in-Chief in paragraph 10 affords the greatest promise of securing the object in view.

3. The necessary further orders will then be issued in the Public Works Department.

(True Extract.)

(Signed) E. L. HANKIN, Colonel,
Secretary to Government.

Memorandum on the Water-Supply of Bangalore.

The importance of this question has of late forced itself so much on public attention, that several schemes have been put forward for meeting the admitted want of an adequate water-supply for this large and rapidly expanding community. The

most direct and comprehensive of these proposals is one entered in the Department Public Works budget of the current official year, which (long delayed for want of proper establishment) is now being elaborated by Mr. H. T. Humphreys, C.E.

2. Before, however, describing generally the scope of the project, it appears desirable to note the past and present condition of the water-supply with the opinions of those who have taken the greatest interest in the question.

Distribution of drainage.

3. From the Muntapum hill, which is the highest point in the immediate neighbourhood of Bangalore (and elevated 3,107 feet above sea level), diverge the two drainage areas, along which the densest portion of the population has grown, viz. (1) the Ulsoor catchment-basin, and (2) that, at the head of which, stands the Durmamboody tank (which forms the main water-supply of the old pettah of Bangalore). The first of these leads off naturally south-east-wards to the Pennér river; and the second would, on the other hand, have led to the Arkavutti in a south-westerly direction, but for the catch-channel supplying the Durmamboody tank, diverting the water back into the Pennér basin.

Pettah supply excluded.

4. As the old pettah does not appear to have increased very much, particularly of late years, and as its water-supply is generally considered to meet its requirements, the subject need only be incidentally considered. The main question, therefore, is more directly connected with the Ulsoor valley, and the two subsidiary ones of Shoolay and Sumpenjee, the drainage of which eventually joins it.

5. A glance at the map of Bangalore will show better the general distribution of the population than any description. The cantonment bazaar being the chief centre of population, Ulsoor and Shoolay are the next, while the mass of the well-to-do military and civil communities is scattered over all the elevated portions excepting those reserved for the parade grounds of the European and native troops.

Earliest existing tanks.

6. When the station was first formed in 1810 (it had apparently no existence before British occupation, all prior to that of any importance being confined to the pettah and fort) the Ulsoor, Sumpenjee and Shoolay tanks were, it is understood, the only reservoirs in existence. The remains of a few old ponds or "cuttays" higher up the valleys show that some of these minor works existed previously (especially in the Bederhully valley), but they were probably of little use, and chiefly intended for cattle. Below these three tanks were, and are to this day, several others, such as the Coramungul, Sonakul, Dumaloor, &c., but as all population here has the tendency of spreading up, not down, the several drainages, there is no practical use in taking these lower reservoirs into account with reference to the immediate subject in hand.

7. It may be as well here to note that apparently from prescriptive usage, the waters of the Ulsoor and Sumpenjee tanks have all along been considered as exclusively appropriated for the use of the garrison, and to this end, the irrigation sluices belonging to each were long ago closed. All cultivation under these tanks has hitherto been from wells. At the present day it is difficult to understand the reasons for the Sumpenjee tank having been devoted entirely for military purposes, as it never has been, nor indeed could be, used by the garrison.

8. In early days the old Sumpenjee supply channel, which diverts much of the water that would otherwise flow down from the Muntapum hill by both feeders of the Ulsoor tank, was looked upon as the great * safeguard of that reservoir. In fact the Resident, Mr. A. Cole, in 1814, expressed his fears that the breaching of the channel bank would be likely to destroy the "bank of the Ulsoor tank." Clearly, therefore, at this time Bangalore had more water at command than it altogether liked.

* It is impossible now to say when the main Sumpenjee catch-channel, north of the Muntapum hill, was constructed; but by General Wetherall's letter in reply to Mr. A. Cole, dated 25th August 1814, it seems that the southern bifurcation of the channel, which drains the southern side of the Muntapum hill, was completed in 1809. The extension of irrigation under the Sumpenjee tank appears to have been the origin of both channels; and probably it was only afterwards (as the cantonment bazaar began to rise and encroach on the west corner of the Ulsoor tank) that its use as a safeguard to the tank and town was discovered.

Miller's tank.

9. A change with the growth of population gradually took place; and in 1854 Captain (now Colonel) Miller, Commissary and Superintendent of Police, undertook, first at his own cost, the construction of the tank at the head of the cantonment bazaar which still most appropriately bears his name. The Commissioner, Sir Mark Cubbon, afterwards approving of the work, paid for it from the public funds. This, it is believed, was the first effort to meet the growing wants of the place; and the work has proved itself to be one of the many benefits conferred on the community by the above-named active and philanthropic officer.

Water-supply for the new cavalry barracks.

10. The next occasion on which the question of water-supply appears to have attracted serious attention was in connection with the new cavalry barracks on the old race-course in 1859, and Captains Wilkieson and Mayne, of the Royal Engineers, jointly reported* that for the object directly in view, a store of water could be maintained in six wells, 40 feet deep and 25 feet in diameter, sufficient for 2,000 souls at five gallons each per diem; but that the means of maintaining the supply (which, however, they had not investigated) would cost a large sum.

Sir Arthur Cotton's objection.

11. Sir Arthur Cotton being called on for his opinion by the Madras Government reported, in his No. 320 of the 9th August 1859, that he was unable to concur with the Commissioner's (Sir Mark Cubbon's) suggestion that the supply for the proposed wells should be pumped up from the Ulsoor tank. His objections were: "1st., the insuperable one, that this tank receives the drainage from a large portion of the cantonment, containing a considerable town, which must render the water unfit for use; 2nd., the great expense of constantly pumping from such a depth."

12. He argued that the general supply of water for the cantonment should be considered, and that the levels would admit of water being led in from the direction of Nandidroog (31 miles north).

His first proposals.

13. Colonel Cotton's calculation was as follows:—"For 100,000 people at 20 gallons a day, the quantity would be $4\frac{1}{2}$ million of cubic yards, and taking the rainfall at 36 inches, and the quantity flowing off at $\frac{2}{3}$ of that, or 2 feet, one square-mile of ground would provide 2 millions of cubic yards, or $4\frac{1}{2}$ millions would be provided by $2\frac{1}{2}$ square miles; and allowing 50 per cent. additional for loss by evaporation, &c., $3\frac{1}{2}$ square miles would supply sufficient." He added also a calculation for flooding 1,000 acres of garden land in the cantonment, which would raise the area whose drainage should be stored to $7\frac{1}{2}$ square miles.

14. The general plan proposed was to run two small parallel banks on each side of the ridge between the cantonment and Nandidroog, half a mile apart for a length of 15 miles and terminating in a cross bund uniting the two, and so forming the tank, the whole cost being roughly estimated at Rs. 25,000. The scheme was to yield large annual returns: first in saving of the carriage of water as at present, and second in irrigating the compounds and other lands.

Colonel Green's explanation of several projects.

15. Captain (now Major) Puckle, at that time Executive Engineer, Bangalore division, was placed at Colonel Cotton's disposal for conducting the requisite surveys, &c., and Colonel Green (the then Chief Engineer) in conveying instructions on the subject † observed that Sir Mark Cubbon was prepared to increase the capacity of Miller's tank in connection with the project for constructing a sewer which was to carry off the cantonment bazaar drainage and prevent its contaminating the Ulsoor tank.

16. This increase of Miller's tank (which was 63 feet above Ulsoor) Colonel Green considered essential in connection with the drainage project, at the same time that it would be necessary to keep up the supply of the Ulsoor tank by a feeding

* 14th May 1859.
† Letter No 1135 of 4th October 1859.

channel to the eastward. Colonel Cotton's project, he explained, was (as he understood it) to construct a reservoir at a level intermediately between the two above mentioned, so as to command the barracks and be fed by channels carried in the direction of Nandidroog.

Length of Nandidroog channel.

17. Captain Puckle in reporting proceedings stated that if the levels were extended to the 30th mile near Nandidroog, the contour line would probably exceed 150 miles in length; and subsequently it was found on actually laying out 30 miles from the starting point (the floor of the old race-course barracks) the line, which wound in an extremely tortuous manner to the eastward, had returned to a point known as Mootapah's chatrum close to Mootacherry church. The direct advance towards Nandidroog was therefore very little.

Sir Arthur Cotton's final conclusions.

18. On the completion of the levels to this extent, Colonel Cotton, in replacing Captain Puckle's services, reported, December 17th, 1859, that the following conclusions had been "fully established":—

"1*st*. That an ample supply of water can be obtained on the west side of Nandidroog without the least injury to the present supply, by making a tank of large capacity which will store the water of copious monsoons to supply the deficiency of a following bad year.

"2*nd*. That the present Mailkota tank, the calingulah of which is 50 feet above the race-course, will be a suitable site for such a tank as is proposed.

"3*rd*. That a tank there to contain 10 millions of cubic yards will supply sufficient water with a large surplus—even in very bad years.

* * * * * * *

"7*th*. That the expense of this will not be excessive, perhaps Rs. 1,40,000 including compensation; but this is a rough estimate."

Colonel Green's objections.

19. Colonel Green * expressed strong doubts as to these conclusions. He did not consider that the Mailkota tank "could be very much enlarged even though the supply of other tanks be intercepted" nor that "50 feet would be found an adequate fall on a channel which would be at least 100 miles in length."

20. The term "copious monsoons" was incorrect as applied to the character of the seasons in that part of the country. The fall of the channel would be insufficient and its direction tortuous; it would intercept in the whole of its great length the rain water from the fields and tanks lower down the slopes; it would become breached in many places accidentally, and in still more places designedly.

21. As the channel would be in "the predicament of a long tank full of water, the bund would need to be replete with waste-weirs or expensive outlets." Finally, the estimate of 1½ lakhs for this work, carried through a country intersected by deep nullahs and studded with rock, would be quite insufficient.

Proposal to pump up from the Ulsoor tank.

22. Colonel Green was of opinion that the race-course barracks would most readily be supplied by picottahs raising water in 4 lifts of from 8 to 10 feet each from the Ulsoor tank; or, if preferable, by 2 small donkey engines. Although the Ulsoor tank received impurities, he considered that the supposed deterioration of the wells adjacent to the tank to be exaggerated, and came to the conclusion that after the "improvement to Miller's tank, and the still more important and more desirable sanitary project connected with the Ulsoor tank," &c., he did not think Bangalore would have anything to complain of on the score of good and pure water.

23. This, with a letter much to the same purport addressed to Colonel Cotton, appears to have finished the discussion, and so far as can now be discovered the project of bringing in water from Nandidroog has been completely shelved. There can, however, be little doubt that the investigations then made were of considerable utility, and have in a great measure led up to the conclusions now arrived at.

* Letter No. 1770 of 4th January 1860.

24. The sewer conveying the filth of the bazaar away from and under the Ulsoor tank was completed in due course in 1864, and the work of following the cantonment drainage system to its legitimate conclusions is now being prosecuted by this department.

Works by the Madras Government for supplying new cavalry barracks.

25. The Madras Government, moreover, undertook in 1863 to raise a water-supply for the new cavalry barracks from the Ulsoor tank, by steam pumps and pipes much in accordance with the idea put forward by Colonel Green as shown above, on a plan matured by Captain Tulloch, R.E.

26. In 1865, Colonel Lawford, when Chief Engineer, being led to believe that it was the intention of the Madras Government to endeavour to have the last-named project applied to the whole of the station and bazaars with a view to Mysore sharing in the outlay, drew up a memorandum, dated 6th July 1865, which, although submitted to the Government of India,* bears so directly on the various schemes proposed that it must be here shortly adverted to.

Colonel Lawford's objections.

27. Colonel Lawford after showing the general scope of Captain Tulloch's project, and that it was supposed to cost 1½ lakhs of rupees, observes: "It appears that in all the schemes hitherto put forward for the water-supply of this station, the very simple plan of retaining the surface drainage in reservoirs on the highest possible levels has been strangely neglected, and the consideration is overlooked, but not only does the water contract greater impurities from the wider area which it drains on its passage to the main reservoir, but that the necessity of raising it involves the most costly and precarious plans. If nearly the whole population of Bangalore is to depend on a supply received from the Ulsoor tank through the working of steam pumps, they may possibly suffer extreme distress from accidental causes which no one can foresee or prevent."

Proposed construction of high-level reservoirs.

28. He shows that the failure of the old wells being entirely attributable to the great increase of population and the character of the soil, the spring level should be raised by constructing reservoirs on the highest levels, (1) by the enlargement of the railway tank (reservoir No. 3) below Miller's, and (2) the formation of one above the latter, (this has since been constructed). He adds that "one if not more reservoirs could be formed on the upper (*i.e.*, northern) feeder of the Ulsoor tank, along which the population tends to spread." This had reference to the railway or so-called Bederhully reservoir, which Colonel Lawford often expressed a wish to see carried out, and which has lately been proposed by the Municipal Board, though in a different form. The remainder of the communication being taken up with a proposal not now likely to be carried out (though extremely good in itself) of supplying the cavalry barracks from wells to the S. W. containing a pure supply of water, and at a shorter distance than the Ulsoor water-works, it is unnecessary to follow it further.

29. The principle, however, laid down here of fixing the empounding reservoirs at the highest possible point, is that which has been consistently acted on by this department, within the limited means of the local administrations, under sanction of the Commissioner.

Works already executed on this principle.

30. Among other works thus carried on in the station of late years, chiefly under Colonel Lawford, the following may be enumerated:—

Enlargement of Miller's tank, completed in 1863.
Construction of the railway, or No. 3, reservoir in 1864.
Do. of No. 1 reservoir (above Miller's) in 1866.
Do. of No. 4 reservoir (below all the above) in 1867.

* Replied to in Colonel Dickens' letter No. 1320*d* of 1st December 1865.

31. These form a continuous chain at the head of the bazaar nullah, and not only receive a fairly pure supply of water, but tend to keep up the spring level in their neighbourhood. The three upper ones are kept free from immediate pollution, under special regulations; and their several capacities with the relative heights of high-water level, above the waste-weir of the Ulsoor tank, are given in the margin. Though of course distribution could be effected from these reservoirs which, from their relative height, command much of the cantonment bazaar, it has not appeared desirable to carry this out:—

Names.	Capacity in cubic feet.	Height above Ulsoor, feet.
No. 1 Reservoir	4,500,000	64·05
No. 2 do. (Miller's) ...	6,000,000	61·05
No. 3 do. (Railway) ...	3,500,000	56·61
No. 4 do.	500,000	28·8
Total capacity in cubic feet ...	14,500,000	

Distribution from any of these undesirable.

1st., as neither in collective capacity, nor in relative command, are they able to do *all* the work required; 2nd., as notwithstanding the purity of the water compared with that of Ulsoor tank, it is not so unobjectionable as could be desired; 3rd., as the town may, at some future day, be expected at least to spread up to Miller's tank, and thus, in spite of the best regulations, add to the contained impurities.

32. In addition to their present value, in affording a comparatively pure water-supply to the upper portions of the cantonment bazaar and native infantry lines, the two lower reservoirs, Nos. 3 and 4 (and especially the former), have the special object of flushing the main sewer. The attainment of this latter object has always been steadily kept in view by this department, in dealing with the several portions of the work, as follows:—

The connection of reservoirs Nos. 3 and 4 with the main drain of the cantonment bazaar.

First.—The oviform sewer carried along and eventually under the end of the Ulsoor tank. The whole of this with its out-fall arrangements and accessories was completed in 1864 at a total outlay of Rs. 1,36,000.

Second.—The extension of the sewer upwards, through the cantonment bazaar (and provided with self-acting arrangements which separate the sewage from storm-waters) was commenced last year, and is now, it may be said, completed at a total outlay of Rs. 61,500.

Third.—The completion of the system as far up as No. 3 reservoir is being estimated for, with a view to the insertion of the project in next budget.

33. In a year and-a-half more, the whole arterial drainage should thus be finished and placed in immediate connection with the series of small reservoirs forming the present water-supply.

34. The principle advocated by Colonel Lawford has been further acted on, in the construction of several minor works, *viz.*, (1) the small reservoir and well at Mootacherry; (2) the reservoir at corner of the Government house compound; (3) that near the Executive Engineer's office; (4) the reservoir on the road of approach to the public offices; (5) one near the new cavalry barracks, &c. Some others have also been carried out by the cantonment municipality, and two more, lately undertaken, have nearly been finished by this department.

Minor reservoirs connected with the water-supply.

35. To complete the general list of such works, it may here be mentioned, that the Shoolay tank was effectually dealt with by this department in the years 1861 and 1863, and not only the water-supply but the whole neighbourhood improved. The Durmamboody tank had also a great deal laid out on it in 1863 under the Commissioner's sanction. The Ulsoor tank itself has also been largely improved by reclamations, &c., at different periods.

36. The gradual growth of opinion and practice following fairly on a knowledge of the wants of the community may be gathered from the foregoing; and it only

remains to advert to the projects which the rapidly increasing requirements of the station within the last few years (and particularly since the opening of the railway) have given birth to.

37. The *first*, which is the Madras scheme, for pumping up water from the Ulsoor tank for the use of the European troops (commenced in April 1863) has already been sufficiently noticed for my present purpose. The works are now rapidly approaching completion and will ere long be fully tested; but whether they end in success or failure, as regards their particular object, I cannot consider them adapted to meet the wants of the general community.

The Madras project.

38. The *second* is the scheme put forward by Major Puckle, President of the Municipal Board, in his printed memoranda of 1st October 1867 and 20th April 1868, respectively; and this project, both from the acknowledged ability of its author and his long local acquaintance with the subject, make it the more necessary to notice its main features in detail.

Major Puckle's project.

39. In the first of the above memoranda, the following observations occur:—

* * * * *

"4. The Commissioner's house on the high ground is nearly, if not, the highest in Bangalore; the foot of the flag staff is 3031 feet above high-water mark at Madras, and is almost on the crest of the water-shed ridge that divides the Pennér from the Arkavutti rivers both of which rise at Nandidroog, the culminating point.

"5. For about one-fourth of the distance from Nandidroog, this ridge commands the flag-staff point; but thereafter there is a long interval, where the crest is on a general level with and in one part lower than it. The Muntapum (1 mile from the flag-staff) is 80 feet higher, but this is on a low conical hill, and the dip between it and the flag-staff is great. If water were pounded below Nandidroog, the difficulty of bringing it in for storage at any high level, would be great, on account of the necessity there would be of constructing long and lofty aqueducts; and even then, all the houses on the high ground would have to be served by force pumps.

"6. *The fall from this ridge is too sharp to admit the possibility of collecting water in the Arkavutti valley for delivery at any commanding point in Bangalore* except by increasing the Mail-kota tank, close up to Nandidroog, which Sir Arthur Cotton in 1859 thought might be done, so as to enable the water to be conveyed along a contour line a little below the crest of the water-shed ridge, into the Ulsoor tank, which is 111 feet below the flag-staff datum, but the cost of the channel contouring round the spurs would be very great, and the supply was thought to be of too precarious a nature to warrant the work being undertaken.

"7. From the peculiar position of Bangalore, it is only from the northern side that water can be collected, *and the Arkavutti valley is too steep to admit of anything but a catch-channel close under its crest, being made.*" * * * * *

and the conclusion arrived at in para. 9, is—

"9. It has been ascertained by levels carefully taken, that water could be stored in Miller's tank (the present crest of the waste-weir of which is about 45 feet below the flag-staff datum) and in a newly proposed reservoir on the railway embankment, ¾ mile from the terminal station; *these are the highest points at which water could perhaps practically be stored with advantage.*"

* * * * *

Although agreeing in much of this, I cannot but hold that a radical error is contained in the sentences which I have put in italics, and that on this is grounded the so-called Bederhully scheme.

40. The project, it is true, has undergone some slight modification, in consequence of the discussion to which it has been subjected; but as its scope as well as the objections to it are sufficiently summarized in my letter, No. 4089-139, of the 15th July 1866, to the Commissioner, I beg here to quote that communication:—

The project as lately modified.

"3. So far as I can gather from the President's letter No. 183, the proposed tank is to supply during the hot season, if possible, the Ulsoor, Shoolay, Coramungul, and Dumlur tanks; to feed the existing wells in the neighbourhood, both public and private, and the public fountains, wells and cattle troughs, to be constructed hereafter.

"4. The reservoir was also, from the President's printed memorandum, to be capable of laying water on to the race-course barracks.

"5. If the reservoir is to supply all the tanks mentioned, during a season of drought, as also fulfil the other functions enumerated,—its capacity must be the greatest possible under the circumstances; for when its services are most required, it will itself be correspondingly reduced by the effects of the season. Thus in seasons of the most severe drought, the Shoolay, Sumpenjee, and Dumlur tanks are almost quite dry, while the Ulsoor and Coramungul tanks would only perhaps be one-third full. The Bederhully tank will not be in a much better condition than these latter; and yet the small residue left in it, must be capable of not only making up for all the deficiencies of the others that supply public fountains, &c.

"6. In addition, moreover, to the great capacity required for this work, the tank must be placed at sufficient height to command the plateau of the race-course barracks, and means must be found by piping or an aqueduct to take the water, either under pressure or by gravitation, across the valley and over the ridge which separates the proposed reservoir from the Shoolay and Sumpenjee tanks.

"7. Such being apparently the extensive duties to be assigned to this work, I do not think I am wrong in saying, that it will be a most expensive project, and that the objects to be attained would be quite incommensurate with the cost, and that further, even supposing that all were done, which is proposed,—the mass of the inhabitants would be nearly as badly off for water as ever; for from the slight command of the work, none of the upper portions of the cantonment bazaar would be touched, nor any of the compounds of the European residents."

Objections entertained to it.

* * * *

41. It appears to me, therefore, that however useful such a subsidiary tank in the neighbourhood of Bederhully might prove, in the manner originally proposed by Colonel Lawford (*vide supra*) I cannot look on it as likely to meet the objects put forward by Major Puckle. In addition to the objections already urged, I would here observe—(1) That the valley is of such a form as only to admit of a comparatively shallow reservoir; the losses from evaporation would therefore be disproportionably great. (2) Population has clearly a tendency to spread up it, and thus in time, create difficulties in retaining a pure supply. (3) There are now grave-yards and old receptacles of town filth within the catchment-basin, which, unless specially dealt with, would pollute the tank, &c.

42. Were a series of small and inexpensive reservoirs constructed in the Bederhully valley, analogous to Nos. 1, 2, 3, and 4, at the upper end of the cantonment bazaar, I could have no doubt of their utility in raising the spring level, &c., and especially if so designed as to flush the main drain, which must at some future day be constructed to cut off the impurities of the growing town, from the Ulsoor tank.

A series of small tanks more desirable.

43. As forming, however, a single head for a pure and sufficient water-supply for the station, I am quite convinced the scheme will never answer.

44. The *third* and last proposal is that entered in the budget of this department, which I shall, however, only describe in the most general terms, as it will remain for Mr. Humphreys, who is now working out the project, to deal with it in detail.

Departmental project.

45. With a view to establishing a safe ground-work for any project which might be undertaken in future, either for water-supply or drainage, I had the whole station surveyed two years ago under the Commissioner's sanction. The cantonment bazaar was worked out in great detail, and the Sappers undertook to execute the general survey as also levels. The latter work was performed very satisfactorily.

Surveys and levels of the cantonment.

46. The next point—acting on Colonel Lawford's principle of empounding a sufficient supply of water at the highest possible level—was to obtain a survey of all the highest gathering grounds, both of the Arkavutti and Pennér rivers. From these investigations, it became clear that by making a cut to the depth of 20 feet through the narrow saddle near the new Muhammadan burial-ground (and past which the water was to be led in a brick culvert) an ample supply could be conducted

First trial.

into and embounded in the valley near the railway station, just above Messrs. Binny and Co.'s coffee works.

47. The gathering grounds lie all round the Muntapum hill extending close up to Hebbal tank (N.), Subadar's Chattram (N.W.), and then (S.) along the Arkavutti drainage—in all 3 square miles skirted by a channel 13 miles in length, with a slope of 9 inches in the mile.

48. Colonels Green and Lawford, as also Major Puckle, having adopted one-third of the average annual rainfall of 36 inches as a fair proportion of the amount that could be empounded, I accepted the opinion and found the total yield (making the most liberal allowance for all sources of loss) would be sufficient for daily supply of 10 gallons of filtered water per diem to a population of 105,000, delivered at 80 feet above the Ulsoor tank. This height commands all the station and barracks, leaving only the few residents on "High Ground" unprovided for.

49. Much of the gathering grounds have hitherto lain fallow, and as the small and comparatively valueless dry crops now raised can be easily put a stop to under a trifling compensation, the perfect cleanliness of the whole area (the soil being highly silicious) may be readily insured. The slopes on all sides are rapid, and the surface if left untilled soon acquires a hard glazed skin, off which the water flows with the utmost rapidity.

50. Mr. Humphreys, who has now been engaged on the project for three months, has, while adopting precisely the same gathering grounds, suggested two important modifications of the original scheme.

Mr. Humphreys' modifications.

51. Instead of placing the empounding reservoir in the railway terminus valley, he has selected, as a site, the dip of the Toomkur road, 2 miles beyond "High Ground," situated immediately south-west of, and close under, the Muntapum hill, in fact, as near as possible the centre of the gathering grounds. In lieu of one long catch-channel circling the whole area, four channels, none of which will be over 3 miles long, will deliver the surface drainage, thus reducing loss by evaporation and sinkage to a minimum.

52. His second improvement is, to score the whole of the gathering grounds over with channels, at different levels, constructed with slopes having maximum longitudinal falls consistent with the cohesive powers of the soil, by which arrangement the discharge of all surface drainage will be expedited to the highest degree.

53. Lastly, the form of Mr. Humphreys' reservoir has great advantages, its surface being everywhere up to the highest water-level extremely small for its depth and capacity,—loss by evaporation will thus be reduced to a minimum. In this respect the site is probably the very best which could be found anywhere in the neighbourhood of Bangalore.

54. Unfortunately the available returns as to the population of the station within municipal limits are most unsatisfactory, as may be seen from the following abstracts of the censuses taken in 1862 and 1863, obligingly furnished by the President of the Municipal Board:—

Census of population within municipal limits.

Population within the Municipal limits.

Classes.	Abstract of Census of 1862.	Abstract of Census of 1863.
Hindus	86,055	42,973
Muhammadans	26,856	13,129
Europeans	1,836	5,226
Eurasians	1,586	1,436
Total ...	123,533	62,764

European and Native soldiers are said to have been excluded in the census of 1862, while European soldiers were included in that of 1863.

55. The present strength of the force is returned by the Deputy Quartermaster-General as consisting of—

European troops	1,900
Native do.	2,500
Families and followers of European and Native troops ...	11,500
Total ...	15,900 souls.

56. The President of the Board does not consider the census of 1863 to be reliable, and probably it is not so ; but that of 1862, to any one acquainted with Bangalore, exaggerates the population absurdly.

57. My own opinion is that, including European troops, followers, &c., the total will not be found to exceed 80,000 in all.

58. It will never in any case be necessary to provide a water-supply for the whole of the residents at the station, as even now along the lowest points of the several drainage lines and below the different reservoirs well water is always obtainable by the inhabitants in the immediate neighbourhood, and the facilities in this respect will be very much increased the moment a sufficient supply is brought in, for the use of the residents on the upper grounds. Nothing can perhaps exceed the purity of the well water below the Ulsur, Shoolay and Sumpenjee tanks, and consequently, taking all the circumstances into consideration, we may fairly strike 20,000 out of the above enumeration, leaving 60,000 who may now be said absolutely to require an extraneous supply, and who will at least be able to pay a small cess for having it brought within their reach.

59. To meet all reasonable demands of the future, it will, I think, be sufficient if we add 50 per cent. to the above and say that the scheme shall provide 10 gallons of filtered water per diem for a population of 90,000 souls. This Mr. Humphreys' project will do.

Number of souls to be provided for.

60. In the margin are given the rainfall registers of the past twenty years taken (with slight correction) from Major Puckle's printed analysis. To this is added the averages of each pair of successive annual registrations for the following reason. The reservoir being designed to hold at any one time the whole yield of a minimum year, it is only reasonable to consider that in all cases the residue from a good year will remain stored to supplement the deficiencies of a succeeding bad one. What we have in fact to calculate on is, not the direct yield of the worst recorded year, but the average of the lowest pair of successive registrations. The years 1854 and 1855 showed the worst combined result to be 28·2 inches, and on this the calculations have been based. I may note here parenthetically that the registration of the year 1840, as given in Major Puckle's table, has been rejected as being manifestly wrong.

Table of Rainfall.

Year.	Registered Rainfall in Inches.	Average of each pair of successive Annual Registrations.	Remarks.
1861 ..	30·5	31·9	
1860 ..	33·3	29·9	
1859 ..	*26·6	32·1	* Lowest reliably recorded rainfall.
1858 ..	37·7	34·0	
1857 ..	30·3	39·3	
1856 ..	48·3	37·7	
1855 ..	27·2	†28·2	† Average of the lowest pair.
1854 ..	29·2	32·0	
1853 ..	34·8	44·9	
1852 ..	55·1	45·2	
1851 ..	35·3	42·4	
1850 ..	49·5	38·6	
1849 ..	27·8	34·0	
1848 ..	40·3	38·9	
1847 ..	37·5	38·4	
1846 ..	39·4	36·1	
1845 ..	32·8	33·6	
1844 ..	34·5	35·9	
1843 ..	37·3	34·3	
1842 ..	31·3	34·6	
1841 ..	37·9		
		20) 722·0	
		36·1 inches average annual rainfall.	

61. At first starting it is proposed to arrange the delivery into the reservoir by catch-channels on only two levels, the one set discharging at a height of 100 feet above the level of the Ulsoor tank waste weir and the other at 120 feet.

62. From the less longitudinal slope given to the former set, the channels are only calculated to deliver into the reservoir one-third of the rainfall of the area drained by them; but from the much greater slope of the upper set of channels (those at 120 feet), the delivery is taken at two-fifths.

Total yield of the gathering ground.

63. The whole yield of the $2\frac{1}{2}$ square miles of gathering ground so drained (taking also into account the direct rainfall into the reservoir itself, which has an average surface of 1,500,000 superficial feet), is thus, for a total rainfall of 28·2 inches, $62\frac{1}{8}$ millions of cubic feet.

64. Now the annual draught for a population of 90,000 at 10 gallons per head per diem is $52\frac{1}{2}$ millions cubic feet, and, assuming losses by evaporation, &c., to be ·2 inches per diem (in the worst season it has been shown to be ·25, but on an experiment recorded by Major Puckle, the value was only ·16), we must add $9\frac{1}{8}$ millions, bringing the total annual draught on the reservoir, by use and loss, up to $61\frac{5}{8}$ millions of cubic feet, consequently there will be a slight margin after meeting all wants.

65. Arrangements are to be made for fixing the sill of the waste weir at 103 feet above Ulsoor tank. But even at the 100 feet level the reservoir will hold at one time 60 millions of cubic feet.

Storage capacity of reservoir.

66. As speaking generally each inch of rainfall on the gathering grounds is sufficient for the annual requirements of 3,000 souls, it follows that, as a rule, the reservoir will, on the average, be able to meet the wants of 24,000 * souls in addition to the 90,000 for whom *certain* provision is made.

* Average rainfall	36·1	
Do. of lowest pair of successive years	28·2	
Difference, say 8 inches		
8 × 3,000 = 24,000 souls.		

67. But the general capabilities of the scheme are by no means restricted within these limits, as there are outlying gathering grounds, the rainfall on which can, at any future time, be brought in to supplement the requirements. One of these, a little south of Yellavunka, has an available area of two square miles, and another piece (now rejected), close adjoining the west extremity of the present gathering grounds, has an area of $\frac{1}{3}$ of a square mile. The catchment area can thus (if ever the growth of population absolutely need it) be doubled.

Additional gathering grounds available.

68. In other words, with an increased outlay which it is unnecessary at present to estimate, *certain* provision can be made for a population of 180,000 with an average yearly yield enough for 228 000.

69. A glance at the topographical features of the ground will at once show that the general parade ground occupies a distinct ridge with population on either side of it, while Mootcherry and St. John's Hill lie along high ground to the north. To command, therefore, all the ground, as also to pass on supplies, if necessary, to the new Cavalry barracks and Artillery, and further allow the Sumpenjee, Shoolay and Ulsoor tanks to pick up all the tail or waste weir † (which, if desired, may be employed for flooding the parade grounds occasionally or upon any other useful object), two distinct sets of iron mains will be needed (one along each of the ridges above mentioned), and from these delivery may take place in any way deemed most suitable hereafter. As the water flowing simply by gravitation will be delivered at a summit level of 80 feet above the waste weir of Ulsoor tank, it will easily command all the ground mentioned, leaving only a very few residents on the "High Ground" unprovided for. Any slight lift by pumping would give even these an ample supply.

Arrangement of the delivery mains.

† The Durmamboody tank, which is the head of the Pettah supply, can thus at times receive aid by placing one of the scour cocks in its feeder.

70. The financial arrangements are those which must unquestionably require much earnest consideration after the estimate has fairly been laid before Gov-

Financial arrangements.

ernment and its details approved of, and, therefore, at this stage of the question, it would appear undesirable to say more than a few words on the subject.

71. Though a very rising community, it cannot be said that Bangalore is at all a wealthy one, in the same sense as even many second-class cities of the Empire, and its Municipality has all along (though making the best use of the means at disposal) been unable, without Government aid, to carry out reforms which elsewhere are considered as purely local and provided for from local funds; I am unable therefore to see how the Municipality could be in a position to meet any of the outlay required for the scheme as above sketched. Government will, therefore, it appears to me, have in some shape to bear the cost of the head works and the two sets of arterial delivery mains referred to.

Share falling on the Municipality.

72. Were this done, it would most appropriately fall on the community to place themselves in connection with the system under, of course, certain well-defined restrictions, but generally in such a manner as best to suit the immediate requirements of the particular class or district which may choose to pay for the necessary sub-mains and other accessories.

73. While thus according an undoubted and lasting boon on the whole station, Government would, at the same time, while imposing proper restrictions, hold itself aloof from all minor details that could be infinitely better disposed of by the Municipal Board, carrying out with their own funds the distribution arrangements most suitable to the special wants of the community.

74. Had the Ulsoor water-works, now being carried out, not been commenced, it would have been a simple corollary to the above proposition that the Madras Government should bear a proportion of the prime cost for the benefit of the European and Native troops and followers; and even now it is much to be hoped that, in case the scheme now working out does not prove as successful as was originally anticipated, some joint action on that which I venture to put forward may yet be found practicable.

(Signed) R. H. SANKEY, Major, R.E.,
Chief Engineer of Mysore.

BANGALORE,
9th September 1868.

Memorandum by Major-General R. H. SANKEY, R.E., C.B.

Owing to the supposed scarcity of water at Bangalore in the early portion of the present season, representations were made by the Municipality to the Mysore Government, and subsequently the station was visited by the Officiating Sanitary Commissioner, Dr. Bidie, whose report was transferred to me for remarks under endorsement, No. 2641, of 8th May 1883, by Secretary to Government in the Military Department.

2. In consequence of this reference I inspected the works at Bangalore in the middle of May, but delayed submitting my remarks, as before doing so I wished to be in possession of an analysis of certain specimens of water taken by me below the new (so-called Ooparhalli) reservoir, and forwarded to the Chemical Examiner for report.

3. Owing to a misadventure with reference to these specimens, I only received the report when I was too much occupied with other matters to take up the subject. Just now also on the eve of departure for England, I fear I can hardly do justice to a matter of such admitted importance.

4. In addition, moreover, to bring an extremely difficult subject from an engineering point of view, complications have been introduced with the rendition of Mysore, which were not foreseen when the original schemes of water-supply were designed.

5. All I can therefore hope to do is to take a general view of the present position of matters and offer some observations as to the policy which to the best of my judgment it would be desirable to follow.

2294 (B)

BANGALORE

WATER SUPPLY

INDEX PLAN.

Water shed Area

Within limits of Original Estimate	*1600 Acres*
Additional area scored in red	*170 do*
Total Watershed	*1770 Acres*

Delivery Channels.

Head Channal marked	*A B*
Saint John's Hill Channel	*B C*
Parade Ground Channel	*B D E*
Shule Branch Channel	*D F*

CATCHMENT AREA 1600 ACRES

0·4 M

0·3 M

Mantapam on hill

NEW RESERVOIR

A

Head Delivery

0·2 M

3 M

Channel

Railway Station

Madras Railway

No 1 Tank

B

No 2 Millers Tank

Railway Tank

No 3 Reserve

C

CANTONMENT BAZAR

Halsur Tank

Additional Area

BANGALORE

D

General Parade Ground

E

CANTONMENT

HALSUR

Damalur Tank

Dharmambudi Tank

Sampangi Tank

SHULE

F

BANGALORE PETTAH

THE FORT

(Signed) C.H.W. Kensington Capt^n R.E.
Secretary to the Govt of Mysore P.W.D

C. Bruce. Major R.E.
Dy Chief Engr D.P.W.

SCALE 2000 FEET TO 1 INCH

Govt Litho Press P.W.D
Chepak, Madras

6. From insufficient acquaintance with the history of the various efforts hitherto made to solve the very difficult problem of giving Bangalore a fair supply of water for domestic purposes, late writers have fallen into not a few misapprehensions. These I am at present unable to discuss, but the subject has been very fully dealt with in my printed memorandum of the 9th September 1868, submitting the general scheme for distributing water all over the station for the new Ooparhalli reservoir.

7. The annexed index map shows the broad features of this scheme. The rainfall of the catchment area, 1,600 acres in extent (with a small additional area of 170 acres to the south not yet connected), is collected in a storage reservoir situated in the third mile of the Toomkur road, and is led by an open masonry channel from A to B. All the work so far has been completed from Mysore Provincial Funds at a capital outlay of Rs. 5,40,169.

8. At B it was intended to have had a pipe head reservoir, from which distribution would be made by two mains, one, B C, serving all the north side of the cantonment bazaar, and B D the south. At D a bifurcation of the southern main was to have been made, sub-main D E serving, if necessary, the European troops, and D F the whole of the Shoolay quarter.

9. Chiefly owing to the restrictions imposed on all outlay in Mysore after the famine, it was decided, after placing the works in a safe condition, to defer completion.

10. Having been mainly responsible for the commencement of these works, it is natural that I should wish to see them finished, convinced as I am that they are designed upon the only sound and feasible basis.

11. Writing in 1859 Sir Arthur Cotton declared against the suggestion then made to supply the troops with water pumped up from the Ulsoor tank. A scheme which has since, however, been carried out. His objections were—"*first*, the insuperable one, that this tank receives the drainage from a large portion of the cantonment containing a considerable town, which must render the water unfit for use; *second*, the great expense of constantly pumping from such a depth."

12. That both one and other of these objections have, as might have been expected, proved true in practice it is needless now to affirm. The disadvantages of the position are borne out by every line of Dr. Bidie's report.

13. The inhabitants of the cantonment bazaar may be harried with endless restrictions, all kinds of works may be devised for separating sewage from storm waters along the several feeders of the Ulsoor tank, but the struggle against nature will in the future prove as hopeless and as expensive as has been the case in the past. The position is an impossible one, and should never have been accepted.

14. Dr. Bidie, in the end of his report, advocates the completion of the Ooparhalli scheme, observing that: "It is possible that the yield may fall short of this estimate (viz., 10 gallons per head per diem for 90,000 inhabitants); but on the other hand, if completed, it is apparently capable of delivering in the station a liberal supply of water of unexceptional quality."

15. In contradistinction to the polluted area which furnishes the supply of the Ulsoor tank, the catchment of the new Ooparhalli reservoir is in the first place free of even a single habitation. Most of it was, if I remember correctly, bought up for Government and thrown out of cultivation; and no doubt the rest can be readily acquired, if necessary.

16. The soil is of the usual red character, very sandy, and lateritic near the central point at the Muntapum. Unfortunately the tufted grass (an *Andropogon* according to Dr. Bidie) has been allowed to take possession of most of the area, and effectually stops the off-flow of rain-water.

17. Again, channels of quick delivery were not, as originally intended, carried out; and as a result of these combined causes, the new reservoir has not filled to the extent that it ought to have done.

18. Very careful returns have been maintained in the Chief Engineer's office in Bangalore of the deliveries into the new reservoir. From these I extract the following results:—

Year.	Fraction of the Total Rainfall on the Catchment as stored in the new Reservoir.
1878	$\frac{5}{11}$ ths.
1879	$\frac{1}{9}$ th.
1880	$\frac{1}{10}$ th.
1881	$\frac{1}{7}$ th.
1882	$\frac{1}{9}$ th.

Average of the five years above nearly 13 per cent. of the total rainfall.

19. Numerous experiments were carried out to ascertain the off-flow from the surface when in different conditions, and, although unable at the moment to quote figures, the difference observed between the results when the soil was maintained free from rank vegetation, and especially where it had attained the hard-glazed condition which with proper arrangements seems to be attainable, was such as to remove any doubts as to the adequacy of the total supply. Though ploughed ground and crops absorb and evaporate frequently nine-tenths of the rainfall, the careful experiments made by Mr. Binny for the Nagpore reservoir showed that the results were altogether reversed with surfaces in a denuded hard condition.

20. By stopping all cultivation, removing and keeping down the grass, particularly the "*Andropogon*," there should, I hope, be no reason to fear short supply. Cattle should, of course, be kept off the ground, and all means used for getting the surface into the most favorable condition, with quick delivery channels, &c.

21. Should unfortunately these efforts fail to produce all the desired results, there are clearly auxiliary methods which are at command.

22. The *first* of these (a method which I believe has already been partially adopted on a special occasion) is the pumping of a supply of water from below sluice level into the sluice cistern. Probably a 10 or 12 horse power engine and centrifugal pumps lifting to a maximum height of 15 feet would here do all that would be necessary.

23. The *second* auxiliary method was, however, the one to which I devoted most attention when last at Bangalore, and certainly at first sight it promised very satisfactory results.

24. The applicability of this method depended on turning to account certain defects in the execution of the works possibly, and certainly in the soil, which I will now very briefly explain.

25. When carrying out the central core of the bund for the new reservoir, consisting of a concrete wall sunk in places to 30 feet below the surface, the soil in places proved to be very rotten. It was soft decaying stuff, and the stoppage of the springs proved to be a most serious difficulty, if indeed it was ever fully overcome.

26. Returns for the past five years now before me show that under the combined action of evaporation and leakage the reservoir surface was lowered between 0·43 to 0·66 of an inch per diem, whereas under evaporation only it should not have fallen more than 0·30 of an inch at the outside. Captain Kensington calulated from this that the losses due to leakage alone would amount to 41,382 cubic feet per diem.

27. An examination of the main bund showed that this leakage might very well be going on either entirely under the concrete wall or round the flanks; but although the whole soil, a short way below the bund, was full of water, there was no indication of any danger or any element of weakness in the work itself.

28. Two points naturally suggested themselves in connection with this leakage—

(1) Will the sediment in the water so puddle the bed, as often occurs, in such a way as gradually but effectually to stop the leakage?

(2) Will it continue and thus present an opportunity for lifting by steam pumping the whole supply required, or in any case a good proportion, from a series of wells established below the bund?

29. Looking to the general character of the soil, I confess I was disposed to the second view, and, judging from the clear and sparkling specimens of water collected from immediately below the main bund, I was in hopes that we had at hand a means of giving practically a supply of filtered water to Bangalore.

30. The analyses (hereto attached) of the specimens collected do not bear out this conclusion in such a manner as to render the adoption of this plan feasible without much further inquiry.

31. Notwithstanding the clearness of the specimens taken, and the fact that traditionally all travellers used the old well here constantly, only two out of the four specimens have been pronounced "*unsable*" by the Chemical Examiner.

32. This comparatively unsatisfactory result may, it is true, be due to the presence of rank vegetation about the holes from which these specimens were collected, but whatever the cause, it would be undesirable to build on this pending further inquiry.

33. All therefore that I at this moment would wish to advance is that in the great leakage which now takes place may yet be found a large auxiliary supply of naturally filtered water which may be pumped up for distribution at no very prohibitive cost.

34. There is also a *third* auxiliary to the scheme (alluded to in paragraph 67 of my report of the 9th September 1868), viz., the possibility of bringing in supply from a fresh catchment area believed to measure two square miles in extent situated a little south of Yellavunka. This has not been examined in detail, and whether the supply from this detached area would be brought in without prohibitive cost remains to be decided. It should certainly be examined.

35. The scheme for the supply from the new Ooparhalli reservoir was originally calculated to give 10 gallons per head per diem to 90,000 inhabitants in the Bangalore cantonment, cantonment bazaar, and military station, to the nearly total exclusion of the Pettah, which, though not well supplied, was not at the time considered to be in anything like the same urgent need in this respect.

36. By the census of 1881 it seems that the following was the population all told as being directly or indirectly concerned:—

1. Cantonment bazaar, civil and military stations	89,274
2. Pettah	62,317
3. Troops	4,259
Grand Total ...	155,850

37. In delimiting the Bangalore Municipality under the late rendition arrangements, the whole of the catchment area of the Ooparhalli reservoir and the reservoir itself were left in Mysore territory; and although the original scheme as above mentioned did not contemplate any inclusion of the Pettah population, it may be thought that as regards the future some allowance on this account would be desirable.

38. This view may, moreover, on other grounds, be considered not unreasonable, as a small portion of the catchment area of the new Ooparhalli reservoir as a fact drained into the supply channel of the Durmamboody tank, on which the Pettah in great measure depends for its water. It has thus to some extent suffered by the construction of the new reservoir. The question is in fact one for discussion between the Governments of Madras and Mysore.

39. For the moment, however, I may, I think, fairly assume that if a supply for 15,000 or 20,000 people were passed down to the Pettah from the Ooparhalli reservoir, it is all probably that would even be either asked for or deemed desirable.

40. We may thus assume that the total population to be provided for will not exceed—

For Cantonment bazaar, civil and military stations and troops	...	110,000
Pettah	...	20,000
Total	...	130,000

This I should consider sufficiently liberal.

41. As regards the unit of supply, viz., 10 gallons per head, I have reason to believe that this may, as the experience since gained of large Indian towns, be at once halved, and that 5 gallons may be taken as the unit. To err on the side of liberality, the cubic foot $6\frac{1}{4}$ gallons might be accepted.

42. It may here be mentioned that Bangalore has in its chain of four reservoirs (at the head of the bazaar) in the Ulsoor tank, and innumerable wells, a very good supply in all ordinary seasons for personal ablutions, for watering cattle, &c.; so that the one cubic foot above really represents little more than the amount needed for drinking and culinary purposes. To this I may further add that investigations of a very painstaking character in the town of Mysore brought out the fact that for these purposes the average amount actually used by natives only amounted to $1\frac{1}{4}$ gallons per head per diem, or just one-fifth of the quantity proposed to be given.

43. I will only add to the above that, to insure a perfectly pure uncontaminated supply, not only must all grazing and cultivation of the catchment area be stopped, but the supply must be conveyed from the reservoir sluice in closed channels and pipes to the points of ultimate delivery.

44. I wish much it had lain in my power to define in more concrete form the precise method of carrying out the Ooparhalli scheme to completion; but this is impossible. The services of a thoroughly professional officer will be necessary to frame the needful estimate after the two Governments concerned have decided on the general principles to be maintained in regard to construction and future administration of the works, the requirements and shares of the two populations concerned, and the incidence of the charges.

45. In Captain Kensington the Mysore Government have an officer not only of special intelligence in and training, but one who has for years devoted close attention to the registration of the facts connected with this work. His advice and assistance to any officer selected for getting up the project would be invaluable.

(Signed) R. H. SANKEY, Major-General, R.E.

23rd September 1883.

Order—dated 5th October 1883, No. 2794 W., Public Works.

The Government concur in the opinion expressed by His Excellency the Commander-in-Chief, that the first and most essential matter in connection with the Bangalore water-supply is the extension and completion of the scheme originated by Major-General Sankey, R.E., C.B., when Chief Engineer of Mysore in 1868.

2. With this object, the services of a thoroughly competent officer will be made available, as soon as possible, for the duty of making the necessary surveys, &c., and for framing the required estimates of cost.

3. The following letter will be addressed to the Resident in Mysore :—

(Here enter No. 2795 W., dated 5th October 1883.)

(True Extract.)

(Signed) J. SHAW-STEWART, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Military Department.
„ Sanitary Commissioner for Madras.
„ Superintending Engineer, Fifth Circle
„ Public Department.

Exd. A. F. Goodall.

Spare Copies

BUILDINGS AND ROADS.
MILITARY WORKS.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated October, 5th.

Recd. *Encl.*

G.O., 5th Oct. 1883, No. 2794 W.

OCTOBER.

Bangalore Water-supply

Ordering the extension and completion of the scheme originated by Major-General Sankey, R.E., C.B., in 1868 for the —.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Military Works.

LETTER—from

COLONEL J. SHAW-STEWART, R.E.,

Secretary to the Government of Madras,

Public Works Department,

To

THE RESIDENT IN MYSORE.

SIR,

On several recent occasions representations have been made to this Government respecting the quality of the water, and the sufficiency of the water-supply, available for the use of the troops and of the cantonment bazaar at Bangalore. After careful consideration of the subject, it appears to His Excellency the Governor in Council that the proper course is, if possible, to extend and complete the scheme originated in 1868 by Major-General Sankey, R.E., C.B., when Chief Engineer of Mysore.

2. With this object, His Excellency the Governor in Council is prepared to appoint a thoroughly competent officer to the special duty of making the necessary surveys, &c., and of framing the required estimates of cost. It is, however, understood that part of the country to be examined lies without the limits of the military cantonment, and I am directed to request that permission for carrying on the survey may be obtained from the Government of His Highness the Maharajah of Mysore, and that any needful assistance may be rendered by His Highness' Department of Public Works to the officer intrusted with the duty.

3. In connection with the subject of this letter, I am directed to forward copy of the Proceedings of this Government, under date the 5th October 1883, No. 2794 W., in which are embodied certain papers respecting the water-supply, together with the memorandum drawn up by Major-General Sankey in 1868, and a second memorandum written by him on the 23rd September 1883.

4. With advertence to this last paper, I am directed to draw attention to the remarks made by General Sankey in paragraphs 35 to 40; and to request that you will ascertain from His Highness' Government whether it is desired that, in the scheme now to be elaborated, provision should be made for a supply to the Bangalore Pettah; and, if so, whether the number of inhabitants to be so provided may be assumed at the figure of 20,000 named by General Sankey.

5. I am to add that, on completion of the surveys, &c., now proposed, a further communication will be made to His Highness' Government in respect to the construction and future administration of the water-works, also with respect to the incidence of the cost.

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

(Signed) J. SHAW-STEWART, Colonel, R.E.,
Secretary to Govt., P.W.D.

OOTACAMUND,
5th October 1883.

Exd. A. F. Goodall.
Spare Copies

BUILDINGS AND ROADS.
MILITARY WORKS.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated October, 5th.

Read. *En*

5th Oct. 1883, No. 2795 W.

OCTOBER.

Bangalore Water-supply

REGARDING the extension of the schem for the — originated by Major-Gener Sankey, R.E., C.B., in 1868.

GOVERNMENT OF MADRAS.

MILITARY DEPARTMENT.

4th September 1883, No. 4846.

Cantonments—Water-supply.

Read the following papers :—

No. 38. *From Lieutenant-Colonel J. EWING, Officiating Quartermaster-General, to Colonel E. L. HANKIN, Acting Secretary to Government, Military Department ; dated Fort St. George, 24th October* 1882, *No.* 8529.

With reference to the Orders of Government as per margin, I have the honor, by order, to request the favor of information as to the result of application to the Resident of Mysore, relative to the purchase of the municipal land in the vicinity of the Dhobies' Wells at Bangalore.

No. 3893, dated 21st June 1880, M.D.
„ 3909, „ 26th July 1882, M.D.

2. The subject of improvement of the water-supply to the troops at Bangalore is now under the consideration of His Excellency the Commander-in-Chief, and the acquisition of the land is a point of considerable importance in connection with this.

No. 39. *To the Resident in Mysore ; dated 27th October* 1882, *No.* 5831.

No. 40. *From Major H. WYLIE, C.S.I., Assistant to the Resident in Mysore, to Colonel E. L. HANKIN, Acting Secretary to the Government of Madras, Military Department ; dated Bangalore, 22nd November* 1882, *No.* 1911-866.

I am directed by the Officiating Resident to acknowledge receipt of your letter, No. 5831, dated 27th October last, and in reply to mention the following circumstances for the information of the Right Honorable the Governor in Council.

2. In Military Secretary's letter, No. 3894, dated 21st June 1880, to the address of the late Chief Commissioner of Mysore, application was made by the Madras Government for the acquisition, by the Military Department, of three plots of ground adjoining the Dhobies' Wells near the Ulsúr tank. The eastern triangular piece of land and the centre piece belonged to private individuals, and the western portion to the Municipality of the Cantonment of Bangalore. It appears that the eastern triangular piece has already been acquired by the Military authorities on payment of compensation to the owner, and it has been transferred to the Madras Government. In regard to the central piece of land, the amount of compensation payable to the owner has been fixed by the District Magistrate of the Civil and Military Station of Bangalore at Rs. 782-12-0, and this decision was communicated to the Lieutenant-General Commanding Bangalore Division in April last, with the request that the Resident might be informed if the Madras Government agreed to pay the amount of compensation fixed, but no reply has as yet been received from that officer.

3. The western plot of ground belongs to the Municipality and requires some special mention. It appears from the records of the Chief Commissioner's Office that the Dhobies' Wells, which now belong to the Military authorities, were originally used, from time immemorial, by the inhabitants of Ulsúr, and by the dhobies of that place, that, on the Military Department applying for the land containing these wells on account of the water works, the Ulsúr community strongly protested against the measure, on the ground that the wells formed their only source of drinking water and their objections were overcome only when it was promised that the amount obtained by the transfer of the land to the Military Department would be devoted to the purchase of the adjoining piece of land, in the same water-bearing deposit, for sinking wells for the use of the inhabitants of Ulsúr. Accordingly the land containing the Dhobies' Wells was made over to the Military Department, and with the amount of Rs. 2,000 received therefor, supplemented by Municipal funds, the Municipality purchased the land now in question, sunk wells in it, and made other improvements therein. The total cost to the Municipality, including the price paid for the land, is stated to have been Rs. 4,265.

4. Subsequently, in 1876, the Military authorities applied to the Chief Commissioner to be put in possession of a portion of this western plot of land in addition to what they had already acquired. The inhabitants of Ulsúr again strongly protested against this measure, and the Municipal President represented to the Chief Commissioner the circumstances under which the land had been obtained, and deprecated its transfer. The Commissioner of the Nundydroog Division and the Deputy Commissioner of the Bangalore District were also of the same opinion. The Chief Commissioner concurred in this view, and the Assistant Quartermaster-General, Mysore Division, was accordingly informed that "the circumstances under which the land had been acquired by the Municipality for the purpose of providing water for the Ulsúr community, which was stated to have no other source of supply, made it expedient that the ground should not be taken up, excepting on the paramount consideration of military exigency."

5. Application has now again been made for the same land in Military Secretary's letter, No. 3894, dated 21st June 1880, to the address of the Chief Commissioner of Mysore. The application seems to have been made because Surgeon-General Crawford reported that the Municipal Commissioners had permitted an excavation made in the land to remain without being filled up, which excavation was filled with water after rains and became "a foul pool through use by dhobies, thereby endangering the purity of the wells." On this point I am directed to invite the attention of the Right Honorable the Governor in Council to para. 16 of General Payn's letter to the Quartermaster-General, No. 188, dated 19th April 1880, in which that officer pointed out the impossibility of there being any percolation from the excavation in the municipal ground to the military wells, and stated that he could not attach any importance to this source of danger. Again, as regards the difficulty of acquiring the land, General Payn remarked that "such a proposition would not, for a moment, be entertained by the Municipality, nor would it be sanctioned by the Chief Commissioner, for, when in 1876 a proposal was made for the acquisition of a *part* of the municipal land for the construction of additional wells, the Municipality emphatically protested against any such proceeding and the Chief Commissioner, in his order on the subject, distinctly declined to sanction it."

6. The application made by the Government of Madras in letter, No. 3894, dated 21st June 1880, was sent to the President, Municipal Commission, through the Deputy Commissioner, Bangalore District, with a request that the municipal land under reference might be made over to the Military authorities. In reply, that officer referred to the circumstances above detailed, and to the hardship to which the Ulsúr community would be subjected if the proposed transfer should take effect, and stated that the Municipal Commissioners would never willingly accord their sanction to part with any portion of the land. He also reported that he had got the whole of the ground contiguous to the municipal well levelled and all inequalities filled in, thus removing all danger of the military wells being contaminated in the manner stated by Surgeon-General Crawford. A copy of the

Municipal President's letter is herewith forwarded for information. No further steps seem to have been taken for the acquisition of the municipal land in question.

7. I am now directed to inquire whether, under the circumstances above mentioned, His Excellency the Commander-in-Chief would still wish to press for the acquisition of the land in question, and if so, to suggest that His Excellency's reasons for so doing may be fully stated for the information of the Resident.

From J. H. ORR, Esq., President, Cantonment Municipal Commission, to the Deputy Commissioner, Bangalore District; dated Bangalore, 11th August 1880, No. 1817.

I have the honor to acknowledge receipt of your docket, No. 596, of the 3rd instant, forwarding Secretary's No. 2519-115, of the 27th ultimo, and its enclosures, with a request to transfer to the Madras Government the municipal land therein referred to; and in reply, I have the honor to state that, as the community of the village of Ulsúr are entirely and wholly dependent for their supply of drinking water on the wells situated on the portion of municipal ground now desired to be taken up by the Madras Government, the Commissioners, I am well assured, will never willingly accord their sanction to part with any portion of this land. I may observe that, on two previous occasions, proposals have been made by the Local Military and Madras authorities, to obtain possession of either portions, or of the whole of this ground, the correspondence that resulted between myself and these authorities, I now beg to forward, and in doing so, I would beg to call particular attention to Colonel Pearse's report, and to the opinion expressed by him as to the inadmissibility of one public body acquiring possession, by means of the Land Acquisition Act, of land already taken up by another public body for a public purpose. Colonel Pearse was decidedly of opinion that the Act could not be put in force under circumstances such as these; and I have reason to believe that his decision in this respect was confirmed by an order of the Local Government, though unfortunately the order was not furnished to me, and consequently no copy is forthcoming in my office.

2. From the correspondence that accompanied your docket under reply, it would appear that the reasons for wishing to obtain possession of this portion of municipal land, and the wells situated thereon, are not that the present supply of water from the military wells is insufficient, for General Payn, in para. 22 of his letter to the Quartermaster-General, Fort St. George, distinctly states "that the tank and Dhoby wells now provide an ample quantity of extremely pure water to troops, followers, and horses"; but because the Municipality have unfortunately permitted some excavations to be made on the ground, which fill with water after rains, and from being used by dhobies, become foul pools of stagnant water, thereby endangering the purity of the military wells; as pointed out, however, by General Payn, in para. 16 of his letter above quoted, little importance can be attached to this source of danger, as observation goes to show that the natural outfall for both the surface and subsoil drainage of the wells and ground is towards the south, in other words, from and not towards the military wells; and further, that a bed of clay or other impermeable material would seem to interpose between the two sets of wells, and which effectually prevents any percolation taking place from one to the other. I may here state that I have now had the whole of the ground contiguous to the municipal well levelled, and all the inequalities filled in, all danger therefore of the military wells being contaminated from this source has now consequently been removed.

3. A sufficient supply of good and wholesome drinking water is a matter of most vital importance to the health, comfort and well-being of a community, and any measure which might in any way affect either the quality or quantity of that supply, ought to be jealously watched, the present proposal of the Madras Government is simply to cut off entirely the community of Ulsúr from the source from which they can alone obtain good drinking water, and is a measure which, if carried into effect, must entail on the residents of that village very great suffering and hardship.

P.S.—I have the honor also to forward, for submission to the Chief Commissioner, a Mahazur from the principal residents of Ulsúr, received since the above was written.

(Copy)

(Signed) L. RICKETTS,
Deputy Commissioner.

No. 6400.

Referred, with advertence to the Quartermaster-General's letter, No. 8529, dated 24th October 1882, to His Excellency the Commander-in-Chief, for favor of reply to the inquiry contained in the concluding paragraph of this letter.

2. It is observed, with reference to the last clause of para. 2, that funds for the purchase of the central piece of land alluded to in that paragraph were provided in O.G., No. 3909, dated 26th July 1882.

(By Order.)

FORT ST. GEORGE,
28th November 1882.

(Signed) E. L. HANKIN, Colonel,
Acting Secretary to Government.

To the Quartermaster-General.

No. 41. *From Lieutenant-Colonel J. EWING, Officiating Quartermaster-General, to Colonel E. L. HANKIN, Acting Secretary to Government, Military Department; dated Fort St. George, 22nd December* 1882, *No.* 10530.

Having submitted to the Commander-in-Chief O.G., No. 6400, dated 28th November 1882 (herewith returned), I am instructed to say His Excellency considers it most important that the municipal land and wells in question should be made over to the Military authorities at a fair valuation.

2. Some years ago the value of pure drinking water was not so clearly recognized as it is now, and it seems easy to understand that the Military authorities did not before press for the transfer to them of this land, though it will be noted that they did apply for it from time to time.

3. Experience has shown that the supply of water from existing military wells does not fully meet the requirements of the British garrison, but has to be supplemented by water drawn from the Ulsúr tank and filtered artificially.

4. Sir Frederick Roberts has gone very carefully into the water-supply question at Bangalore, and is satisfied that every endeavour should be made to dispense with the Ulsúr tank water.

5. This can only be done by securing for military purposes more land adjoining that containing the Dhobies' Wells and in the same water-bearing deposit, in which additional wells may be sunk.

6. The distance of the municipal wells from the "Ulsúr" quarter of the town leads His Excellency to think that the value of these wells to the inhabitants of that part is somewhat exaggerated; he has been given to understand that the Dhobies' Ghât constructed by the Municipality for the use of the dhobies (at the time the present Dhobies' Wells were transferred to the military) remains almost unused, and he believes he is correct in surmising that inquiry would show that the number of people who use the wells is comparatively insignificant.

7. I am to mention that the purchase of the land referred to in para. 2 of the O.G. under reply has since been concluded, and it is in the possession of the Military authorities.

No. 42. *To the Resident in Mysore; dated 5th January* 1883, *No.* 37.

No. 43. *From Major H. WYLIE*, C.S.I., *Assistant to the Resident in Mysore, to Colonel E. L. HANKIN, Secretary to the Government of Madras, Military Department; dated Bangalore, 18th April* 1883, *No.* 134-66.

With reference to your letter, No. 37, dated 5th January 1883, on the subject of obtaining for the Military Department a piece of land belonging to the Municipality near the Dhobies' Wells in Ulsúr, I am directed by the Resident to forward herewith, for the information of His Excellency the Governor in Council, an extract from the proceedings of the Municipal Board of the civil and military station of Bangalore, dated 27th January, from which it will be seen that that body consents to give up, for a fair valuation, a portion of the land applied for, viz., the small piece near the hedge close to the military boundary, with the two wells situated therein. The other well, with the piece of land in which it is situated, will, it is said, be retained for the use of the inhabitants of Ulsúr, by whom it is largely resorted to for drinking water. A survey plan showing the plot of ground proposed to be given up to the Military Department and a statement of valuation of the said land are herewith forwarded for information.

2. I am directed to invite the attention of His Excellency the Governor in Council to paras. 3 and 4 of my letter, No. 1911-866, dated 22nd November last, to your address, in which the circumstances under which the Dhobies' Wells were made over to the Madras Government are detailed. These wells had for many years been used by the inhabitants of Ulsúr, and when the Military Department applied for them on account of the water works, much opposition was raised by the Ulsúr community to the transfer, on the ground that the wells formed their only source of drinking water, and the wells were given up only when another piece of land in the same water-bearing deposit was purchased for them. It is this last-mentioned piece of land that is now asked for by the Military Department. Sir James Gordon most readily recognizes the importance of supplying good water to the troops, and it seems to him that in this respect the Bangalore cantonment has not been neglected. At the same time the civil population must not be lost sight of, and their claim to pure drinking water must be treated with consideration and respect. It is a matter of vital importance to them. Under these circumstances I am to say that Sir James Gordon feels it incumbent on him to support the Municipal Board in declining to give up *all* the ground and wells asked for by the Military Department, and he trusts that, under the circumstances, the Military authorities will not press for any additional surrender of land or wells in that quarter.

EXTRACT FROM THE PROCEEDINGS OF THE MUNICIPAL COMMISSION, CIVIL AND MILITARY STATION, BANGALORE, DATED 27TH JANUARY 1883.

Application from Madras Government for the transfer of a piece of Municipal land at the Ulsúr Dhoby Ghât.

7. Read letter No. 2266-103, dated 15th January 1883, from the Assistant to the Resident relating to an application from the Madras Government for the transfer of a piece of municipal land at the Ulsúr Dhoby Ghât.

Proposed by Mr. Campbell that the Municipality should consent to part with the two wells under the hedge close to the military boundary at a fair valuation, retaining the other well for the use of the caste inhabitants of Ulsúr.

Seconded by Mr. Lee.

The Board notes that the waters of the two wells which it is proposed to cede are not used for drinking purposes, but only for washing.

The water of the well it is proposed to retain is largely used, and the well is the main source of the drinking supply of the caste inhabitants of Ulsúr.

Carried unanimously.

(True Extract.)

(Signed) E. P. MALTBY,
President, Municipal Commission,
Civil and Military Station, Bangalore.

8th February 1883.

Statement showing the valuation of well, ground, and trees, &c., on the Dhoby Ghât at Ulsur required by Madras Government.

No.	Particulars.	Amount.
		RS.
1	Well No. 9/9	195
1	Well No. 10/10	250
677	Square yards of ground, at 0-4-0 per sq. yd. ...	169
14	Trees of different kinds, average price Rs. 3 ...	42
2	Bamboo bushes, lump sum	7
	Total ...	663

BANGALORE,
14*th March* 1883.

(Signed) G. GIBSON,
Offg. Municipal Executive Engineer.

No. 2339.

Referred, for favor of opinion, to His Excellency the Commander-in-Chief, with advertence to the Quartermaster-General's letter, No. 10530, dated 22nd December 1882, and previous correspondence.

(By Order.)

21*st April* 1883.

(Signed) E. L. HANKIN, Colonel,
Secretary to Government.

To the Quartermaster-General.

No. 44. *From Colonel R. C. STEWART, Officiating Quartermaster-General, to Colonel E. L. HANKIN, Secretary to Government, Military Department; dated Ootacamund, 28th August* 1883, *No.* 697.

In returning the reference order from Government, No. 2339, dated 21st April 1883, with enclosures, I am directed to say that His Excellency the Commander-in-Chief is prepared to accept the proposals of the Municipality of Bangalore, conveyed in the Assistant Resident's letter, No. 134-66, dated 18th April 1883, viz., to relinquish, for a fair valuation, the plot of ground and the two wells referred to in the neighbourhood of the Dhobies' Wells at Bangalore.

No. 45. ORDER THEREON, 4th September 1883, No. 4846.

The Resident in Mysore will be requested to obtain possession, in behalf of the Madras Government at a fair valuation, of the piece of land and two wells at Ulsúr, which the Bangalore Municipality have consented to relinquish to the local Military authorities.

No. 46. *To the Resident in Mysore; dated 4th September* 1883, *No.* 4847.

(True Extract.)

(Signed) E. L. HANKIN, Colonel,
Secretary to Government.

To the Quartermaster-General.
" Public Works Department.
" Adjutant-General, for information.

Exd. P. L. Pereira.

Govt. of (1883) Madras.

MILITARY.

To THE QUARTERMASTER-GENERAL,
&c., &c., &c.

Dated September, 4th.

Issued

Recd. Encl.

G.O., 4th September 1883, No. 4846.

SEPTEMBER.
Nos. 38—46.

Cantonments—Water-supply.

Bangalore.—The Resident in Mysore requested to obtain possession, in behalf of the Madras Government, of the piece of land and two wells at Ulsúr, which the Bangalore Municipality have consented to relinquish to the local Military authorities.

No 2572 Reg 14th Sept 83

Communicated

to S.E. Dist Circle

Sd/ C B

N.S.

No 2572 Reg 14th Sept 83

S.E. Fifth Circle

No C-1 Dr 84 Office of Sanitary Commissr
Cotacamund 5th May 1883

From

G. Bidie Esqre M. B. C. I. E.
Offg Sanitary Commissioner, Madras

To

The Chief Secretary to Government
Public Department
Ootacamund

Sir,

Having learned that the Water supply of the Cantonment of Bangalore was running short I lately paid a visit to the station, so as to ascertain the actual state of affairs, and have now the honor to submit the following remarks on the subject to the Right Honorable the Governor-in-Council.

2. Being situated on the crest of the water shed between the basins of the Arkavati and South Pennar rivers, the water supply from local sources must always be limited and more or less precarious, being entirely dependent on the rain* fall in the immediate neighbourhood of the station; and it is greatly to be regretted that a civil community has been gradually allowed to settle down in and around the Cantonment, in numbers much beyond the resources of the existing tanks and wells.

* about 35 inches per annum

3. A still more deplorable fact is the imprudence which here, as elsewhere, has allowed followers and a civil population to house themselves in the valley above the principal tank of the station, so that its gathering grounds lie to a great extent in crowded native bazaars. In other words by the neglect of our predecessors the chief water supply of the station is contaminated to such an extent, that it is now necessary to maintain at great expense pumping machinery and filtering beds, to render the fluid fit for the use of the troops.

4. The water supply of Bangalore is got partly from tanks and partly from wells. The European garrison receives its supply from the Ulsoor tank and the Dhobies' wells close behind its bund, while Native troops and the civil Population draw water from 3 small reservoirs known as Miller's tanks and from various wells. Miller's tanks are situated in the same valley, but higher up than the Ulsoor tank. The wells in the bazaar are all of great depth running down through a variable thickness of decayed gneissic strata to the lime rock, on the surface of which, in favorable sites, there is a limited and capricious percolation of potable water, which frequently dries up in the latter months of the year.

5. In addition to the above a large impounding reservoir was recently constructed, at a cost of over 5 lacs of Rupees, in a valley near the 3rd mile stone on the Bellary road. The gathering grounds of this tank consist chiefly of low rounded uncultivated hills covered largely with a tufted grass, an Andropogon, and are clean and all that could be desired. This scheme was to provide 10 gallons of filtered water per diem to each person in a population of 90,000, but unfortunately it has never been completed and is therefore practically useless.

6. As already stated the gathering grounds of the Ulsoor reservoir consist largely of the inhabited area within cantonment limits, but in addition to the water collected there it formerly received supplies from the northside of Muntapum hill, an eminence some miles north of the station. These it appears have been to some extent diverted into the new tank referred to in the preceding para, so that for sometime they have been partly lost to Ulsoor, and its sister tank the Sampanjee, which used to receive any surplus flow and act as a safety valve to Ulsoor. At the same time it further appears, that in the northern outskirts of Bangalore the old channel leading

leading from this distant collecting area to Ulsoor and Sampangee has been interfered with in passing through private grounds, so that practically by these measures nearly all supplies from the north have been cut off from the station tanks.

7. At the time of my visit to Bangalore there was only a very small supply of water remaining in Miller's tank, and in the various wells on which the Native troops and the Civil Community chiefly depend. As regards the wells the small quantity of water that accumulates in them during the night, when drawing is purposely stopped, is rapidly exhausted, and then numbers of people may be seen waiting till enough has again percolated, to allow of its being scooped up with a special tin, which they have invented for the purpose. In the Ulsoor tank at the date of my visit the average depth of the water was under 5 feet, representing a supply which ought to be sufficient till rain comes. In the present strait, however, in addition to the troops large numbers of the Civil Population also draw water from the Ulsoor lake, so that its production, when we further take into account the great amount of evaporation, must, failing timely rain, be very rapid.

8. It will thus be seen that the Civil Population of the Cantonment of Bangalore are now suffering greatly from a deficient and impure water supply. Hitherto it appears to have been too much the custom to treat the matter as if the Military and Civil Populations had conflicting interests in the water supply, but I am of opinion that from a sanitary point of view these must, as matters now stand, be regarded as identical. It is no doubt to be regretted that the Civil Population of the Cantonment were allowed to outgrow the available water supply and to pollute its sources, but the evils have been accomplished and the most that we can now do is to mitigate their effects. The insufficient and bad water supply must tell rapidly on the health of the Civil Population, and if they suffer from epidemic disease we can hardly hope to restrict its ravages to the limits of the bazaar. Hitherto the station has been a fairly healthy one for troops, and it enjoys climatic and other advantages quite exceptional in the tropics, but we must face the possibility of a defective water supply rendering it in course of time untenable as a Military position, if some remedy be not provided.

9. The arrangements made for the separation of

of sewage from storm water in the channel leading to the Ulsoor tank from the Cantonment Bazaar are very ingenious and as efficient as practicable, and so are those in connection with the north tank or settling basin, but we cannot shut our eyes to the fact, that this reservoir must always be liable to dangerous pollution. No doubt the supply of water formerly received from the North beyond Cantonment limits and from clean gathering grounds tended to reduce this risk by dilution, and I am therefore disposed to regard the loss of the northern feeder as one of very serious consequence, not only with reference to pollution, but also with regard to possible failure of supply.

10. The lake itself is fairly conserved but still there is room for improvement, as I observed a good deal of human ordure in the lower end of the Cantonment Bazaar channel and also in the upper tank or settling basin. On two occasions also, in a small inlet below the Cantonment bazaar, I found people engaged in washing piles of dirty clothing and Puckallies complacently filling their bags from the same source. On enquiry I was told that this water was being collected for sale in the bazaar

bazaar. Surely, when water is so scarce and so precious a little more care might be exercised in its protection. The shallow margins of the tank are fringed with Cyperus articulatus (and two other species) Panicum paludosum (and two other species) Jussiæa repens, Herpestes monniera, Polygonum glabrum, Marsilea quadrifolia &c. The body of the tank is now teeming with Vallisneria spiralis, Potamogeton, and Hydrilla verticillata; and Pistiastratiotes and Trapa bispinosa have been introduced. These are all beneficial when kept within moderate bounds, and their presence seems to have almost entirely banished the objectionable Confervoideæ, once so plentiful. The waters are also tenanted by one or two species of Carp, several Siluridæ and an Ophiocephalus; and the Gouramie has lately been introduced. In 1882/83 filtered water was supplied to the European troops from the tank and Dhobies' wells to the extent of 53,445 gallons per diem, at a cost of 1796 gallons per Rupee.

11. As regards the quality the water has, under the order of the Surgeon General H. M's Forces, been periodically analysed, and declared potable on filtration. The pumping and filtering arrangements are all most carefully attended to by the Engineer in charge, Mr. Smith, and the instructions given in para 4 of G.O. * Military Deptt. № 3578 of 13th July 1882 have been punctually carried out. I was therefore surprised to find that, notwithstanding such

such injunctions regarding the conservancy of the rock on which the filter bed and pumping machinery are located, a path-way was being constructed up the back of the declivity from near the boat house. This is intended, I understand, to allow the people of the station to view the boat races from the summit of the rock, and, of course, there will be the usual refreshment arrangements and congregation of native servants. I have to recommend, therefore, that the path-way under construction be at once stopped, and that no one, except on business, be allowed to enter the enclosure containing the pumping and filtering apparatus. I am also of opinion that the Boat-pier and Boat-house are too near the feeding pipe of the filter bed. Indeed I was told, on good authority, that both men and dogs sometimes bathe here, within a few feet of the great feeding pipe through which the water is raised from the lake. Clearly we should scrupulously avoid everything likely to impair the quality of the water, and exercise a most fastidious cleanliness in a matter of such vital importance.

12. It now remains to say a few words regarding the future water supply of the station. The demands on the existing tanks and wells are more likely to increase than diminish, while on the other hand their normal yield will doubtless be reduced by the withdrawal of the supply which used to be delivered at a high level by the channel coming in from the north, referred to in para 6. Not only did this channel aid in feeding elbiller's tanks and the Ulsoor lake, but also helped to keep up the supply in various wells in the lower parts of the Cantonment. This therefore is a matter that requires early attention, although its remedy will only give partial and temporary relief. It is further most desirable that the works connected with the new tank on the Bellary road be completed as early as possible. This project, as already stated, was calculated to supply 10 gallons of water per diem, per head, for a population of 90,000. It is possible that the yield may fall short of this estimate, but on the other hand if completed it is apparently capable of delivering in the station a liberal supply of water of unexceptionable quality.

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

Bidie M.B. C.I.E
Offg Sanitary Commissioner
Madras

Pg 13-7-83. 243. 2247.

mily

Postacammud
7th May 1883.

86

Transferred to
Military Department
with the Hon'ble Mr.
Sankey's d.o. note 7th
7th May.

Quarter
Chief Secretary.

No: 2641. 87

Transferred to
the Chief Engineer
P.W. Dept. for
favor of the
necessary action.

Chauhan Col:
Secry to Govt.
Postacammud
8th May 1883.

From No. 2701
Pr Cons 39/49.
G. Bidie Esqre M.B. C.I.E.
Offg: Sanitary Commissr
Bangalore

To From
The Chief Secretary to Govt
Public Deptt.
Postacammud

D. 7/5/83.
R. 7/5/83.
Dated 5th
Recd 7th } May 1883.

No: C-1

Endo: None.

Submitting remarks
on the water supply of the
Cantonment of Bangalore.

CHIEF SECRETARY 7 MAY 83

Transferred

28

Mily: 1883 (Deptt:
no: 5064

From
The Qr. mr. General
To
The Secy. to Govt: m.d.

of 29 August
Rec'd 30 —
no: 699

7 Enclosures &
1 plan —

Forwards with remarks
Correspondence regarding the
impurity of the Ulsoor Tank
at Bangalore as a source of
water supply to the Troops

S. O.

C. 4. 9. 83.
R/B-9. 83.

Water Supply.
Bangalore
H.G. dtd 19 Sept 83. Pm. 5092, Pag.

29. 8.

QUARTERMASTER-GENERAL'S OFFICE,
H.Q. Div. Ootacamund
29th August — 1883.

No. 699

From
THE QUARTERMASTER-GENERAL,

To
THE Secretary to Government
Military Department

SIR,

The impurity of the Ulsoor Tank as a source of water supply to the Troops at Bangalore has been realized by the Commander-in-Chief since his first visit to that Station in December 1881, and the recent outbreak of Enteric fever, of which there have been no less than 48 cases amongst the British Troops between 1st January 1882 and 31st July 1883, of which 18 have terminated fatally, seems to His Excellency to show that early measures should be adopted for remedying matters. —

2. I am accordingly desired to forward for submission to Government the Proceedings (A) of a Special Committee which assembled last year under the Commander-in-Chief's orders to report on the present source of supply, with a strong recommendation that early and earnest consideration may be given to the subject. —

3.

3.

Sir Frederick Roberts is satisfied that the present supply is impure and dangerous to the health of Troops and civil population for it is impossible, in his opinion, that water taken from a reservoir, the gathering ground of a large part of one of the main feaders of which is covered by a dense bazaar, can be made safely drinkable

4. The normal condition of the feader referred to, and of the drains leading into it, is described in letter, copy attached (B) of a Medical Officer who recently inspected them - and so long as water liable to be thus contaminated is permitted to find its way into the Tank, His Excellency the Commander in Chief feels sure that nothing will be gained by attempting to improve the supply from that source. -

5. Sir Frederick Roberts has lately caused three different samples of the water distributed to the Troops from the Ulsoor Tank to be analysed, as under: -

I. Water direct from the Ulsoor Tank.

II. Water taken after passing through the filter bed.

III. Water taken from the Dhobies' wells. -

For

The result of the analyses of these samples, is that "all three contain a very large amount of Organic impurity."

6. With reference to the above Analyses, I am desired to remark that Sir Frederick Roberts has lately perused a paper in a Scientific Journal on this subject of Analyses of water, from which it seems clear that though Organic impurities can, by analysis, be detected when present in water, Science has not yet succeeded in demonstrating what portion of that Organic matter is injurious to health. -

7. For this purpose - To decide in fact as to the wholesomeness or otherwise of any particular water, it is necessary to be acquainted with the physical surroundings of its source, and no better proof of the dangerous quality of the Ulsoor Tank water could, in His Excellency's opinion, be adduced than the personal experience of Dr Waters, gained by his visit to the main feader of the tank, the state of which is graphically illustrated in his report attached to this letter.

8. Government will observe from the above mentioned Analyses that one of the samples was taken after it had passed through the filter bed and another from the Dhobies' Wells - Both these samples were found

to

to contain organic matter, and it would seem therefore that no amount of filtration can free water of impurity which may or may not be injurious to health in accordance with the condition of the source from whence the supply emanates.—

9. It seems unnecessary to Sir Frederick Roberts to enter into discussion as to how a project for supplying the European Garrison of Bangalore with water from so small a source as the Ulsoor Tank was ever originally contemplated or approved. What now concerns His Excellency is the best and most economical mode of supplying the Troops with pure water, and in this he earnestly hopes to receive the support of Government.—

10. The Government will perceive that in the Proceedings of the Committee which accompany this letter, and in the various reports which have been from time to time written on the Ulsoor Water Works, the matter is well nigh exhausted. None of the recommendations for the improvement of the water of the Tank commend themselves to His Excellency, believing as he does that the only true course to pursue is to obtain water for the Troops from another source.—

11. The Commander-in-Chief thinks

thinks there are three courses open to the Government which he now begs to submit:—

First. To extend the scheme originated by Major General Stanley C.B. R.E. when Chief Engineer in Mysore, for supplying the Town of Bangalore with water, and to apply it to the use of the Garrison. It is understood that two or three Lacs of Rupees have already been expended on this project. With what result His Excellency is not in a position to judge, but it seems to Sir Frederick Roberts that it is a work which, if successful, would be of such enormous benefit to the Garrison that it is worthy of the closest examination and the most earnest consideration.—

Second. By the construction of a channel along the South margin of the Tank into which the drainage of the Town would be diverted and ultimately discharged alongside the waste Weir.—

Third To undertake the construction of a series of wells in the vicinity of the European Barracks from which the Garrison would be supplied with drinking water.—

12. His Excellency would deprecate

the

the assembly of any further Committee, but he would advocate the appointment of a specially selected Officer to confer with the Government of Mysore as to the possibility of elaborating Major General Lankey's scheme as well as of considering the other two propositions herein mentioned.-

13 The second of these would commend itself to Sir Frederick Roberts, were it possible to divert the whole of the drainage of the Town from the Tank, but His Excellency very much fears that a large portion of the drainage from the pollutted ground to the West and North-West would still find its way into the Tank and that this scheme would not have the effect of cleansing the water of all impurity.

14. The third proposal seems to Sir Frederick Roberts to hold out the best hope of affording to the Garrison a satisfactory supply of drinking water, for the wells would be under Departmental Supervision and free from all possible Contamination.-

I have the honor to be
Sir
Your obedient Servant
R Stewart Brig. General
Quarter Master General

32

36

Mr 21
8087/83.

Army Form A 2.
(Late W. O. Form 263.)

50 11

* N.B.—In Form being applicable to any Board of Officers, or Committee, or Court of Inquiry, this blank to be filled in accordingly.

The Signature of each Officer composing the Board, &c., should be attached at the end of the Proceedings.

PROCEEDINGS of a * Committee

assembled at Bangalore

on the 8th August 1882 at Sec'y

by order of Lieut. General W. Payn C.B.

for the purpose of making replies to certain questions regarding the Ulsoor Military Water Works

PRESIDENT.

Lieut. Col. W. E. Burton, R. E.

MEMBERS.

Surgeon Major Waker, A. M. D.

Mr Smith, Engineer, Ulsoor Water Works.

The Committee having assembled pursuant to order, ~~proceed to~~ on the 8th Instant, ~~it~~ read the paper placed before it viz: the Memorandum marked A hereto annexed. On the 9th, 10th & 11th & 15th the Committee again met and inspected the following localities and

F. & T. 5000 3—63.

W. B. MOORE, LAWRENCE ASYLUM PRESS—1882.

Works connected with the Ulsoor Water
Supply - The Ulsoor Tank, Cantonment
Bazaar Supply Channel and Bazaar
Street Surface Drains, the 3 Millers
Tanks, Coopertally Village, Mankapam
Hill and gathering ground near the
Railway Station. The Tanneries, the
Dhobies' Walls, the Cavalry Royal Artillery
and R. H. C. Artillery Lines and walls
mentioned in Appendix "B".

III The Committee find that during
the 12 Months immediately preceding
1st August 1882 the quantity of
(as Stated by Mr Smith)
Water actually used was as
follows in Col: VIII the Strength of
the Garrison entitled to the use
of the Ulsoor Water during that time
being as shewn opposite each
month Column I — III. The quantities
and

and Strength being the daily average of the Months named.

Period	European					Average quantity required @ 16 per Man Woman and Child 12 per horse 2 per Indian followers.	Average quantity actually used daily.		Quantity in accounts for, daily Gallons.
	Officers & Men	Women.	Children	Indian followers.	& Cooks.				
I	II	III	IV	V	VI	VII	VIII		IX
							× as deducted by Mr Smith		
1881.									
July—									
August—	1332	167	301	772	466	35,936	53,268	Day	17,332
September—	1332	202	322	774	465	36,664	62,851	Day	26,187.
October—	1336	209	328	796	494	37,468	50,809	Week	13,341
November—	1296	206	326	713	425	35,774	46,280	Day	10,506
December—	1286	179	326	714	422	35468	46,003	Day	10,535
1882.									
January—	1291	200	330	714	419	35,592	41,536	Day	5,944
February—	972	144	279	404	232	25,712	55,750	Day	29,838
March—	1104	154	283	404	232	28,248	53,955	Day	25,707
April—	1856	164	310	718	774	48,004	57,601	Day	9597

Wanted

4

In Dy no 10275

I	II	III	IV	V	VI	VII	VIII	IX
1882								
May ____	1870	169	310	718	778	48,356	54,126	Wd 5,770
June ____	1860	166	303	718	772	47,964	60,349	Wd 12,885
July ____	1869	164	301	717	769	48,006	48,516	Wd 510
						463,412	631,564	168,152
Daily average throughout the year						38617	52,630	14,013
Unaccounted for. Stolen or wasted daily						—	—	

We wish to point out that whilst the quantities in Col: VIII are the quantities noted in the records of the Inkoor Water Works Engine Houses - they bear no relation either with the Strength of the Garrison or the Season of the year against which they are noted. It is therefore doubtful if Col: IX really represents the quantity of water wasted or unnecessarily used. Again it is purely a matter of Opinion whether the quantities stated in Col: VII as "required" is less or more, than sufficient for legitimate requirements of the Troops. Still it is a matter of fact that we (see this

expensively Steam pumped water running to waste thro' the horse foot path in Royal Artillery Lines and evidences of its being used elsewhere also for irrigation purposes, as well as by the inhabitants of the populous Village called Grass Cutters Lines.

The increase of this Village, which may be seen by a comparison of the Maps of 1870 with its present area, is very rapid and must have a prejudicial effect on the proper Water Supply of the Troops.

2. If the horses were watered at the wells hereafter mentioned and the 750 Native followers entitled to water (the number of followers is from the present extent of the grass cutters lines & population of which probably approximates to 7,000) were only allowed to use well water, as is feasible, the quantity of Water necessary would be under 30,000 Gallons — per diem & if annual Strength of Garrison be as it was last year. The details of these Calculations are in Appendix C.

3. The existing wells in or near the lines are shewn in Appendix B.

Plan Mounted Parade

× No 25
× 26

× wells if provided with bullock pumps and watering troughs be suitable for the horses of 2/3 R. A. these are distant from the lines 600 Yards, the wells No 29a & No 28b would similarly be sufficient for the horses R/1 R. A. the lines of which are distant

47 S.P.15

610 & 860 yards respectively; an encroach-
-ment at present exists round the well 29a
which should in any case be removed
as an early date = that well No 29b would
similarly be sufficient for British
Cavalry horses = the Stables of which
are nearer to this well than to the existing
Tulsoor Water watering trough. This very
doubtful during which months in the
dry season these wells would supply
water if constantly used as above, for
the Troop horses. There are no wells, commu-
-nicably near which could be similarly
used by H. M. Artillery; the nearest being
22, 23 Dumboo Tank distant 1600 yards.

4. The only well actually "in the
"lines" which could be made use of is
No 29b ^ viz: in the British Cavalry
Lines. The Dhobies wells water has been
analysed by Surgeon Pedlow, A.M.D.
This is clear palatable and of good
quality, and contains only a small
amount

amount of Organic matter which could in a great measure be accounted for by Surface washings running into the wells direct from the Surface of ground.

5. It has not, owing to these wells not being in constant use the water being Stagnant a fair Sample for analysis could not be obtained but we have reason to believe it is of good quality.

6. The existing quantities now in each of these wells is shewn in Appendix B. Column of remarks.

7. On account of these wells being pumped under varying conditions and circumstances and at uncertain periods it is not possible to give reliable and useful answers to this question. The quantity tested by us on the 9th, 10th, 11th August 1882 averaged 18,300 gallons daily.

29 S.B. 18

8. The Dhobies' Wells were last thoroughly cleansed of all silt &c in November 1876. From the wells being constantly pumped dry viz: on 3 or 4 days a week. The height of water in them is a variable one. The wells having been constantly pumped for 7 years last past - it is impossible to say how high the water will stand if not pumped in wet or dry season. The yield is greatly affected by height of water in tank and the local rainfall. The wells would dry 3 or 4 weeks before the tank dried.

9. It is desirable to surround each well with a 12 inch parapet wall to prevent contamination by surface washings.

10. About 32,000 gallons per diem can be filtered artificially at the Dhobies Wells

Wells filter. During the last 6 months ending 31st July 1882 the supply from the Dhobies wells has been almost daily supplemented by means of this filter - it is more convenient to use this filter in preference to the Rock filter on account of economy of fuel.

11. The water in the Dhobies' Wells filter has been analysed by Surgeons Pedlow and McLaughlin, A. M. D. the water is clear after filtration and no traces of Nitric or Nitrous acids are shewn by the ordinary tests & only a small quantity of Chlorine and oxidisable Organic matter.

It is usable at present after filtration but its composition varies, the Organic matters being now in a state of extreme dilution in the tank in consequence of the late rains.

12. If the Government would require

the plot of Municipal land near the road
marked I there would be ample room
in the laterite bed for 6 new wells which
together with the 3 existing ones in this
plot and with 3 new wells which might
usefully be added to the System in the
Govt. Topo adjacent – there is reasonable
hope of adding 6,000 gallons per diem to
the Supply: but this would not suffice
for the use of the Garrison.

Vide plan II.

Shewn in yellow.

13. The bed of laterite within &
without the Govt. land is insufficient
to Supply by means of wells the total
quantity required for the daily use
of the troops.

But if in lieu of Sinking more wells
in this laterite a longitudinal tank or
Cistern were Constructed (as shewn in
plan II attached) its inner Side made
of dry Stone walling, and its outer
Side of Stone in lime mortar and
cement plastered, there is every reason
to

to be clear from the nature of the Soil and Surrounding Circumstances that a largely increased Supply of laterite filtered water over and above what new wells would Supply, will be obtained after the Municipal track of ground ( ) has been acquired by Govt. We would strongly recommend this in preference to Sinking any more wells.

This to be considered that the cistern will not only yield an additional Supply of water over and above what a few wells could give, but it could be extended as shewn in dotted lines so as to enclose the whole of the laterite bed, when enough laterite filtered water would in all probability be obtained, sufficient in fact to Supply the whole Garrison.

12. Eight wells and the necessary underground galleries or channels between them will cost about Rs. 3000/- this in our opinion, more effective system method would cost about Rs. 4000/- viz:

if built on Plot B only.

15. The Engineer's establishment which works the Steam Machinery & Supervises the distribution of the water in Barracks cost Rs. 537/- per mensem.

The Cost of fuel-all wood-for the 12 months ending 31st July 1882 Cost Rs. 3463/-

16. The quantities ranges between 30 to 35,000 gallons per diem.

17. In order to keep as much of the Surface filth of the catchment basin as possible out of the tank it will be necessary and practicable to-

(a) Surround the tanneries by an open ditch and bank, the ditch inside the bank, and made so as to discharge its contents into an underground masonry Sewer to below the tank at a cost approximating to Rs. 25,000/-

Large Plan.

(b) Surround the Mahomedan Burial ground

ground N.N.W. of the Railway Station
by the Completion of existing bund and
ditch - to ensure by Military inspection
(viz: by means of a Sanitary Inspector
acting under the orders of the Lieut. General)
that all Burials in it and other ad-
-jacent Burial grounds take place 6 feet
below the Surface, as well as to pre-
-vent bazaar Sweepings being depo-
-sited, as is now the case, anywhere
within the Catchment basin.

(c). To stop all the drain holes in the
Side walls of the main or paved feeding
channel - this will prevent the greater
part of the Sweepings & filth of the
adjacent Side Streets from passing
directly into the channel, as is now
the case - and to cause the channel to
be daily cleaned.

To cut off the whole of the Streets
bazaars & of the Cantonment bazaar
and Sites of houses of European

population by an intercepting storm water channel will too much reduce the natural or legitimate drainage area of the Ulsoor Tank which has already been considerably diminished (without the contemplated beneficial result to the Garrison anticipated at the time) by the Bangalore New Water Works and by the raising of the weir of the lower Miller's tank 1 foot.

The reduction of legitimate drainage area here alluded to is indicated on the Map hatched and tinted blue.

This reduction is the more to be regretted by the Military Authorities as the gathering ground taken thereby from the Ulsoor Tank was the only gathering ground it had which was unclouded by any impurity.

A perusal of appendix C an extract from the Memorandum of the Chief Engineer dated 9th September 1868

on

on Mr Humphrey's project will shew that it was the intention to fully supply the Garrison with water from this tank upon its completion - this may now be said to be found impossible - therefore we are of opinion that the drainage area thus taken from the Ulsoor Tank should be restored to it - more especially as it is the supposed intention of the Mysore Govt. to divert the water of this tract from Mr Humphrey's to the Dhamanbadi or Pekka Tank.

(d) The parapet walls of the pawed channel in many parts are too low to prevent filth & Surface washings of the adjacent roads being swept &c into it.

(e) Two silting traps are very necessary one at the end of the west feeder (pawed channel) and one at the end of the South feeder.

(f) If the silt traps proposed for safe guarding the tank from impurities

Coming about by the South feeder
is made — the angle of the bank can
thereby be cut off by a bund and
mask weir built over the existing filth
channel — this filth channel will thereby
wholly without the bank and this bund
would obviate any engineering difficulty
of rebuilding the filth channel outside
the bank.

(g) We think the Sanitary Supervision
of the Cantonment bazaar is conduct-
-ed without due regard to the purity
of the water in the Ulsoor Tank — Some
of the feeding channels are publicly
resorted to by the natives & used as
latrines — filth of all description is fre-
-quently seen in them, and during the
rain-fall washed into the tank — even
in the main or paved channel old
clothes, dead animals, human excreta,
and filth of all description are to
be seen at all times except of course
immediately after the heavy rain
storm

Storm. — 87 80 26

18. The Completion of a Suitable paling round the lower bank — and a Cactus or aloe hedge round the upper bank will be both practicable and very essential in order to preserve the walks & beds of the banks from constant direct contamination in all seasons. Convenient arrangements at certain places being at the same time made to enable the trading population to freely draw water into their hand vessels. Such places to be flagged and approached by a flight of steps and always kept in a proper Sanitary State.

19. (a) The Agram or Cavalry Cistern Gallons.
Should contain 2,80,000

(b) The Ulsoor or R. H. A — Do — 1,79,000

(c) The Parade or B. Infantry — Do — 1,12,500

(d) The Hospital iron Cistern — Do — 11,495

But the Agram Cistern will now

contain only 184,000 gallons, and the Wilsons only 148,000 gallons - both owing to Constructive errors.

The Parade & Hospital Cisterns contain their proper quantities respectively.

31st August 1882
Cheepank

W. H. Austen Lt Col R.E. President.

W. Waters M.D.
Surgeon Major
H.M.D.

J. Smith
Engr in Chf "Wilson
Water Works"

} Members.

O.M. GENERAL'S OFFICE, BANGALORE DIVISION
No 430
DATE 29.9.82
BANGALORE.

W. Wayn Lt Genl
Commanding Bangalore Division

Mr E 2
8187/83

L Dyce 1078

Ellsoor Tank Water Supply

1. What quantity of water is required daily for the troops at Bangalore, who are supplied with water from the Ellsoor tank?

2. What quantity would suffice, supposing that water was supplied to human beings only, and that horses and other animals were watered from other sources?

3. What other sources are there, and at what distance from the several lines?

4 Are there any wells in the lines which receive water from the Ellsoor Tank, which could be made use of to assist the supply?

5. Has the water in the wells been analysed and with what results?

6. What quantity of water could be drawn from them daily on an average

7. What quantity of water can the

the Dhobies wells supply on an average throughout the year, without any assistance from the water in the filter tank near them?

8. Have the Dhobies wells ever been pumped out, deepened and thoroughly cleaned? if so give the last date. at what height does the water stand in the wells in the dry and in the rainy season, and does the height correspond with the height of the water in the tank? When the tank is dry or low do the Dhobies' wells continue to yield a fair supply of water?

9. Is it not desirable on sanitary grounds to have each of the Dhobies' wells surrounded by a low parapet wall to prevent contamination by surface washings, and to have the covers ventilated?

10. What quantity of water can the

the filter tank supply, and how often during the last six months has it been found necessary to resort to it to supplement the supply drawn from the Dhobies' wells?

11. Has the water in the filter tank been analysed, by whom, and with what result.

12. If the wells, in the Municipal track of ground immediately adjoining the Dhobies wells belonging to Government, were made over for the use of the station would the total quantity of water then available suffice for the use of the Garrison?

13. If not how many more wells would be required, and could room be found for them, in proper soil, where the Dhobies' wells now are, or in the Municipal track of ground immediately adjoining?

14. What would be the approximate cost of sinking the number of wells required?

15. What is the cost to Government of the establishment now employed in arranging for the water supply, and what is the average annual expenditure of fuel.

16 What amount of water is drawn on an average from the Ellsoor Tank to supplement the supply from the Dhobie's wells.

17 As the impurity of the water in the Ellsoor Tank is chiefly due to surface filth of every description being washed into the tank during the rains, could the tank be supplied from higher tanks or higher ground as is the case to a considerable extent at present, and the surface filth and washings of the streets, bazaars &c intercepted by a Circular storm water channel?

17. Is there any engineering difficulty in carrying the filth channel outside the tank instead of under it as at present.

18. Would it be practicable to have the tank completely surrounded by a low wall or suitable paling, in order to preserve the water from contamination by natives directly resorting to it, and to make convenient places on a lower level with delivery taps? These places to be flagged and approached by a flight of steps.

19. What amount of water in gallons can be stored in the several reservoirs in the lines, and are these all water tight?

W H Burton Lt. R.E.
President.
31st August 1852.

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8085/83

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									cft.	gallons
29a	Near Dhobies Village behind the Cavalry Hollaway's Lines near Neelasundrum Road	"	880 yds	610 yds	380 yds	12'	29'	Not known 9'	1017	6356½
29b	Between Cavalry Stables & Cavalry Hospl	"	"	"	"	12'	46'	6'	7½ 1979	2368¾
10	S. W. Corner of Eidoor Tank					9½	25'	12sft	3' 212	1525
11	— Do —	For British Infantry				13'	23'	—Do—	6" 796.	
12	— Do —	Lodo yards from Single Mens Barracks.				14'	19'	—Do—	3' 461	
13	— Do —					15'	19'	—Do—	3' 530	5512½

Total 24,000 Gallons

To the pank
31st August 1882

W H Anstey Lt. Col. R.E.
President.

List of Military Wells which can assist the water Supply from Nilsoor Tank throughout the year.

No. of Military Wells marked on Plan.	Situation of Well.	Distance from R.H.A Stables as walked by horses	Distance from Cavalry as walked by horses.	Distance from 2/2nd R.A Stables as walked by horses	Distance from 1/3 Stables as walked by horses.	Diameter of Well.	Solid depth from Surface of ground to Water in dry season	Depth of Water in dry season	Depth of Water in May 62	Quantity of Water in Wells in gallons	Remarks.
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
										Gallons.	
1	Cavalry Barracks Family Quarters	"	600 yds	"	"	"	"	"	"	"	
2a	Lime Kiln South of	"	1760 "	1500 yds	1260 yds	12'	33'	Not known	16'	1809	
2b	Agram Hospital	"	1760 "	1500 "	1260 "	6½ x 5½	24½	Do	7½	268	
3a	Dumloor Tank West Margin	1600 yds	2050 "	1780 "	1550 "	4½	15½	Do	11'	174	
3b			2050 "	1780 "	1550 "	4½	15½	Do	11'	174	
3c			2050 "	1780 "	1550 "	4½	15½	Do	11'	174	
22			2290 "	2020 "	1790 "	12'	16'	Do	13'	1470	9187½
22d			2200 "	1900 "	1700 "	12'	18'	Do	16'	1809	
23			2130 "	1860 "	1630 "	12'	31'	Do	24½	2770	17312½
24	Gopaul Moodys Chuttram near Dumloor Tank	"	2230 "	1960 "	1720 "	9½	23'	Do	18½	1311	
25	Cashop Roadon	"	1200 "	930 "	600 "	12'	25'	Do	20'	2261	14131¼
26	Lower Agram Road Cashop Agram Barrack	"	1200 "	930 "	600 "	12'	34'	Do	28'	3166	19787½
27	Slaughter House inside	"	1260 "	1000 "	760 "	4'	13½	Do	9½	1193	
28a		"	1260 "	930 "	700 "	4'	13½	Do	9½	1193	
28b	Do outside	"	1130 "	860 "	600 "	12'	23'	Do	16'	1809	11306½

Period	Europeans Men	Women	Children ×16		Natives ×2	Gallons	Horses ×12	Gallons	Grand Total
I	II	III	IV		V	VI	VII	VIII	IX
1881									
August-	1332	167	301	1800	772		466		
			Gallons	28,800		1544		5592	35,936
September-	1322	202	322	1846	774		465		
			Gallons	29,536		1548		5580	36,664
October-	1336	209	328	1873	796		494		
			Gallons	29,968		1592		5928	37,488
November	1296	206	326	1828	713		425		
			Gallons	29,248		1426		5100	35,774
December-	1286	199	326	1811	714		422		
			Gallons	28976		1428		5064	35,468
1882									
January.	1291	200	330	1821	714		419		
			Gallons	29,136		1428		5028	35,592

I	II	III	IV ×16	V ×2	VI	VII ×12	VIII	IX
1882. February	972	144	279	404		232		
			1395					
	Gallons-		22,320		808		2784	25,312
March-	1104	154	283	404		232		
			1541					
	Gallons-		24656		808		2784	28,218
April-	1856	164	310	718		774		
			2330					
	Gallons-		37,280		1436		9288	48,004
May-	1870	169	310	718		778		
			2349					
	Gallons-		37,584		1436		9336	48,356
June-	1860	166	303	718		772		
			2329					
	Gallons-		37,264		1436		9,264	47,964
July-	1869	164	301	717		769		
			2334					
	Gallons-		37,344		1434		9228	48,006

Callespark
31st August

W. H. Burton Lt. Col. R.E.
President

Mr E5
8187/83

Mr 8501/1483

33 Extract from Chief Engineer's Memorandum on Mr Humphreys Project for Bangalore Water supply 5/9th September 1868.

× × × ×

56. The President of the Board does not Consider the Census of 1863 to be reliable and probably it is not so, but that of 1862, to anyone acquainted with Bangalore, exaggerates the population absurdly.

57. My own opinion is, that including European troops, followers, &c. the total will not be found to exceed 80,000 in all.

58. It will never in any Case be necessary to provide a water-supply for the whole of the residents at the station, as even now along the lowest points of the several drainage lines, and below the different reservoirs, well water is always obtainable by the inhabitants in the immediate neighbourhood, and the facilities in this respect will be very much increased

the

the moment a sufficient supply is brought in for the use of the residents on the upper grounds. Nothing can perhaps exceed the purity of the well water below the Ellsoor, Shoolay and Sumpengee tanks, and Consequently taking all the Circumstances into Consideration, we may fairly strike 20,000 out of the above enumeration, leaving 60,000 who may now be said absolutely to require an extraneous supply, and who will at least be able to pay a small Cess for having it brought within their reach.

59. To meet all reasonable demands of the future, it will, I think, be sufficient if we add 50 per cent to the above, and say that the scheme shall provide 10 gallons of filtered water per diem for a population of 90,000 souls. This Mr. Humphreys project will do.

× × × ×

60. A glance at the topographical features of the ground will at once show that the general Arrangement parade ground occupies a distinct ridge, of the Delivery with population on either side of it; while Mains Mootcherry

Mootcherry and St. Johns Hill lie along high ground to the north. To Command (1) therefore all the ground, as also to pass on supplies if necessary to the new Barracks and Artillery, and further allow the Sumpengee, Shoolay and Ellsoor tanks to pick up all the tail or waste-weir (which if desired may be employed for flooding the parade grounds occasionally or upon any other useful object) 2 distinct sets of iron mains will be needed (one along each of the ridges above mentioned) and from these delivery may take place in any way deemed most suitable hereafter. As the water flowing supply by gravitation will be delivered at a summit level of 80 feet above the waste-weir of Ellsoor tank, it will easily Command all the ground mentioned, leaving only a very few residents on the "High Ground" unprovided for. Any slight lift by pumping would give even these an ample supply.

× × × ×

74. Had the Ellsoor water works, now being carried out, not been commenced, it would have been a simple Corollary to the above proposition that the Madras Government should bear a proportion of prime cost for the benefit of the European and Native troops and followers — and even now, it is much to be hoped, that in Case the scheme now working out, does not prove as successful as was originally anticipated, some joint action on that which I venture to put forward, may yet be found practicable.

x x x x

compd W

(A true extract)

D. Wilson Lieut
A. Engineer

W. H. Burton Lt. Col. R.C.
President

31 — 8 — 82

87

Nov 16
818/83

Bangalore
8th Augt 1883

No 1043

To
The Asstt Qr Mr Genl
Bangalore Division
Bangalore.

Forwarded for submission
to the Lieutenant Genl
Commanding
I am able from my own
observation to corroborate
the general statements
brought forward by Surgn Major
Waters, and consider it of
essential consequence to
the health of the Troops
that effectual steps should
be taken to obviate the
evil conditions represented.

Sd/ W.S. Murray
Dy Surgn Genl
Mhw Ff.
Bangalore Divn

P.S.
Requests favor of infor=
mation as to the result of
steps taken.

Sd/ W.S.M.

True copy/

Sd/ W.S. Murray
Dy

North Station Hospital
Bangalore 8th Augt 1883

No 467.
83

From Surgn: Major R Waters
a.m.d
Senr Med. officer
North Station Hospl

To
The Dy. Surgeon Genl
Mhw Forces

Amongst the causes
which contribute to the
pollution of the water
supply at this station
I desire to bring to your
notice the foul condition
of the main channel or
principal feeder of the
Ulsoor Tank, from which
is derived, in conjunction
with the Dhobies wells,
all the water used by
the British Troops.
2. This main channel,
about

about 30 feet Wide,
runs through the bazaars
and receives the surface
water therefrom, the over-
flow of the tanks on the
higher ground, and the
water from the collecting
grounds beyond, it is
flagged throughout and
has a wall on each side,
so that there need not
be the slightest diffi-
culty in keeping it
clean. But to all
appearances there has been
no attempt made in
respect to its cleanliness.
Yesterday I Examined
it Carefully and found
the bottom of the Channel
Covered with accumulations
of filth of every descrip-
- putrid mud, human
hair (thrown in by the barbers
who sit and carry on
their trade at the side
of the Channel) dead
animals, baskets, chattees,
old shoes, hats, straw,
rags, Vegetable debris, and
Refuse of Every description,
whilst throughout, from
End to End, I found Excreta
of men, horses, Cattle and
goats. I also found the
top of the walls covered
in numerous places with
human Excreta - the Chan-
nel being used as a Retirine,
the people sitting, for this
purpose, on the low parapet
walls. The roads alongside
the Channel are almost
Equally pollutted, Excrement
and filth being deposited
there and washed through
the openings in the walls
into the Channel on the oc-
Currence of Rain.

3. On the floor of this
Channel, at its very
Commencement

Commencement, at the End
Next the Ulcer Tank,
I found yesterday within
the Space of a few yards, 16
deposits of fresh human
Excrement, one had a close
resemblance to the pea-soupy
Character of Enteric Fever
Excreta.

4. The Channel is perpetu-
ally polluted and the filth
is washed into the tank
on the occurrence of Every
Shower. I have repeatedly
Examined it and walked
from End to End, as I did
Yesterday, and never found
it otherwise than in the
Condition above described.

5. As respects the Ulcer
Tank itself the same foul
practices continue that
were formerly reported.
Yesterday I saw it used
for bathing and ablution
purposes, for watering and
washing horses and Cattle,
washing of Clothing &c &c;
I also saw during the short
time

time I was there 12 men
bathing in it, and others
without number per-
forming their ablutions
with all their attendant
filthy practices; of these
Latter I saw one urinat-
ing at the Edge of the
water, and on a former
occasion I saw a man
urinating whilst stand-
ing up to his knees in
the water washing him-
self.

6. I wish to bring this
to your notice as such
a Condition of the main
Channel and tank is
not only horrible and re-
pulsive, but is attended
with great danger to
the lives of the troops

Surg. R. Waters.
Surgeon Major and
Senr Med. Offr

True Copy
C Bracebridge

True Copy
Surg. R. Waters
Surg. Major A.M.D.

(B)

P 27
8087/83

No. 5092

P. 89.
67

Government of Madras.

MILITARY DEPARTMENT,

Received the 19 Sept 1883

From the Quarter Master General, No. 699, dated 29 August 1883.

Ord-dated 19/Sept/83. No 5092

The Right Honorable the Governor in Council entirely concurs in opinion with His Excellency the Commander-in-Chief that the question of the water supply to the troops at Bangalore imperatively demands immediate and most careful consideration and the earliest possible action in view either to the removal of the causes that now so largely contribute to the contamination of the water of the Ulsoor tank or to the adoption of such other measures as may be deemed desirable for securing

securing an adequate supply of pure drinking water to the troops at Bangalore.

2- The question is however essentially a professional one - and will be referred for early consideration in the Public Works Department, in continuation of Military Departts No 2641, dated 8th May 1883, with the suggestion that a specially selected officer be deputed to the duty indicated in para: 12 of the Quarter Master General's letter - as also to consider and report, without avoidable delay, which of the measures proposed by His Excellency the Commdr: in Chief in para: 10 affords greatest promise of securing the object in view.

3- The necessary further orders will then be issued in the Public Works Department.

(True Extract)

Colonel,
Secretary to Govt.

To

The Quarter Master General
& Public Works Department.

With all the papers.

Pol Eco. 8087
R/1-83.
OLL-21-9

8-41
69

MEMORANDUM ON THE WATER-SUPPLY OF BANGALORE.

The importance of this question has of late forced itself so much on public attention, that several schemes have been put forward for meeting the admitted want of an adequate water-supply for this large and rapidly expanding community. The most direct and comprehensive of these proposals is one entered in the Department Public Works Budget of the current official year, which (long delayed for want of proper establishment) is now being elaborated by Mr. H. T. Humphreys, C. E.

2. Before, however, describing generally the scope of the project, it appears desirable to note the past and present condition of the water-supply, with the opinions of those who have taken the greatest interest in the question.

Distribution of Drainage.

3. From the Muntapum hill, which is the highest point in the immediate neighbourhood of Bangalore (and elevated 3,107 feet above sea level,) diverge the two drainage areas, along which the densest portion of the population has grown, *viz.*, (1) the Ulsoor catchment-basin, and (2) that, at the head of which, stands the Durmamboody tank (which forms the main water-supply of the old pettah of Bangalore). The first of these leads off naturally south-east-wards to the Pennaur river; and the second would, on the other hand, have led to the Arkavutti in a south-westerly direction, but for the catchchannel supplying the Durmamboody tank, diverting the water back into the Pennaur basin.

Pettah Supply excluded.

4. As the old pettah does not appear to have increased very much, particularly of late years, and as its water-supply is generally considered to meet its requirements, the subject need only be incidentally considered. The main question, therefore, is more directly connected with the Ulsoor valley, and the two subsidiary ones of Shoolay and Sumpenjee, the drainage of which eventually join it.

5. A glance at the map of Bangalore will shew better the general distribution of the population, than any description. The Cantonment Bazaar being the chief centre of population, Ulsoor and Shoolay are the next; while the mass of the well-to-do military and civil communities is scattered over all the elevated portions, excepting those reserved for the parade grounds of the European and Native troops.

Earliest existing Tanks.

6. When the station was first formed in 1810, (it had apparently no existence before British occupation, all prior to that of any importance being confined to the pettah and fort) the Ulsoor, Sumpenjee and Shoolay tanks were, it is understood, the only reservoirs in existence. The remains of a few old ponds or "cuttay" higher up the valleys, shew that some of these minor works existed previously (especially in the Bederhully valley); but they were probably of little use, and chiefly intended for cattle. Below these three tanks, were, and are to this day, several others, such as the Coramungul, Sonakul, Dumaloor, &c., but as all population here has the tendency of spreading up, not down, the several drainages, there is no practical use in taking these lower reservoirs into account, with reference to the immediate subject in hand.

7. It may be as well here to note that apparently from prescriptive usage, the waters of the Ulsoor and Sumpenjee tanks have all along been considered as exclu-

sively appropriated for the use of the garrison; and to this end, the irrigation sluices belonging to each were long ago closed. All cultivation under these tanks has hitherto been from wells. At the present day it is difficult to understand the reasons for the Sumpenjee tank having been devoted entirely for military purposes, as it never has been, nor indeed could be, used by the garrison.

8. In early days the old Sumpenjee supply channel, which diverts much of the water that would otherwise flow down from the Muntapum hill by both feeders of the Ulsoor tank, was looked upon as the great *safe-guard of that reservoir. In fact the Resident Mr A. Cole in 1814, expressed his fears that the breaching of the channel bank would be likely to destroy the "bank of the Ulsoor tank." Clearly, therefore, at this time, Bangalore had more water at command than it altogether liked.

Miller's Tank.

9. A change, with the growth of population, gradually took place; and in 1854 Captain (now Colonel) Miller, Commissary and Superintendent of Police, undertook, first at his own cost, the construction of the tank at the head of the Cantonment, Bazaar, which still most appropriately bears his name. The Commissioner, Sir Mark Cubbon, afterwards approving of the work, paid for it from the public funds. This, it is believed, was the first effort to meet the growing wants of the place; and the work has proved itself to be one of the many benefits conferred on the community by the above named active and philanthropic officer.

Water-supply for the new Cavalry Barracks.

10. The next occasion on which the question of water-supply appears to have attracted serious attention, was in connection with the new Cavalry Barracks on the old race-course in 1859, and Captains Wilkieson and Mayne of the Royal Engineers jointly reported† that for the object directly in view, a store of water could be maintained in 6 wells, 40 feet deep and 25 feet in diameter, sufficient for 2000 souls at 5 gallons each per diem; but that the means of maintaining the supply (which however they had not investigated) would cost a large sum.

Sir A. Cotton's Objection.

11. Sir Arthur Cotton being called on for his opinion by the Madras Government reported, in his No. 320 of the 9th August 1859, that he was unable to concur with the Commissioner's (Sir Mark Cubbon's) suggestion that the supply for the proposed wells should be pumped up from the Ulsoor tank. His objections were: "1st, "the insuperable one, that this tank receives the drainage from a large portion of the "Cantonment, containing a considerable town, which must render the water unfit for "use; 2nd, the great expense of constantly pumping from such a depth."

12. He argued that the general supply of water for the Cantonment should be considered, and that the levels would admit of water being led in from the direction of Nundidroog (31 miles north).

His first Proposals.

13. Colonel Cotton's calculation was as follows:—"For 100,000 people at 20 "gallons a day, the quantity would be 4½ million of cubic "yards, and taking the rain-fall at 36 inches, and the "quantity flowing off at ⅓ of that or 2 feet, one square

*It is impossible now to say when the main Sumpenjee Catch Channel, north of the Muntapum hill, was constructed; but by General Wetherall's letter in reply to Sir A. Cole, dated 25th August 1814, it seems that the southern bifurcation of the channel which drains the southern side of the Muntapum hill, was completed in 1809. The extension of irrigation under the Sumpenjee tank appears to have been the origin of both channels; and probably it was only afterwards (as the Cantonment Bazaar began to rise and encroach on the west corner of the Ulsoor tank.) that its use as a safe-guard to the tank and town was discovered.

† 14th May 1859.

"mile of ground would provide 2 millions of cubic yards, or 4½ millions would be "provided by 2½ square miles; and allowing 50 per cent additional for loss by evapo- "ration, &c., 3½ square miles would supply sufficient." He added also a calculation for flooding 1,000 acres of garden land in the Cantonment, which would raise the area, whose drainage should be stored to 7½ square miles.

14. The general plan proposed was to run two small parallel banks on each side of the ridge between the Cantonment and Nundidroog, half a mile apart for a length of 15 miles and terminating in a cross bund uniting the two, and so forming the tank, the whole cost being roughly estimated at Rs. 25,000. The scheme was to yield large annual returns: first in saving of the carriage of water as at present, and second in irrigating the compounds and other lands.

Colonel Green's Explanation of several Projects.

15. Captain (now Major) Puckle, at that time Executive Engineer, Bangalore Division, was placed at Colonel Cotton's disposal for conducting the requisite surveys, &c., and Colonel Green (the then Chief Engineer) in conveying instructions on the subject* observed that Sir Mark Cubbon was prepared to increase the capacity of Miller's tank in connection with the project for constructing a sewer which was to carry off the Cantonment Bazaar drainage and prevent its contaminating the Ulsoor tank.

16. This increase of Miller's tank (which was 63 feet above Ulsoor) Colonel Green considered essential in connection with the drainage project, at the same time that it would be necessary to keep up the supply of the Ulsoor tank by a feeding channel to the eastward. Colonel Cotton's project, he explained, was (as he understood it) to construct a reservoir at a level intermediately between the two above mentioned, so as to command the barracks and be fed by channels carried in the direction of Nundidroog.

Length of Nundidroog Channel.

17. Captain Puckle in reporting proceedings stated that, if the levels were extended to the 30th mile near Nundidroog, the contour line would probably exceed 150 miles in length; and subsequently it was found on actually laying out 30 miles from the starting point (the floor of the old Race-Course Barracks) the line, which wound in an extremely tortuous manner to the eastward, had returned to a point known as Mootapah's Chutrum close to Mootacherry church. The direct advance towards Nundidroog was therefore very little.

Sir A. Cotton's final Conclusions.

18. On the completion of the levels to this extent, Colonel Cotton, in re-placing Captain Puckle's services, reported, December 17th 1859, that the following conclusions had been "fully established."

1st "That an ample supply of water can be obtained on the west side of Nundidroog, without "the least injury to the present supply, by making a tank of large capacity which will store the water "of copious monsoons to supply the deficiency of a following bad year.

2nd. "That the present Mailcottah tank, the Callingalah of which is 50 feet above the Race- "Course, will be a suitable site for such a tank as is proposed.

3rd. "That a tank there to contain 10 millions of cubic yards, will supply sufficient water "with a large surplus—even in very bad years.

* * * *

7th. "That the expense of this will not be excessive, perhaps Rs. 1,40,000 including compen- "sation; but this is a rough estimate."

* Letter No. 1135 of 4th October 1859.

19. Colonel Green *expressed strong doubts as to these conclusions. He did not consider that the Mailcottah tank "could be very much "enlarged even though the supply of other tanks be inter- "cepted" nor that "50 feet would be found an adequate "fall on a channel which would be at least 100 miles in length."

Colonel Green's Objections.

20. The term "copious monsoons" was incorrect as applied to the character of the seasons in that part of the country. The fall of the channel would be insufficient and its direction tortuous; it would intercept in the whole of its great length the rain water from the fields and tanks lower down the slopes; it would become breached in many places accidentally, and in still more places designedly.

21. As the channel would be in "the predicament of a long tank full of water, "the bund would need to be replete with waste-weirs or expensive outlets." Finally, the estimate of 1½ lacs for this work, carried through a country intersected by deep nullahs and studded with rock, would be quite insufficient.

22. Colonel Green was of opinion that the Race-Course Barracks would most readily be supplied by picottahs raising water in 4 lifts of from 8 to 10 feet each from the Ulsoor tank; or if preferable by 2 small donkey engines. Although the Ulsoor tank received impurities, he considered that the supposed deterioration of the wells adjacent to the tank to be exaggerated, and came to the conclusion that after the "improvement to Miller's tank, and the still more important and more desirable sanitary project connected with the Ulsoor tank," &c., he did not think Bangalore would have anything to complain of on the score of good and pure water.

Proposal to pump up from the Ulsoor tank.

23. This with a letter much to the same purport addressed to Colonel Cotton appears to have finished the discussion, and so far as can now be discovered the project of bringing in water from Nundidroog has been completely shelved. There can however be little doubt that the investigations then made were of considerable utility, and have in a great measure led up to the conclusions now arrived at.

24. The sewer conveying the filth of the Bazaar away from and under the Ulsoor tank was completed in due course in 1864, and the work of following the Cantonment drainage system to its legitimate conclusions is now being prosecuted by this department.

25. The Madras Government moreover undertook in 1863 to raise a water-supply for the new Cavalry Barracks from the Ulsoor tank, by steam pumps and pipes much in accordance with the idea put forward by Colonel Green as shewn above, on a plan matured by Captain Tulloch, R. E.

Works by the Madras Government for supplying new Cavalry Barracks.

26. In 1865, Colonel Lawford, when Chief Engineer, being led to believe that it was the intention of the Madras Government to endeavour to have the last named project applied to the whole of the station and bazaars with a view to Mysore sharing in the outlay, drew up a memorandum dated 6th July 1865, which although submitted to the Government of India† bears so directly on the various schemes proposed that it must be here shortly adverted to.

27. Colonel Lawford after shewing the general scope of Captain Tulloch's project, and that it was supposed to cost 1½ lacs of rupees, observes, "it appears that in all the schemes hitherto put "forward for the water-supply of this station, the very simple

Colonel Lawford's Objections.

* Letter No. 1,770 of 4th January 1860.

†Replied to in Colonel Dickens' letter No. 1320 *d* of 1st December 1865.

"plan of retaining the surface drainage in reservoirs on the highest possible levels has "been strangely neglected, and the consideration is overlooked, but not only does the "water contract greater impurities from the wider area which it drains on its passage "to the main reservoir, but that the necessity of raising it involves the most costly and "precarious plans. If nearly the whole population of Bangalore is to depend on a "supply received from the Ulsoor tank through the working of steam pumps, they may "possibly suffer extreme distress from accidental causes which no one can foresee or "prevent."

28. He shews that the failure of the old wells being entirely attributable to the great increase of population and the character of the soil, the spring level should be raised by constructing reservoirs on the highest levels, (1) by the enlargement of the Railway tank (Reservoir No. 3) below Miller's, and (2) the formation of one above the latter, (this has since been constructed.) He adds that "one, if not more reservoirs could be "formed on the upper (*i. e.* northern) feeder of the Ulsoor tank, along which the "population tends to spread." This had reference to the Railway or so called Bederhully reservoir, which Colonel Lawford often expressed a wish to see carried out, and which has lately been proposed by the Municipal Board though in a different form. The remainder of the communication being taken up with a proposal not now likely to be carried out (though extremely good in itself) of supplying the Cavalry Barracks from wells to the S. W. containing a pure supply of water, and at a shorter distance than the Ulsoor water works, it is unnecessary to follow it further.

Proposed construction of High Level Reservoirs.

29. The principle however laid down here of fixing the empounding reservoirs at the highest possible point, is that which has been consistently acted on by this department, within the limited means of the local administrations, under sanction of the Commissioner.

30. Among other works thus carried on in the station of late years, chiefly under Colonel Lawford, the following may be enumerated:—

Works already executed on this Principle.

Enlargement of Miller's tank, completed in 1863.

Construction of the Railway or No. 3 Reservoir in 1864.

Do. of No. 1 Reservoir (above Miller's) in 1866.

Do. of No. 4 Reservoir (below all the above) in 1867.

31. These form a continuous chain at the head of the Bazaar nullah, and not only receive a fairly pure supply of water, but tend to keep up the spring level in their neighbourhood. The three upper ones are kept free from immediate pollution, under special regulations; and their several capacities with the relative heights of high-water level, above the waste-weir of the Ulsooor tank, are given in the margin. Though of course distribution could be effected from these reservoirs which, from their relative height, command much of the Cantonment Bazaar, it has not appeared desirable to carry this out:—1st as neither in collective capacity, nor in relative command, are they able to do *all* the work required;—2nd as

NAMES.	Capacity in cubic feet.	Height above Ulsoor, feet.
No. (1) Reservoir	4,500,000	64·05
No. (2) do. (Miller's) ...	6,000,000	61·05
No. (3) do. (Railway) ...	3,500,000	56·61
No. (4) do.	500,000	28·8
Total capacity in cubic feet...	14,500,000	

Distribution from any of these undesirable.

notwithstanding the purity of the water compared with that of Ulsoor tank, it is not so unobjectionable as could be desired;—3rd as the town may, at some future day, be expected at least to spread up to Miller's tank, and thus spite of the best regulations add to the contained impurities.

The connection of Reservoirs Nos. 3 and 4 with the Main Drain of the Cantonment Bazaar.

32. In addition to their present value, in affording a comparatively pure water-supply to the upper portions of the Cantonment Bazaar, and Native Infantry Lines, the two lower reservoirs, Nos. 3 and 4 (and especially the former), have the special object of flushing the main sewer. The attainment of this latter object has always been steadily kept in view by this department, in dealing with the several portions of the work, as follows:—

1st. The oviform sewer carried along and eventually under the end of the Ulsoor tank. The whole of this with its out-fall arrangements and accessories was completed in 1864 at a total outlay of Rs. 1,36,000.

2nd. The extension of the sewer upwards, through the Cantonment Bazaar (and provided with self-acting arrangements which separate the sewage from storm-waters), was commenced last year, and is now, it may be said, completed, at a total outlay of Rs. 61,500.

3rd. The completion of the system as far up as No. 3 Reservoir, is being estimated for, with a view to the insertion of the project in next Budget.

33. In a year and a half more, the whole arterial drainage should thus be finished, and placed in immediate connection with the series of small reservoirs forming the present water-supply.

Minor Reservoirs connected with the Water-Supply.

34. The principle advocated by Colonel Lawford has been further acted on, in the construction of several minor works, *viz.*, (1) the small reservoir and well at Mootacherry; (2) the reservoir at corner of the Government House compound; (3) that near the Executive Engineer's office; (4) the reservoir on the road of approach to the Public Offices; (5) one near the new Cavalry Barracks, &c. Some others have also been carried out by the Cantonment municipality, and two more, lately undertaken, have nearly been finished by this department.

35. To complete the general list of such works, it may here be mentioned, that the Shoolay tank, was effectually dealt with by this department in the years 1861 and 1863, and not only the water-supply but the whole neighbourhood improved. The Durmamboody tank had also a great deal laid out on it in 1863, under the Commissioner's sanction. The Ulsoor tank itself has also been largely improved by reclamations, &c., at different periods.

36. The gradual growth of opinion and practise following fairly on a knowledge of the wants of the community may be gathered from the foregoing; and it only remains to advert to the projects which the rapidly increasing requirements of the station, within the last few years, (and particularly since the opening of the Railway) have given birth to.

The Madras Project.

37. The *first*, which is the Madras scheme for pumping up water from the Ulsoor tank for the use of the European troops (commenced in April 1863), has already been sufficiently noticed for my present purpose. The works are now rapidly approaching completion and will ere long be fully tested; but whether they end in success or failure, as regards their particularo bject, I cannot consider them adapted to meet the wants of the general community.

Major Puckle's Project.

38. The *second* is the scheme put forward by Major Puckle, President of the Municipal Board, in his [illegible]ted memoranda of 1st October 1867 and 20th April 1868, respectively; and this project both from the acknowledged ability of its author, and his long local acquaintance with the subject, make it the more necessary to notice its main features in detail.

39. In the first of the above memoranda, the following observations occur:—

* * * * *

"4. The Commissioner's House on the High Ground is nearly, if not, the highest in Bangalore; "the foot of the flag staff is 3031 feet above high-water mark at Madras, and is almost on the crest "of the water-shed ridge, that divides the Pennaur from the Arkavutti rivers both of which rise at "Nundidroog, the culminating point.

"5. For about one fourth of the distance from Nundidroog, this ridge commands the flag staff "point; but thereafter there is a long interval, where the crest is on a general level with, and in "one part lower than it. The Muntapum (1 mile from the flag staff) is 80 feet higher, but this is on "a low conical hill, and the dip between it and the flag staff is great. If water were pounded below "Nundidroog, the difficulty of bringing it in for storage at any high level, would be great, on account "of the necessity there would be of constructing long and lofty aqueducts; and even then, all the "houses on the High Ground would have to be served by force pumps.

"6. *The fall from this ridge is too sharp to admit the possibility of collecting water in the "Arkavutti valley for delivery at any commanding point in Bangalore* except by increasing the Mail-"kota tank, close up to Nundidroog, which Sir Arthur Cotton in 1859 thought might be done, so as to "enable the water to be conveyed along a contour line a little below the crest of the water-shed ridge, "into the Ulsoor tank, which is 111 feet below the flag-staff datum, but the cost of the channel "contouring round the spurs would be very great, and the supply was thought to be of too precarious "a nature to warrant the work being undertaken.

"7. From the peculiar position of Bangalore, it is only from the northern side that water can be "collected, *and the Arkavutti valley is too steep to admit of anything but a catch channel close "under its crest, being made.*"

* * * * *

and the conclusion arrived at in para 9, is

"9. It has been ascertained by levels carefully taken, that water could be stored in Miller's "tank (the present crest of the waste-weir of which, is about 45 feet below the flag-staff datum), and "in a newly proposed reservoir on the Railway embankment, $\frac{3}{4}$ mile from the terminal station; *these "are the highest points at which water could perhaps practically be stored with advantage.*"

* * * * *

Although agreeing in much of this, I cannot but hold, that a radical error is contained in the sentences which I have put in italics, and that on this, is grounded the so-called Bederhully scheme.

The Project as lately modified.

40. The project, it is true, has undergone some slight modification, in consequence of the discussion to which it has been subjected; but as its scope as well as the objections to it are sufficiently summarized in my letter No. 4089—439 of the 15th July 1866, to the Commissioner, I beg here to quote that communication.

* * * * *

"3. So far as I can gather from the President's letter No. 183, the proposed tank is to supply "during the hot season, if possible, the Ulsoor, Shoolay, Coramungul, and Dumloor tanks; to feed the "existing wells in the neighbourhood, both public and private, and the public fountains, wells and "cattle troughs, to be constructed hereafter."

"4. The reservoir was also from the President's printed memorandum to be capable of laying "water on to the Race-Course Barracks."

"5. If the reservoir is to supply all the tanks mentioned, during a season of drought, as also fulfil "the other functions enumerated,—its capacity must be the greatest possible under the circumstances; "for when its services are most required, it will itself be correspondingly reduced by the effects of the

"season. Thus in seasons of the most severe drought, the Shoolay, Sumpenjee, and Dumloor tanks, "are almost quite dry, while the Ulsoor and Coramungul tanks would only perhaps be one-third full. "The Bederhully tank will not be in a much better condition than these latter; and yet the small "residue left in it, must be capable of not only making up for all the deficiencies of the others that "supply public fountains, &c.

"6. In addition, moreover, to the great capacity required for this work, the tank must be placed "at sufficient height, to command the plateau of the Race-Course Barracks, and means must be found "by piping or an aqueduct, to take the water, either under pressure or by gravitation, across the valley "and over the ridge which separates the proposed reservoir from the Shoolay and Sumpenjee tanks.

"7. Such being apparently the extensive duties to be assigned to this work, I do not think I "am wrong in saying, that it will be a most expensive project, and

Objections entertained to it.

"that the objects to be attained would be quite incommensurate with the "cost, and that further, even supposing that all were done, which is proposed,—the mass of the inhabi- "tants would be nearly as badly off for water as ever; for from the slight command of the work, none "of the upper portions of the Cantonment Bazaar would be touched, nor any of the compounds of the "European residents."

* * *

41. It appears to me therefore, that however useful such a subsidiary tank in the neighbourhood of Bederhully might prove, in the manner originally proposed by Colonel Lawford, (*vide supra*) I cannot look on it as likely to meet the objects put forward by Major Puckle. In addition to the objections already urged, I would here observe—(1) That the valley is of such a form as only to admit of a comparatively shallow reservoir; the losses from evaporation would therefore be disproportionably great. (2) Population has clearly a tendency to spread up it, and thus in time, create difficulties in retaining a pure supply. (3) There are now grave-yards, and old re- ceptacles of town filth, within the catchment basin, which unless specially dealt with, would pollute the tank, &c.

42. Were a series of small and inexpensive reservoirs constructed in the Be-

A series of Small Tanks more desirable.

derhully valley, analogous to Nos. 1, 2, 3, and 4, at the upper end of the Cantonment Bazaar, I could have no doubt of their utility in raising the spring level, &c., and especi- ally, if so designed as to flush the main drain, which must at some future day be constructed to cut off the impurities of the growing town, from the Ulsoor tank.

43. As forming, however, a single head for a pure and sufficient water-supply for the station, I am quite convinced the scheme will never answer.

44. The *third* and last proposal is, that entered in the Budget of this depart-

Departmental Project.

ment, which I shall however only describe in the most general terms, as it will remain for Mr. Humphreys, who is now working out the project to deal with it in detail.

45. With a view to establishing a safe ground-work for any project which might be undertaken in future, either for water-supply or drainage, I had the whole

Surveys and Levels of the Cantonment.

station surveyed two years ago under the Commissioner's sanction. The Cantonment Bazaar was worked out in great detail, and the Sappers undertook to execute the general survey, as also levels. The latter work was performed very satisfactorily.

46. The next point,—acting on Colonel Lawford's principle of empounding a sufficient supply of water at the highest possible level,—was to obtain a survey of all the highest gathering grounds, both of the Arkavutti and Pennaur river. From

these investigations, it became clear that by making a cut to the depth of 20 feet

First Trial.

through the narrow saddle near the new Mahomedan burial ground (and past which the water was to be led in a brick culvert) an ample supply could be conducted into, and empounded in the valley near the Railway station, just above Messrs. Binny and Co.'s coffee-works.

47. The gathering grounds lie all round the Muntapum hill extending close up to Hebbal tank (N.,) Subedar's Chuttrum (N. W.,) and then (S.) along the Arka- vutti drainage—in all 3 square miles skirted by a channel 13 miles in length, with a slope of 9 inches in the mile.

48. Colonels Green and Lawford, as also Major Puckle, having adopted ½rd of the average annual rain-fall of 36 inches, as a fair proportion of the amount that could be empounded, I accepted the opinion and found the total yield, (making the most liberal allowance for all sources of loss), would be sufficient for daily supply of 10 gallons of filtered water per diem, to a population of 105,000, delivered at 80 feet above the Ulsoor tank. This height commands all the station and barracks, leaving only the few residents on "High Ground" unprovided for.

49. Much of the gathering grounds have hitherto lain fallow, and as the small and comparatively valueless dry crops now raised can be easily put a stop to, under a trifling compensation, the perfect cleanliness of the whole area (the soil being highly silicious) may be readily insured. The slopes on all sides are rapid, and the surface if left untilled soon acquires a hard glazed skin, off which the water flows with the utmost rapidity.

50. Mr. Humphreys who has now been engaged on

Mr. Humphreys' Modifications.

the project for 3 months, has, while adopting precisely the same gathering grounds, suggested two important modifi- cations of the original scheme.

51. Instead of placing the empounding reservoir in the Railway Terminus valley, he has selected, as a site, the dip of the Toomkoor road, 2 miles beyond "High Ground" situated immediately south-west of, and close under, the Muntapum hill, in fact as near as possible the centre of the gathering grounds. In lieu of one long catch-channel circling the whole area, four channels, none of which will be over 3 miles long, will deliver the surface drainage, thus reducing loss by evaporation and sinkage to a minimum.

52. His second improvement is, to score the whole of the gathering grounds over with channels, at different levels, constructed with slopes having maximum longitudinal falls consistent with the cohesive powers of the soil, by which arrange- ment the discharge of all surface drainage will be expedited to the highest degree.

53. Lastly, the form of Mr. Humphreys' reservoir has great advantages, its surface being everywhere up to the highest water-level extremely small for its depth and capacity,—loss by evaporation will thus be reduced to a minimum. In this respect the site is probably the very best which could be found anywhere in the neighbourhood of Bangalore.

54. Unfortunately the available returns as to the population of the station

Census of Population within Municipal limits.

within municipal limits are most unsatisfactory, as may be seen from the following abstracts of the censuses taken in 1862 and 1863, obligingly furnished by the President of the Municipal Board.

POPULATION WITHIN THE MUNICIPAL LIMITS.

CLASSES.	Abstract of Census of 1862.	Abstract of Census of 1863.
Hindoos	86,055	42,973
Mahomedans	26,856	13,129
Europeans	1,836	5,226
Eurasians	1,586	1,436
Total.....	123,533	62,764

European and native soldiers are said to have been excluded in the census of 1862, while European soldiers were included in that of 1863.

55. The present strength of the force is returned by the Deputy Quarter Master General as consisting of.—

European Troops	1,900
Native do.	2,500
Families and followers of European and Native Troops ..	11,500
Total....	15,900 souls.

56. The President of the Board does not consider the census of 1863 to be reliable and probably it is not so, but that of 1862, to any one acquainted with Bangalore, exaggerates the population absurdly.

57. My own opinion is, that including European troops, followers, &c., the total will not be found to exceed 80,000 in all.

58. It will never in any case be necessary to provide a water-supply for the whole of the residents at the station, as even now along the lowest points of the several drainage lines, and below the different reservoirs, well water is always obtainable by the inhabitants in the immediate neighbourhood, and the facilities in this respect will be very much increased the moment a sufficient supply is brought in, for the use of the residents on the upper grounds. Nothing can perhaps exceed the purity of the well water below the Ulsoor, Shoolay and Sumpengee tanks, and consequently taking all the circumstances into consideration, we may fairly strike 20,000 out of the above enumeration, leaving 60,000 who may now be said absolutely to require an extraneous supply, and who will at least be able to pay a small cess for having it brought within their reach.

59. To meet all reasonable demands of the future, it will, I think, be sufficient if we add 50 per cent to the above, and say that the scheme shall provide 10 gallons of filtered water per diem for a population of 90,000 souls. This Mr. Humphreys' project will do.

Number of Souls to be provided for.

60. In the margin are given the rain-fall registers of the past 20 years taken (with slight correction) from Major Puckle's printed analysis. To this is added the averages of each pair of successive annual registrations for the following reason. The reservoir being designed to hold at any one time the whole yield of a minimum year, it is only reasonable to consider, that in all cases the residue from a good year, will remain stored to supplement the deficiencies of a succeeding bad one. What we have in fact to calculate on is, not the direct yield of the worst recorded year, but the average of the lowest pair of successive registrations. The years 1854 and 1855 shewed the worst combined result to be 28·2 inches, and on this the calculations have been based. I may note here parenthetically that the registration of the year 1840 as given in Major Puckle's table has been rejected as being manifestly wrong.

TABLE OF RAIN-FALL.

YEAR.	Registered Rain-fall in Inches.	Average of each pair of successive Annual Registrations.	REMARKS.
1861	30·5	31·9	
1860	33·3	29·9	*Lowest reliably recorded rain-fall.
1859	*26·6	32·1	
1858	37·7	34·0	
1857	30·3	39·3	
1856	48·3	37·7	
1855	27·2	28·2 †	†Average of the lowest pair.
1854	29·2	32·0	
1853	34·8	44·9	
1852	55·1	45·2	
1851	35·3	42·4	
1850	49·5	38·6	
1849	27·8	34·0	
1848	40·3	38·9	
1847	37·5	38·4	
1846	39·4	36·1	
1845	32·8	33·6	
1844	34·5	35·9	
1843	37·3	34·3	
1842	31·3	34·6	
1841	37·9		
		20) 722·0	
		36·1 inches average annual rain-fall.	

61. At first starting it is proposed to arrange the delivery into the reservoir by catch-channels on only two levels, the one set discharging at a height, of 100 feet above the level of the Ulsoor tank waste-weir, and the other at 120 feet.

62. From the less longitudinal slope given to the former set, the channels are only calculated to deliver into the reservoir ⅓rd of the rain-fall of the area drained by them, but from the much greater slope of the upper set of channels (those at 120 feet) the delivery is taken at ⅔ths.

Total Yield of the Gathering Ground.

63. The whole yield of the 2½ square miles of gathering ground so drained (taking also into account the direct rain-fall into the reservoir itself, which has an average surface of 15,00,000 superficial feet) is thus for a total rain-fall of 28·2 inches, 62⅛ millions of cubic feet.

64. Now the annual draught for a population of 90,000 at 10 gallons per head per diem is 52½ millions cubic feet, and assuming losses by evaporation, &c., to be ·2 inches per diem (in the worst season it has been shewn to be ·25, but on an experiment recorded by Major Puckle, the value was only ·16) we must add 9⅛ millions, bringing the total annual draught on the reservoir, by use and loss, up to 61⅛ millions of cubic feet, consequently there will be a slight margin after meeting all wants.

65. Arrangements are to be made for fixing the sill of the waste-weir at 103 feet above Ulsoor tank. But even at the 100 feet level, the reservoir will hold at one time 60 millions of cubic feet.

Storage Capacity of Reservior.

66. As speaking generally, each inch of rain-fall on the gathering grounds is sufficient for the annual requirements of 3,000 souls, it follows that as a rule the reservoir will, on the average, be able to meet the wants of *24,000 souls in addition to the 90,000 for whom *certain* provision is made.

*Average rain-fall in each of lowest pair of successive years	36·1 28·2
Difference, say 8 inches 8 × 3000 = 24,000 souls.	

Additional Gathering Grounds available.

67. But the general capabilities of the scheme are by no means restricted within these limits as there are outlying gathering grounds, the rain-fall on which can, at any future time, be brought in to supplement the requirements. One of these, a little south of Yellavunka, has an available area of 2 square miles, and another piece (now rejected) close adjoining the west extremity of the present gathering grounds, has an area of ½ of a square mile. The catchment area can thus (if ever the growth of population absolutely need it) be doubled.

68. In other words with an increased outlay which it is unnecessary at present to estimate, *certain* provision can be made for a population of 180,000 with an average yearly yield enough for 228,000.

Arrangement of the Delivery Mains.

69. A glance at the topographical features of the ground, will at once shew that the general parade ground occupies a distinct ridge, with population on either side of it; while Mootcherry and St. John's Hill lie along high ground to the north. To command therefore all the ground, as also to pass on supplies if necessary to the new Cavalry Barracks and Artillery, and further allow the Sumpenjee, Shoolay and Ulsoor tanks to pick up all the tail or *waste-weir (which if desired may be employed for flooding the parade grounds occasionally or upon any other useful object) 2 distinct sets of iron mains will be needed (one along each of the ridges above mentioned) and from these delivery may take place in any way deemed most suitable hereafter. As the water flowing simply by gravitation will be delivered at a summit level of 80 feet above the waste-weir of Ulsoor tank, it will easily command all the ground mentioned, leaving only a very few residents on the "High Ground" unprovided for. Any slight lift by pumping would give even these an ample supply.

Financial Arrangements.

70. The financial arrangements are those, which must unquestionably require much earnest consideration, after the estimate has fairly been laid before Government, and its details approved of, and therefore at this stage of the question, it would appear undesirable to say more than a few words on the subject.

71. Though a very rising community, it cannot be said that Bangalore is at all a wealthy one, in the same sense as even many second class cities of the empire, and its municipality has all along (though making the best use of the means at disposal) been unable, without Government aid, to carry out reforms which elsewhere are considered as purely local, and provided for from local funds; I am unable therefore to see how the municipality could be in a position, to meet any of the outlay required for the scheme as above sketched. Government will, therefore, it appears to me, have in some shape to bear the cost of the head works, and the two sets of arterial delivery mains referred to.

72. Were this done, it would most appropriately fall on the community to place

* The Durmamboody Tank, which is the head of the Pettah supply, can thus at times receive aid by placing one of the scour-cocks in its feeder.

Share falling on the Municipality.

themselves in connection with the system, under of course certain well defined restrictions, but generally in such a manner as best to suit the immediate requirements of the particular class or district, which choose to pay for the necessary sub-mains and other accessories.

73. While thus according an undoubted and lasting boon on the whole station, Government would, at the same time, while imposing proper restrictions, hold itself aloof from all minor details that could be infinitely better disposed of by the Municipal Board, carrying out with their own funds, the distribution arrangements most suitable to the special wants of the community.

74. Had the Ulsoor water works, now being carried out, not been commenced, it would have been a simple corollary to the above proposition that the Madras Government should bear a proportion of the prime cost for the benefit of the European and Native troops and followers—and even now, it is much to be hoped, that in case the scheme now working out, does not prove as successful as was originally anticipated, some joint action on that which I venture to put forward, may yet be found practicable.

BANGALORE,
9th September, 1868.

R. H. SANKEY, MAJOR, R. E.,
Chief Engineer of Mysore.

R 48

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Memorandum by Surgeon [illegible]
Sanitary Commr to Govt

Owing to the supposed Scarcity of water at Bangalore in the early portion of the present season, representations were made by the Municipality to the Mysore Government, and subsequently the station was visited by the Officiating Sanitary Commissioner Dr. Bidie, whose report was transferred for remarks, under endorsement No. 2641 of 8th May 1883 by Secretary to Government in the Military Department.

2 - In consequence of this reference I inspected the works at Bangalore in the middle of May, but I

Report on the Water Supply of Bangalore

delayed submitting my remarks, as before doing so I wished to be in possession of an analysis of certain specimens of water taken by me below the newly so called (or perhaps "La") Reservoir, and forwarded to the Chemical Examiner for report.

3 - Owing to a mis adventure adventure with reference to these specimens I only received the report, when I was too much occupied with other matters to take up the subject.

Just now also on the eve of departure for England I fear I can hardly do justice to a matter of such admitted importance.

4 - In addition moreover to being an extremely difficult subject from an Engineering point of view, complications have been introduced with the rendition of Mysore which

which were not foreseen when the original Schemes of water supply were designed.

5 - All I can therefore hope to do is to take a general view of the present position of matters, and offer some observations as to the policy which to the best of my judgment it would be desirable to follow.

6 - From unsufficient acquaintance with the history of the various efforts hitherto made to solve the very difficult problem of giving Bangalore a fair supply of water for domestic purposes, late writers have fallen into not a few misapprehensions.

These I am at present unable to discuss: but the subject has been very fully dealt with in my printed memorandum

of the 9th September 1868,
submitting the general Scheme
for distributing water
all over the station for the
new Cossaboolly reservoir.

7. The annexed Index
map shows the broad
features of this Scheme—
The rainfall of the catchment
area 1600 acres in extent
(with a small additional
area of 170 acres to the
South not yet connected) is collected
in a storage reservoir situated
in the third mile of the
Toomkur road, and is led
by an open masonry channel
from A to B— All the
work so far has been
completed from Mysore
Provincial Funds, at
a Capital outlay of Rs
5,40,169.

8—At B it was intended
to have had a pipe head

reservoir from which distri-
bution would be made
by two mains, one, BC,
serving all the north side
of the Cantonment Bazaar
and BD the South. At D
a bifurcation of the Southern
main was to have been
made, a submain DE serving
if necessary the European
troops, and DF the whole
of the Shooting quarter.

9— Chiefly owing to the
restrictions imposed on all
outlay in all parts after the
famine it was decided,
after placing the works
in a safe condition, to
defer Completion.

10 Having been mainly
responsible for the commence-
ment of these works it is
~~[illegible]~~ natural that I
should wish to see them
finished, Convinced as
I

I am that they are designed upon the only sound and feasible basis.

11 Writing in 1859 Sir Arthur Cotton declared against the suggestion then made to supply the troops with water pumped up from the Ulsoor tank. A Scheme which has since however been carried out.)

His objections were "first "the insuperable one that "this tank receives the "drainage from a large "portion of the Cantonment "containing a Considerable "town which must render "the water unfit for use "Second the great expense "of Constantly pumping from "Such a depth."

12- That both one and other of these objections have, as might have been expected, proved true

in practice it is needless now to affirm. The disadvantages of the position are borne out by every line of Dr Bidie's report.

13 - The inhabitants of the Cantonment Bazaar may be harried with endless restrictions, all kinds of works may be devised for separating sewage from storm waters along the several feeders of the Ulsoor Tank, but the struggle against nature will in the future prove as hopeless and as expensive as has been the case in the past. The position is an impossible one, and should never have been accepted.

14 - Dr Bidie in the end of his report advocates the Completion of the 60 or 70 lakh Scheme, observing that "this provides that the

"the yield may fall short
"of this estimate (namely 30 gallons per diem
"per head for 5000 inhabitants)
"but on the other hand
"if completed it is
"apparently capable of
"delivering in the station
"a liberal supply of
"water of unexceptional
"quality."

15- In combination with the polluted area which furnishes the supply of the Alwar Tank the catchment of the new Sparkhali reservoir is in the first place free of even a single habitation - much of it was if I remember correctly brought up for Government and thrown out of cultivation - and no doubt the rest can be readily acquired if necessary.

16- The soil is of the usual red character very sandy and lateritic near the central point at the Mundapam.

Unfortunately the tufted grass (an "Andropogon" according to Dr Bidie) has been allowed to take possession of most of the area, and effectually stops the off-flow of rain water.

17- Again channels of quick delivery were not as originally intended carried out, and as a result of these combined causes the new reservoir has not filled to the extent that it ought to have done.

18 Very careful returns have been maintained in the Chief Engineer's office in Bangalore of the deliveries into the new reservoir. — From these I extract the following results

Year	Fraction of the total rainfall or the catch-ment as stored in the new reservoir
1878 —	$\frac{2}{11}$ ths
1879 —	$\frac{1}{9}$ th
1880 —	$\frac{1}{10}$ th
1881 —	$\frac{1}{7}$ th
1882 —	$\frac{1}{9}$ th

Average of the five years above nearly 13 per cent of the total rainfall.

19 Numerous ~~experiments~~ experiments were carried out to ascertain the off-flow

from the surface when in different conditions and although unable at the moment to quote figures the difference observed between the results when the soil was maintained free from rank vegetation, and especially when it had attained the hard glazed condition which with proper arrangement seems to be attainable, was such as entirely to remove any doubt as to the adequacy of the total supply — though prolonged ground and crops absorb & evaporate frequently 9/10ths of the rainfall, the careful experiments made by Mr Binnay for the Bangalore reservoir, showed that the results were altogether reversed with surfaces in a denuded

hard condition.

20- By stopping all cultivation, removing and keeping down the grass, particularly the "Andropogon", there should shortly be no reason to fear short supply. Cattle should of course be kept off the ground, and all means used for getting the surface into the most favourable condition for both quick delivery channels to

21- Should unfortunately these efforts fail to produce all the desired results there are clearly auxiliary methods which are at command.

22 The first of these (a method which I believe has already been partially adopted on a certain occasion) is

the pumping of a supply of water from below sluice level into the sluice cistern. Probably a 10 or 12 Horse Power Engine and centrifugal pump lifting to a maximum height of 15 feet would be found to do all that would be necessary.

23- The second auxiliary method was however the one to which I devoted most attention when last at Bangalore, and certainly at first sight it promised very satisfactory results.

24- The applicability of this method depended on turning to account certain defects in the ~~Execution of the~~ work, possibly, and certainly in the soil, which I will now very briefly explain.

25- When carrying out the contract core of the ground

bund for the new reservoir, consisting of a concrete wall sunk in places to 30 ft below the surface, the soil in places proved to be very rotten.

It was both decaying stuff and the stoppage of the springs proved to be a most serious difficulty, if indeed it was ever fully overcome.

26. Returns for the last five years now before me (supplied by Captain Tennington Coleraine) show that under the combined action of evaporation and leakage the reservoir surface was lowered between 0.43 to 0.66 of an inch per diem whereas under evaporation only it should not have fallen more

than 0.30 of an inch at the outside.

Captain Tennington calculated from this that the loss due to leakage alone would amount to 41,382 cubic ft per diem.

27. An examination of the main bund showed that this leakage might very well be going on either entirely under the concrete wall or round the flanks but although in any case although the whole soil a short way below the bund was full of water there was no indication of any danger or any element of weakness in the work itself.

28. Two points naturally suggested themselves in connection with this leakage

(1) Will the sediment in the water

as to seal the bed as often occurs in

in such a way as [illegible] to stop the leakage?

(2) Will it continue and thus present an opportunity for lifting by steam pumping the whole supply required or in any case a good proportion, from a series of wells established below the bund?

29 Looking to the general character of the soil I confess I was disposed to the second view and judging from the clear and sparkling specimens of water collected from immediately below the main bund I was in hopes that we had at hand a means of giving practically a supply of filtered water to Bangalore.

30- The analyses (hereto attached) of the specimens collected do not bear out this conclusion in such a manner as to render the adoption of this plan feasible without much further enquiry.

31- Notwithstanding the clearness of the specimens taken, and the fact that traditionally all travellers used the old well here constantly, only two out of the four specimens have been pronounced "usable" by the Chemical Examiner.

32- This comparatively unsatisfactory result may it is true be due to the presence of rank vegetation about the holes from which these specimens were collected, but whatever the cause it would be undesirable

undesirable to build on this
pending further enquiry.

33- All therefore that
at this moment would
wish to advance is that
in the great leakage
which now takes place
may yet be found a
large auxiliary supply of
naturally filtered water
which may be pumped
up for distribution at
no very prohibitive cost.

34- There is also a third
auxiliary to the Scheme
alluded to in para 67
of my report of the 9th
September 1868) viz
the possibility of bringing
a supply from
a fresh catchment
area believed to measure
2 square miles in extent
situated a little South
of Yellavanka - This

has not been examined
in detail and whether
the supply from this
detached area would
be brought in without
prohibitive cost remains
to be decided. It should
certainly be examined.

35- The Scheme for the
supply from the new
& partially reservoir was
originally calculated
~~on the basis~~ at 20
10 gallons per head per
diem to 90,000 inhabitants
in the Bangalore Cantoon-
ment, Cantonment
Bazaar, and Military
Station, to the nearly
total exclusion of the Petta,
which though not well
supplied was not at
the time considered
to be in anything like
the same urgent need
in this respect.

By

36- By the Census of 1881 it seems that the following was the population all told as being directly or indirectly concerned.

1 Cantonment Bazaar & Military Station ...	89,274
2. Petta ...	62,819
3 Troops ...	4,257
Grand Total	155,850

37- In delineating the Bangalore Municipality under the late redistribution arrangements, the whole of the catchment area of the Hoparhalli reservoir and the reservoir itself were left in Mysore territory and although the original Scheme as above mentioned did not contemplate any extension of the Petta population it may be thought that as regards the future some allowance, on this account would be desirable.

38- This view may moreover not on other grounds be considered unreasonable, as a small portion of the catchment area of the new Hoparhalli reservoir as at present drained into the supply Channel of the Dunnambody Tank, on which the Petta in great measure depends for its water- It has thus to some extent suffered by the construction of the new reservoir.

The question is in fact one for discussion between the Governments of Madras and Mysore.

39- For the moment however I may I think fairly assume that if a supply for 15,000 or 20,000 people were passed down

down to the Pettah from the Ooparhalli reservoir this also probably that would ever be either asked for or deemed desirable.

40- We may thus ~~roundly~~ assume that the total population to be provided for will not exceed

For Cantonment Bazaar & military station and troops	110,000
Pettah	20,000
Total	130,000

Third I should consider sufficiently liberal.

41- As regards the unit of supply viz 10 gallons per head, I have reason to believe that this may as the experience since gained of large Indian towns be at once halved, and that 5 gallons may be taken as the unit - To err on the side of liberality the cubic foot 6¼ gallons might be ~~taken~~ adopted

42- It may here be mentioned that Bangalore has in its chain of 4 Reservoirs (at the head of the Bazaar) in the Ulsoor tank, and innumerable wells, a very good supply in all ordinary seasons for personal ablutions, for watering Cattle &c. So that the 1 Cubic foot above really represents little more than the amount needed for drinking and culinary purposes - To this I may further add that investigations of a very painstaking character in the town of Mysore brought out the fact that for these purposes the average amount actually used by natives only amounted

accumulated to 1/4 gallons per head per diem or just 1/5th of the quantity proposed to be given.

43 - I will only add to the above that to insure a perfectly pure uncontaminated supply not only must all grazing and cultivation of the catchment area be stopped, but the supply must from the reservoir thence be conveyed in closed channels and pipes to the points of ultimate delivery.

44 I wish much it had lain in my power to define in more concrete forms the precise method of carrying out the Doperhall scheme to completion, but this is impossible. The services of a thoroughly professional officer will be necessary to frame the needful estimate after the two Governments concerned have decided on the general principles to be maintained in regard to construction and future administration of the works, the requirements and shares of the two populations concerned, and the incidence of the charges.

45 - Sir Captain Kensington the Mysore Government have an officer not only of special intelligence and training but one who has for years devoted close attention to the registration of the facts connected with this work. His advice and assistance to any officer selected for

for setting up the project
would be invaluable.

D. H. Hawley
Major General

1883.

From

THE CHEMICAL EXAMINER,

Madras,

No. 1109

Dated 20 } July 1883.

Received

ENCLOSURES.

To

THE *Executive Engineer*
Bangalore Division
Mysore D.B.H.

REFERENCE.

Your *Docket* No. $\frac{\text{Doc}}{2300}$

7th July 1883.

SUBJECT.

Has the honour to supply Analyses of 5 samples of water received with your docket of above date.

Sd/- F. K. Rogers. M.B.&C.

Chemical Examiner.

(True copy)
F K Rogers M.B. & C.R.C.S.
Chemical Examiner
20 July 1883.

ors 21.9

BANGALORE WATER SUPPLY

INDEX PLAN

2294/91

Watershed Area

Within limits of Original Estimate	1600 Acres
Additional area scored in red	170 do
Total Watershed	1770 Acres

Delivery Channels

Head Channel marked	A. B.
Saint John's Hill Channel	B. C
Parade Ground Channel	B D E
Shale Branch do	D. F.

CATCHMENT AREA 1600 ACRES

A.M.

Mantapam on Hill

New Reservoir

Head Delivery

Channel

ADDITIONAL AREA

Railway Station

Madras Railway

Miller's Tank

CANTONMENT BAZAR

Halsur Tank

BANGALORE CANTONMENT

General Parade Ground

HALSUR

Damalur Tank

Dharmambudi Tank

Sampangi Tank

BANGALORE PETTAH

THE FORT

CHULE

Scale 2000 ft to an inch

C. Hunter Stanford Captain R.E.
Secretary to the Govt of Mysore
P.W.D.

Lithographed in the Survey Office P.W.D.
10th May 1892.

Sheet 25.

14/5/83

My dear Colonel

Herewith memo:
Expanding pop[ulation] furnished
by the Census office - The
Specimen of water from the
Spring behind hous is rather
cloudy, the last night's rain
perhaps - I am sorry I
missed you as thought the
above specimen with me also
one from Miller's No 4 Reservoir

I enclose 2 tracings of the Palace
trees will be awfully obliged for
the design for kindly promising
me — yrs very truly
C Hallett Keeling Esq

Dr Rogers letter has been
despatched the specimens of
bats go by tonights train —

Popln (Census 1881.)

1. Cantonment bazaar includ
C & Military Stn. — 89,274
2. Petta _____ 62,317
3. Troops _____ 4,259
Total 1,55850

1 & 2 according to new municipal
limits —
3 - Includes families of soldiers &c.

C Hallett
14/5/83.

Bangalore — 19/5/83

MYSORE GOVERNMENT

94

My dear Colonel

Yr. of 17th — (1)4(2)

The areas above the Dharmabud tank feeder intercepted are as follows: ——

	acres
By old Sampangi feeder —	57
By new reservoir chan[l]s —	171
Total ——	222

Proposed addl. estension of feeders chanls of new reservoir round Sollyfound will cut off 170 acres more from the

Dharmahdi, this letter has
has not been done —
(3) I think the extension of existing
feeder to Dharmahdi below
new reservoir feasible but exp
also I doubt whether the addl.
acres wd be obtainable within
giving the feeder so slight a fall
as to render it inoperative —
will have levels taken regard
again —

the Lowest Point of the valley
that in rear of the bund is 48.00
floor of delivery Chamber at Chinna
89.00
say lift with Reservoir
the surface of the ground 50ft
before a mean lift of 60ft
should be provided for at least —
individually I consider 5 gals per
and per diem of filtered water Quite
ample — What are the actual results
at Madras? Mr Griffith has been
now for some time & Shd be
to give some idea —

The Peeta popul- of 60,000 is very Concentrated, that of Cantonment of 90,000 very Scattered, therefore a Supply for 120,000 shd- suffice or 600,000 gals- Of other figures less favorable except perhaps taking the cost of lifting water from the rock it wd- be better to allow $\frac{2}{3}$ rds thereof the figures wd- become $\frac{600,000}{1700} \times \frac{2}{3}$ = Rs 150 or Rs 53,000 per an: Which wd- be only 7as per head Supply What about interest on outlay of Capital Rs ?

9/6

I sent you up 6 Litho plans yesterday, hope they are what you require - I am sorry to say I have not as yet been able to get a clean Specimen of the water close to the bund, the Spring tide brings away some red stuff with it - I will report again a few days hence - No rain as yet - Yrs very truly

C Abbott Kensington

Kensington
29/5/83

Lyndhurst,
Ootacamund.
9th May, 1883.

Dear Sankey,

I return with many thanks the Copy of your Memo. on the Bangalore water supply; and am glad you are going down to have a look at the place again. I quite agree with you that the Ulsoor tank is objectionable as a source of water supply, that theoretically, nothing could be worse, but so far it has been a case of that or nothing. I trust therefore you may be your way to making the new reservoir on the Bellary road take its place, or at any rate equal to the supply of all the drinking water required. Such new

arrangement - bonds, however, still
to be taken with risk as other
matter of two practices is explains to
but it is found that they any offers
task to objectionable entirely for
drinking & cooking. Of course no
one knows the locality as well as
yourself so are best fairs as much
attention to the subject to I feel
that if anything can be done in
the way of overcoming the difficulties you are the man
to undertake the task. I trust
before you will be able to carry
some practical scheme to a close
in a reasonable time that is very
before you are out of the woods
If are glad only to learn to realise
the scarcity of water at Bangalore

city has gradually may render the
finest military station in India
practically untenable by troops.
I think you would shortly get the
necessary funds.

Hoping to see you & have
a talk on the subject when you
return to Bangalore,

Yours very
Sd/-

B17 C 11.7.83

1883

From

The Chemical Examiner,

Madras.

No. 1111

Dated 20th July 1883.

Received 21st July 1883.

Enclosures. 1.

To

The Major C. Bruce R.E.
Chief Engineer
P.W.D

Reference.

Your Memo No. 1317 dated
11th July 1883.

Subject.

I have the honour to enclose copy of the analyses of the samples of water referred to in your Memo of above date. If these results be compared with those previously forwarded

02 Aug 1.7
att 3 of Ret 24/9 att 24/9 Ret 5/10

It will be seen that the figures agree very closely. The different dates at which the two sets of samples were collected is quite sufficient to explain such differences as do exist.

Y K Rogers. H.B. M.R.C.S.
Chemical Examiner

20 July 18

To W

Bangalore water Supply.

The previous papers on the subject were sent to General Sankey on the 8th May since which they have not returned to the office. Meanwhile investigations are understood to have been made in correspondence with D. W.

K.S.
19.7.

C. A. W.

Please send this by first post to General Lawder at Madras. He took previous papers with him, for discussion with Major Bowen, with intention to prepare a complete memorandum on the subject, before leaving Madras.

saw KS 19-7 DW 19/7 19-7-83

S.A.V.

Please send this on at once to Club, & post Sunday letter under cover marked "Urgent".

CV

102

Forwarded

Ch

Sam

21/9

Can

General Saulter's memo was copied on Saturday on emergency. I noticed at the time that it was not at all well done, but some allowance must be made for the hurry with which it was written.

There was no time to have it re-copied, as Dr. wanted it in a great hurry to send to Genl Sanitary.

I mention this with reference to Genl Sanitary's remark that the memo has been "indifferently copied"

L W

Papers

Can

Received this 24th morning. R Arbuthnot.

Sales
These belong to the
Hampshire Water Supply
file.

Carr
Forwarded to the
with copies of Smith's
memo dated [illegible]

Fo.
0/25

To W. 105

Mangalore Water Supply.

To assist you in arriving at the approximate cost of completing the above scheme I have collected the following notes on the cost of pumping engines & art of working:

To premise:— The population to be supplied at Mangalore may be taken at 150,000, so that at 5 gallons per head per diem a supply of 750,000 gallons will be required. I assume average depth of well or connected wells 6 to 10 ft, and lift from ground level 70 ft.

Shorebrae

Water supply = 250,000 gallons
Raised — 157 feet
Horse power — 20.34
Absolute H.P. — 36.70
Employed 2 Engines of 20 H.P. each
Cost of steam-pumps, engine house &c. Rs. 27,300
Cost of working per mensem — Rs. 1135

Ahmedabad

water Supply = 133000 gallons
Lift — 52 feet.
Engines — 1.5 H.P.
1.6 H.P.

Cost of engines, engine house &c. Not given
Cost of working per mensem. Rs. 840

P.T.O.

Hyderabad

water supply = 70,750 gallons
Lift — 130 ft.
2 Ramm & Repier pumps worked by small engines give 5000 gallons per hour of one pump.
Cost of pumps, engines, &c - not given.
Cost of working per annum. Rs. 380

Ulsoor.

water supply = 46,000 gallons.
Lift — 78 feet.
Engine in work — 12 H.P. nominal
Cost of engine — Rs. 24000
This engine pumped up 129,565 gallons in 5 hours 13 min. a day say 250,000 gallons in a day of 10 hours.
Cost of working per annum Rs. 895 — (Rs. 895-4-0)

(This last example is an exceptional one and useless, I think, as regards comparisons of relative cost & charges, &c.)

Scholefield affords, it seems, the best example to compare with Nanjalore. The supply it will be found is exactly one third of what Nanjalore requires. The cost of working the Nanjalore scheme would not of course be 3 times the Scholefield charges; probably only 1¾ times or Rs. 2000 per annum say.
The engines & pumps at Nanjalore

exact not, it would appear at first sight, cost 3 times the machinery, &c, at Scholefield, yet the important example I now quote would make the proportionate cost still greater.

Peterborough.

water supply = 750,000 gallons.
Lift as raised — 153 feet.
Cost of engines & pumps - £9000 or Rs. 1,04,000

(The cost of engine house, boiler house, chimney shaft, &c. was £5985, but this is of no value for purpose of comparison).
Two beam engines, each working two pumps of bucket & plunger type, delivered exactly 750,000 gallons in 12 hrs. — just the supply we want. This machinery cost in England £9000 & it is presumed is the most suitable & economical of its kind.

Maidenbury Estimates for a
water supply = 5,50,000 gallons.
Theoretical H.P. 17.2
Required H.P. 30
Cost of Engines & works &c. Rs. 36000
Cost of working per annum Rs. 900

The costs affected by steadily pumps are valueless the working being intermittent & supply small.

107

Waddeley's estimate, proportionately increased for 750,000 gallons would give very different results from the Peterborough example. And comparing it with Shakespeare, although his supply calculated on is 2½ times Shakespeare his cost of maintenance is Less and his machinery only Rs. 36,000 against Rs. 27,300.

Judging from all this it is very difficult how to arrive at the approximate cost of your proposal for Nangalore, but, speaking very roughly, we might say —

Cost of engines & pumps Rs 1,00,000
— of engine house, shaft, &c. Rs. 20,000
— of working for minimum Rs. 2000

(The Wilson Rock engine pumping up to the Harvadko the quantity required in Nangalore for one month's supply — viz. 750,000 gallons × 30 — would consume about 180 tons of fuel. This at Rs. 10 per ton, the Nangalore price, would be Rs. 1800. I have also made estimate of consumption of fuel on extract from Capt. Smith's report on Wilson water works.)

The above estimate for maintenance of supply (excluding interest, allowance for determination, &c.) would give a value of about 1 anna for 700 gallons.

108

Humphreys Estimate for Distributing mains was Rs. 269,607; Henderson's Rs. 2,91,081 for mains and main pipe. Neither Estimates did not include a branch to the Pettah.

To supply the population of the Pettah (62,317) a branch channel may be taken off at a convenient distance from the present new cistern. It might be an open masonry duct, carried in near the village of Pettah & when it approaches the Pettah & Lalbagh Lines. It would discharge into the Dharmambudy Tank, level of sill of weir of which is 29, the level of new cistern for Orsphalli Reservoir being 89,50 The ground is very level and this channel will require very careful alignment. It might, before reaching the Dharmambudy Tank, "bifurcate" in the Bleaden Lines and either in the village west of the Railway crossing.

Or, so far as the Pettah supply is concerned, the channel might take off from near the lower Sanjay falls below the Reservoir, the

Population - Census of 1881

(1) Catchment basin & district - 89,274
(2) Paterson — 62,317
(3) Passaic — 4,259
Total — 1,55,850

level of which is 43, or 14 ft. above Barmanbury city. A small reservoir here, having a lift only of four feet, would partially supply the 3 000 000 gallons required at a very low rate.

Possibly then the Paterson people would not consent to bear a portion of the cost of machinery and working in proportion to their population.

An important point in connection with the proposal under consideration is the capacity of wells behind the Osparkalli reservoir to yield 750 000 gallons daily.

The 16 Dobbin wells behind Allerton Park were pumped nearly dry in 6 days in May 1871, yielding during the 6 days 330,000 gallons. They had a united perimeter of 500 ft. and it is easy to imagine, notwithstanding what a number of wells will be required to give 750 000 gallons in one day in a dry season.

At the Osparkalli reservoir the infiltration would presumably be much more rapid on account of the great head, but considering

this great head & pressure & the comparatively great fall on the saturated soil, will there not be an element of danger to the high bank and its concrete core, even keeping the works well away below the new slopes.

I note this merely as a point requiring apparently to be weighed.

Finally I would suggest that as regards the matter of cost of machinery, power required, & best description of, we make a reference home to some well established firm, giving them the quantity of water to be supplied, rate of supply, depths from which water must be lifted and height to which raised. We could then get a really reliable estimate to go on.

CJ.
7/8/83.

S.a.w

Bangalore Water Supply

111

Papers to be printed:

(1). Dr Hidick's Report.

(2). G.O. Mil. Dept. on letter from A.M.G.

(3). Genl Sankey's Memo. of Sept: 1868

(4). Do - of Sept, 1893.

These to be printed in full in above order.

The Index Plan, referred to in para 7 of Genl Sankey's second Memorandum, is to be lithographed & attached to the proceedings. I hope I will have this done neatly & expeditiously.

Please is there necessary instruction in above.

CJ
5/10

No. 2794 W Public Works Department.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Under date the 5th Octr/83

Read the following

Endorsement on the Military Department on letter from the offg: Sanitary Commr. Madras, No. C-1 a/ 5th May/83	M.E. No. 2641 a/ 8th May/83
From the Mily: Dept	" — " 5092 a/ 17th Septr/83
Memorandum on the water-supply of Bangalore by Major. R.H. Sankey, R.E. Chief Engineer of Mysore	" — " —— a/ 9th Septr/83
Memorandum by Major-General R.H. Sankey. C.B. R.E.	" — " —— a/ 23d Septr/83

(Map to the letter)

The Government concur in the opinion expressed by His Excellency the Commander-in-Chief, that the first and most essential matter in

connection with the Bangalore water supply, is the extension and completion of the scheme originated by Major General Sankey, R.E. C.B, when Chief Engineer of Mysore in 1868.

2. With this object, the services of a thoroughly competent officer will be made available as soon as possible for the duty of making the necessary surveys, &c, and for framing the required estimates of cost.

3. The following letter will be addressed to the Resident in Mysore.

W
3.10.83

(M.E. No 2795 Way 15th October 83) The Military Dept 15
The Sanitary Commr 4
The Public Dept 7/
" S.E. Tipptr Circle 6

To

Public Works Department 1362

To,

The Resident in Mysore.

Sir,

On several recent occasions, representations have been made to this Govt respecting the quality of the water, and the sufficiency of the water supply, available for the use of the troops and of the Cantonment bazaar at Bangalore. After careful consideration of the subject, it appears to H.E. the Governor in Council that the proper course is, if

possible, to Extend and complete the scheme originated in 1868 by Major General Sankey, R.E. C.B. when Chief Engineer of Mysore.

2. With this object, H.E. the Governor in Council is prepared to appoint a thoroughly competent officer to the special duty of making the necessary surveys, &c., and of framing the required estimates of cost. It is however understood that part of the country to be Examined lies ~~within~~ without the limits of the ~~the territory of H.H.~~ military Cantonment, ~~H.H. Maharaja of Mysore~~, and I am directed to request that permission for carrying on the survey may be

the Govt. of obtained from His Highness the Maharaja of Mysore, ~~Government~~, and that any needful assistance may be rendered by His Highness' Department of Public Works to the officer intrusted with the duty.

3. In connection with the subject of this letter, I am directed to forward copy of the Proceedings of this Govt. under date the 5th October ~~5~~ No. 2794. W, in which are embodied certain papers respecting the water supply, together with the Memorandum drawn up by Major General Sankey in 1868, and a second Memorandum written by him on the 23rd September 1883.

4. With advertence to the last paper, I am directed to draw attention to the remarks made by General Sankey in paragraphs 35 to 40; and to request that you will ascertain from His Highness' Govt. whether it is desired that, in the scheme now to be elaborated, provision should be made for a supply to the Bangalore Pettah; and, if so, whether the number of inhabitants to be so provided may be assumed at the figure of 20,000, named by General Sankey.

5. I am to add that, on completion of the surveys, &c., now proposed, a further communication will be made to His Highness' Government in respect to the construction and future administration of the water-works, also with respect to the incidence of the cost.

Ex. Dept.

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PUBLIC WORKS

CONCERNS BOTH BRITISH INDIA AND INDIAN STATES.