

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following papers :—

From A. P. DECLOSETS, Esq., C.E., to the Secretary to Government, Public Works Department, and to the Sanitary Commissioner, dated Madras, 10th July 1885.

WATER-SUPPLY OF MADRAS.

Memorandum upon the boring of an artesian well 3 feet 3 inches (1 metre) diameter.

As the boring for one artesian well at the People's Park has been discontinued, owing to the tools having indicated the gneiss formation underlaying, and as it is intended, as far I understand, to make some other trial borings at some other spots in the Madras grounds, I have the honor to forward for your consideration the following opinions.

If trial borings are to be made, I will ask to be permitted to suggest that they should be executed into the alluvial valley of the Kortalayár, not far from the head of the canal conducting the waters of that river into the Cholaveram and Red Hills tanks, and that if the boring reaches an artesian water-sheet, that is, a water-sheet gushing and overflowing the level of the ground, an artesian well of 3 feet 3 inches (1 metre) diameter should be bored and its water diverted into the Red Hills supply channel.

My reasons for selecting the Kortalayár alluvium for such boring are—

- (1) The negative results arrived at in the Kuam alluvium, its geological composition leaving very little hope of finding ascending water-sheets below Madras town.
- (2) That the identical conformation of the Kortalayár alluvium with those of the Pondicherry (Gingee river) and of the Cauvery, into both of which artesian springs have been found to exist, tend to prove that the Kortalayár alluvium must contain also water-bearing strata which once tapped will overflow and gush above the level of the ground.
- (3) That it is proved by a boring at Ennore that the Kortalayár alluvium could supply artesian water-sheets.
- (4) That if a convenient water-sheet is found into this alluvium, it could be conveyed in town without extra cost by the means of the Red Hills canal.
- (5) Finally that the cost of an artesian well of 3 feet 3 inches diameter could be repaid within 2 or 3 years by a tax at the rate of 3 pies per annum per head of the general population.

I will examine in detail each of the above reasons.

- I. From the geological conformation of the ground upon which Madras and its suburbs are constructed, and of which a map is here annexed, it is perceived that the gneiss formation of the Little Mount near the river Adyar dips into a northern direction under a certain angle and extends underground probably 12 or 13 miles, rising again to reappear in the neighbourhood of Calastray.

Several borings executed during last year in Madras seem to prove that such is the case.

The well No. 1, bored lately at the People's Park, reached the gneiss at about 60 feet.

Well No. 2 at Napier Foundry reached a rock supposed to be gneiss at 66 feet.

Well No. 3 at Ráyapuram came upon gneiss at a depth of about 72 feet.

Well No. 4 at Tondiarpet at about 75 feet.

Well No. 5 at Washermanpettah reached at 80 feet.

(A well bored years ago into the old Custom House at Madras found the gneiss at about 67 feet).

Well No. 6, bored at Ennore, has not encountered the gneiss; after tapping a layer of carbonate of lime (?) at 214 feet below ground, water rose into the pipe, and presently stand in the same at 6 feet above the level of the water of the Ennore lake.

The five wells 1 to 5 have been bored into the Kuam alluvium; the well No. 6 into that of the Kortalayár; the Kuam alluvium has an area of about 8 square miles, and is composed of sandy tracts covering some small patches of blue clay, laying generally upon the gneiss; the small thickness of this alluvium gives, therefore, no hope of finding artesian waters and sufficient head for such; this has been proved so far by the borings. The well at Napier Foundry tapped a water-sheet which overflowed the pipe, but I have ascertained afterwards that the water was the same as that of the Seven Wells; the overflow was due to the boring having been executed at a place below the level of the Seven Wells water. The Kuam alluvium is contiguous to that of the Kortalayár, and it could be supposed that the waters of the latter might penetrate into the Kuam alluvium; but this is dubious, as it is probable that the tertiary formation of the Red Hills dipping eastwards forms a ridge between the two alluviums underground.

II. The geological maps of the Kortalayár, of the Ponniár and Gingee rivers and of the Cauvery delta, will show that these alluvial basins are surrounded by identical formations, viz., on the west by gneiss, on the north and south by gneiss tertiary formation, cretaceous or Sriperumbudur series, on the east by the sea of Bay of Bengal.

All these strata superposed have a slope eastward.

It is to be observed that in the Kortalayár basin the cretaceous formation is replaced by the Sriperumbudur series.

These formations underlying the alluviums mentioned offers a similar stratification, that is—

Under the alluvial deposits composed of layers of clay and sand, we found the tertiary formation laying upon the cretaceous or in case of Kortalayár upon the Sriperumbudur series, and under these the gneiss or granite. It is to be admitted that such being the case, and during the sitting process of these alluviums, the same or identical materials have been deposited upon the old formation constituting the former basin or valley of the Kortalayár and Narnaveram, of the Ponniár and Gingee, and of the Cauvery rivers.

Therefore, if artesian waters have been found in the two last basins, there is much probability that artesian waters will also be found in the Kortalayár alluvial basin.

Dr. King of the Geological Survey admits the hypothesis that near Cauvery-pakkam, at the upper end of the Kortalayár valley, there may be an underground outlet, through which the waters of the Pálár can reach the strata of the Kortalayár alluvium; a boring executed by Mr. Adrienne deClosets in 1883 for a native, at Pitchevakkam, $7\frac{1}{2}$ miles south-east from Arkónam and 7 miles, south-west from Kadambatúr, would have tested Dr. King's theory if the funds at the disposal of the native had been sufficient, but the boring was stopped at 84 feet for want of pecuniary means.

III. The well bored at Ennore, although without the necessary precautions, has, however, reached the depth of 214 feet without coming in contact with the gneiss; we have been informed that at 214 feet the tools bored a stratum of carbonate of lime? from under which the water rose into the pipe and stood at the present level about 6 feet above the level of the lake of Ennore.

From the report of the workmen we are led to surmise that, during the boring process, the pipe has traversed several water-bearing strata which, perhaps, would have supplied gushing streams if properly caught, but owing to powerless apparatus, the pipe was sunk loose into the bore-hole, and the consequence was that ascending

waters would have flowed around the pipe outside and have been lost in the permeable sandy strata above, which the boring had traversed; this would explain why the waters stand now in the pipe at 6 feet only when the head obtainable could be at the rate of 7 to 8 feet per mile, if starting from the extremity of the alluvium at Nagari which is at an altitude of 396 feet above mean sea level, and considering that the altitude of the Kortalayár valley near Pólúr is 290 feet. From the above, I am led to believe that the Kortalayár and Narnaveram river alluvium contains water-bearing strata which could be turned to profit by artesian wells.

IV. Supposing, therefore, that the above considerations should induce to bore an artesian well into the Kortalayár alluvium, I should suggest that the spot upon which such boring is to be made should be as near as possible the head of the channel diverting the waters of the Kortalayár into the Cholaveram and Red Hills tank; for this purpose a trial boring would be made so as to ascertain whether an ascending water-sheet exists below, and what supply is to be relied upon; to minimise the expenditure of such boring for trial it could be made with a light apparatus, as may be had in the Public Works Department Stores, or by a set of our own tools; the large apparatus obtained from Europe would be employed further for larger boring.

After having found the convenient water-sheet, the following operation would be to sink an artesian well of 3 feet 3 inches (one metre), in diameter, and further to use the large boring apparatus. Artesian wells of such diameter have been already bored elsewhere, for instance at the Butteaux Cailles near Paris a well of 47 inches diameter was bored in 1867. Another well near Passy of a diameter of 3 feet 29 inches has been successfully bored. This well has a depth of 1,913 feet from the ground line to the water stratum, and delivers daily 3,799,000 gallons of water.

I consider that there will be not much difficulties in boring a well of the same diameter near the Kortalayár, previous boring, such that at Ennore, having only shown strata easily traversed without any interference from rock. The tertiary formation will have perhaps to be bored, but the materials composing its beds are soft enough, and will oppose no difficulties. It is even possible that a water-bearing stratum should be arrived at above the tertiary ground.

The quantity of gallons, supplied by a well of one metre diameter (3 feet 3 inches) will be, as far as our observation upon the several artesian wells of the Pondicherry and Cauvery basins has shown, 3,000,000 gallons in 24 hours.

The wells observed had pipes of $7\frac{1}{2}$ inches, and their delivery per minute at 3 feet above the level of the ground was 100 litres per minute at 22.03 gallons, that is a supply of 31,680 gallons.

The well above supplying 3,000,000 gallons daily will allow 7.950 gallons per head of the Madras population. The cost of sinking an artesian well of 3 feet 3 inches diameter could be estimated about as follows; the time employed supposed to be 12 months:—

	RS.
Wages	1,440
Repairs and occasional tools	1,200
Engine, fuel, oil, grease and sundries	1,500
Iron pipe, half-inch thick rivets and packing	3,000
Superintendence	6,000
Contingencies	2,800
Total ...	15,740

To recoup this expenditure, a water-rate of 3 pice per head of inhabitant per annum will refund the cost within 2 or 3 years.

The advantage of the scheme is that no new works would be required so as to bring water in town, and that the objection as regards boring at great distance from it would disappear. Besides, the main and branches in Madras could be used for the water of the artesian well, and there would be no necessity for establishing a junction.

Admitting that an artesian well should be bored successfully inside Madras, nothing proves that the head obtained would be sufficient for the service.

In the case suggested above, that is if an artesian sheet is discovered in the Kortalayárs the head will be the same as that of the present water-works, and if a water deficiency from the Red Hills tank was arising, the artesian water will keep the same head, avoiding the necessity for pumping.

From Dr. W. KING, Superintendent, Geological Survey of India, to the Secretary to Government, Public Works Department, dated 30th January 1886, No. 75.

I have the honor to return, with thanks, the letter and accompanying map of Mr. A. deClossets on the subject of artesian exploration in Madras, referred to in G.O., No. 2676 W., dated 10th November 1885.

2. I have also to tender my thanks for the copy of Mr. L. Cornet's report of 20th June last, on the "People's Park boring," and the accompanying tracing giving the different strata passed through. The latter shall be returned in due course, as I have sent it on to the Director, Geological Survey of India, to be copied in our office for record.

3. Being personally acquainted with Mr. deClossets and knowing his praiseworthy endeavours in artesian boring in Southern India, it has given me great pleasure to read his proposal for trial in the Kortalayár alluvial tract, the geological relations of which he seems to have read up with great care. On the latter subject, and indeed generally with regard to the possibilities of the Kortalayár tract, I would, however, suggest, before any plan be decided on, that Mr. R. Bruce Foote be consulted. Mr. Foote is now the Superintendent, Geological Survey of India for Madras, and he surveyed and reported on the geology of the Madras country.

4. You will remember that in my last letter to Government, No. 1011, dated 30th October 1885, I confined myself exclusively to the neighbourhood of Madras itself, but in my original letter on the artesian capabilities of the Madras country generally, the possibly more hopeful condition of the Kortalayár basin was pointed out.

5. Now, with regard to Mr. deClossets' scheme for tapping this region, relying as he does upon the rise of water (reported to be 6 feet over the backwater level) in the boring at Ennore, I can only venture, in an unprofessional way, to suggest a few points which strike me as in the way of its success. It is to be noticed in the first place that his proposed site is at least 12 miles further inland than the Ennore work, and almost immediately at the northern end of the Red Hills plateau of tertiary sand-stones, where it may be presumed that the rise of water would be less than at Ennore. (I do not suppose that, for this distance inland, the gradient of the alluvial tract would be so rapid as indicated by Mr. deClossets, but it would be appreciable enough). The probability of a good depth of alluvium immediately to the north of the Red Hills plateau is, I think, doubtful, for, as far as I recollect, the Kortalayár river is, at that point, cutting its way in the sand-stones. [The foundations of the anicut or dam (if there be one) backing the river water into the channel to the Cholaveram tank ought to give evidence on this matter]. Next, it is a question with me whether the hoped-for rise of water in the proposed boring would be sufficient for the levels of the Cholaveram and Red Hills tank channels.

6. Mr. deClossets' proposal looks as feasible, provided the above objections can be met; while the cost would be as reasonable, taking his rate for the larger proposed work as compared with the excessive charges (excepting cost of plant) incurred at the People's Park boring, that I am fain to advise that trial should be made with a small tube and plant at any rate. I suppose Mr. deClossets would carry out the experiment more reasonably than any one else: it would be to his interest to do so. (On the matter of cost of boring, it may not be out of the way, I trust, to state that I am now having case borings carried out here by a European whose pay last year was Rs. 250 a-month, rising to Rs. 300 this year. This rate may help as a guide to charges on an experiment like that proposed which should only last for a few months).

7. Mr. deClossets evidently fears the shallow sub-alluvial occurrences of the Red Hill sand-stones just as much as I do and looks to the contingency of having to bore into these rocks. A boring of this kind would open up the further question in artesian development in Southern India, viz., the water-bearing, or porous, condition of the tertiary sand-stones, that is provided the Red Hills rocks and those of the larger patch northward and the smaller patch westward (in deClossets' map) are continuous under the alluvial tract. If these are not continuous, then the floor of the Narnaveram river alluvium and some extent of that of the Kortalayár will consist of gneiss or crystalline rocks, in which case there is just a possibility that the water-bearing strata of the alluvial tract resting on the gneiss might be in communication with fortuitously arranged or disposed porous strata of the sand-stones on either side.

8. I do not place much reliance on such a tailing-in of porous deposits; but should the tube of the boring apparatus encounter sand-stones below the alluvium, it might be almost advisable — if only on scientific grounds — to run down into them also to the gneiss which cannot be at any great depth. I need scarcely point out that there is no use running into the gneiss, the presence of which will now be ascertained by its hardness.

From R. BRUCE FOOTE, Esq., F.G.S., Superintendent, Geological Survey of India, to the Under Secretary to Government, Public Works Department, dated Bellary, 6th March 1886, No. 774.

I have the honor to acknowledge receipt of reference, No. 763 C., dated 24th February 1886, giving cover to letters from Mons. A. deClossets and Dr. W. King about artesian borings to be tried in the alluvial valley of the Kortalayár, and requesting my opinion on the subject. In reply, I beg to state that on geological grounds I regard Mons. deClossets' proposal as a reasonably promising one, the alluvium of the Kortalayár being of considerable extent and depth, and there being great probability of its containing permanently water-bearing strata capable of being tapped by borings as in the case of the Gingee river near Pondicherry.

2. As I showed in my memoir on the geology of Madras (Memoirs, Geological Survey of India, Volume 18) the alluvium of the valley now drained by the Kortalayár river was really formed by the much larger Pálár river, whose course was subsequently diverted.

The Kortalayár river probably still receives a considerable supply of water from the Pálár by filtration, while the two principal affluents, the Tirutani and Nagari rivers, also bring large contributions, so that altogether the valley conveys seaward a very important volume of water.

3. Monsieur deClossets' site for the proposed borings does not, however, appear to be the most favorable that might be chosen. The probability of the alluvium occurring in its full depth close to the north end of the Red Hills is very small, for not only is the river cutting into the tertiary sand-stones on its southern bank (as pointed out by Dr. King), but there is also an inlier of the sand-stones rising through the alluvium about a mile to the north-west which forms the Manjakaranei hills. This inlier of the sand-stones which you will find given on my geological map of the Madras country (north-east $\frac{1}{4}$ sheet of atlas sheet No. 78) seems to indicate strongly by its position that the axis of the old Pálár valley lay to the north, or north-west, of it and not close to the present scarp of the Red Hills plateau. My idea would be to try the boring nearer to the axis of the valley where the alluvium is likely to be thickest.

4. Monsieur deClossets seems unaware of the existence of the Manjakaranei inlier; at least his map, which in other respects is only a copy of mine, omits the inlier.

Should the boring in the alluvium of the Kortalayár fail to show useful artesian water-sheets, I quite concur with Dr. King that it would be very desirable that the boring be carried deeper through the possibly underlying tertiary and secondary (Sriperumbudur) formations, and, if necessary, down to the surface of the gneiss. The wells forming the tertiary and secondary formations of that region are of such very moderate hardness that the expense would be small (in case of the trial boring being

made only of small diameter), while the knowledge to be gained as to the water-bearing conditions of those sub-alluvial rocks will be of great value.

From A. P. DECLOSETS, Esq., C.E., to the Secretary to Government, Public Works Department, dated Madras, 17th March 1886.

I have the honor to acknowledge the receipt of the letter from the Deputy Chief Engineer, Public Works Department, and dated 15th March 1886, referring me to the Chief Engineer, Public Works Department, and to inform you that I am prepared to carry out the experiment recommended by Dr. King in paragraph 6 of his letter at the site mentioned by Mr. Bruce Foote, and on the following terms.

1. Plant, implements and machinery necessary, to be supplied by Government on the spot selected for operations, and upon my indenting on the Public Works Department Workshops and Stores.

2. In case I shall use some of my own boring tools, the transport of the same will be paid by Government without any other charge.

3. Temporary sheds or huts, if necessary, will be erected at the Government expense.

4. A monthly sum of Rs. 250 will be affected for boring expenses, proper, and such as—

	RS.
Wages	82
Clerk	15
Assistant Boring Engineer	100
Sundries	53
Total ...	250

5. I am requesting that you shall be pleased to appoint myself temporarily under the title of Executive Engineer on special duty, with a pay of Rs. 500 per mensem during the time employed in boring operations, but without travelling or other allowances.

ENCLOSURES.

MEMORANDUM.

A well of say 70 yards deep will cost at the rates mentioned:—

	RS.
From 0 yards to 20 yards deep	400
" 20 " to 30 "	250
" 30 " to 40 "	300
" 40 " to 50 "	350
" 50 " to 60 "	400
" 60 " to 70 "	450
Total ...	2,150

Memorandum on Trial Borings.

In my report, dated 10th July 1885, I was proposing to bore an artesian well as near as possible the head of the channel leading the Kortalayár water in the Red Hills tank; this boring was to be done, if possible, near Cholaveram; but this site was so near the tertiary formation that the result may have been dubious, and I was then advocating a trial boring to be made previously. I am of the same opinion as Mr. Bruce Foote, that in boring in the north-west of the Manjekarane hill near Nuttong for instance, there would be more chance to find water perhaps with sufficient head to be conducted in the Cholaveram channel; but Nuttong is about two miles from the head of the Cholaveram channel.

Reverting to the trial borings to be made in the Kortalayár alluvium. Before trying on the site recommended by Mr. Bruce Foote, I think, first of all, a boring should be made at a spot not

far from the lock of the Ennore canal about 2 miles north-west from Trivatore, as I have good reasons to believe that years ago a gushing stream was found there at a depth not exceeding 25 or 30 feet, and lost subsequently; such trial will be made within 5 or 6 days' work. It will be very important, under a geological point of view, to ascertain this in relation with the probable underground extension of the Red Hills formation eastwards; if water was found there it would not be difficult to convey it into town.

Subsequently, trial borings could be started on the site recommended by Mr. Bruce Foote at perhaps 13 or 14 miles north of Madras, and successively going up into the Kortalayár alluvium.

I can mention some more facts as to the probable existence of water-bearing strata which could be tapped for gushing waters. A boring at Pichevakkum village situated near the Kortalayár 8 miles south-east of Arkónam was made two miles north from the outcropping tertiary formation and one mile south of the gneiss formation; the strata traversed constituting the alluvium were clays and sands diversely coloured, down to the depth of 39 feet; during the boring process the water in the piping was at a level of 12 feet below the ground; at that depth the boring traversed a stratum of greenish clay, and the water rose into the pipe to the level of 4 feet below the ground; the boring was continued to 84 feet deep, but discontinued for want of funds. However, it has proved the existence of an underground water-bearing stratum.

Lower down in the valley at Kadambatúr, Madras Railway Station, the surface water-sheet stands generally at 6 feet below the ground; but if a boring of 18 feet to 20 feet is made, the water rises to a level of about 2 feet from the ground; probably the water-sheet found at Pichevakkum exists also under Kadambatúr.

It could be thought that if borings were made lower down in the valley near the village of Kilianur for instance, there would be some chance of tapping water strata supplying gushing stream and the more so in descending the valley down to the coast.

MADRAS,
20th March 1886.

(Signed) A. P. DECLOSETS,
Civil Engineer.

From A. P. DECLOSETS, Esq., C.E., to the Chief Engineer, Public Works Department, dated Madras, 20th March 1886.

I have the honor of informing you that my letter, dated 17th March 1886, had for object to propose arrangements for boring artesian wells of large diameter; but, as for the present, it would be only required to make trial borings, I have the honor to propose for such trial borings into the Kortalayár alluvium, another arrangement by contract, which will be more economical and suit Government views better than the arrangements mentioned in my letter of the 17th of March 1886.

2. I consider that a boring of 7½ inches will be the more suitable for the object in view; and instead of using the Government boring apparatus which is too heavy for the diameter proposed, I will employ my own set of tools which can bore down to a depth of 500 feet.

3. For conducting the operations I intend to employ one of my sons who has great practice in artesian well boring, and who has already bored nine or ten wells, either in Pondicherry or elsewhere; but I will have myself the control of the operations.

The terms I have the honor of proposing are—

(1st.) I will contract to make a boring of 7½ inches diameter upon the site pointed out by Mr. Bruce Foote, or any other at the following rates:—

From 0 yards to 20 yards deep, Rs. 20 per lineal yard.	
Do. 20 " to 30 " " 25 do.	
Do. 30 " to 40 " " 30 do.	
Do. 40 " to 50 " " 35 do.	
Do. 50 " to 60 " " 40 do.	
Do. 60 " to 70 " " 45 do.	

and so on increasing the cost per lineal yard by Rs. 5 at every 10 yards deep.

(2nd.) Government will supply, free of charge, if it was necessary, some plant, implement or machinery to assist my operations. I will supply myself the boring apparatus, free of charge.

(3rd.) Government will supply the iron pipes necessary for the boring or pay for the same supplied by myself at the rate of Rs. 4-8-0 per each length of 4 feet.

(4th.) If rocks other than gneiss or laterite are met in the boring process, the work, if continued, would be paid at the rate of Rs. 350 per mensem; this during the passing through the rock found.

(5th.) Temporary sheds or huts, when necessary, will be erected on the works at Government expense.

(6th.) Travelling allowance will be given to myself at the rate usual for Executive Engineer, whenever my presence will be required at the boring works.

Memorandum from the Under Secretary to Government, Public Works Department, to the Superintendent, Geological Survey of India, dated 23rd March 1886, No. 1182 C.

Forwarded to Mr. Bruce Foote, in continuation of No. 763 C., dated 24th February 1886, for favor of opinion as to the suitability of the sites now proposed by Mr. deClosets in the memorandum attached to his letter.

From R. BRUCE FOOTE, Esq., F.G.S., Superintendent, Geological Survey of India, to the Deputy Chief Engineer, Public Works Department, dated Bellary, 1st April 1886, No. 802.

In reply to reference, No. 1182 C., dated 23rd March 1886, I have the honor to inform you that I can see no objection, on geological grounds, to the fresh boring sites proposed by Mons. deClosets, whether near the canal lock two miles north-west of Trivatore, or at a point 13 or 14 miles north of Madras, or at the two places he names higher up the Kortalayár valley, viz., Kilianur or Kadambatúr.

With regard to the boring site near the head of Cholaveram feeding channel, I am still of opinion that it should lie to the west or north-west of the Manjakarane hill near Cannapur or Acrabaucum (of sheet 78). Monsieur deClosets is mistaken as to the exact position of the village of Nuttong (Nattam) which he now proposes; the place really lies two miles north-east of the hill and not to the north-west of it as he supposes.

I regret having had to delay my reply for several days owing to indisposition.

From Colonel H. L. PRENDERGAST, R.E., Superintending Engineer, V Circle, to the Chief Engineer, Public Works Department, dated Chepák, 9th April 1886, No. 154.

In reply to your memorandum, No. 1142 C., (will follow) dated 26th March 1886, I have the honor to report that, judging by the experience of the expenses incurred on the artesian well in the People's Park, the cost of an experimental boring beyond the Red Hills, to a depth of 60 feet, will be not less than Rs. 550, making no allowance for special supervision.

2. Details are given in the enclosed estimate.

3. There is no subordinate in the division who has had practice in boring of this nature.

ORDER—dated 5th May 1886, No. 1128 W., Public Works.

Monsieur deClosets proposes to carry out trial artesian borings at a specified site in the Kortalayár basin, and in his letter, dated 20th March 1886, he mentions the rates at which he is prepared to carry out experiments on contract. The rate for a boring 60 feet deep is set down at Rs. 400. The Superintending Engineer's estimate for a boring of the same depth amounts to Rs. 550.

2. As it is desirable that the proposed experiment should be made, the Government resolve to request Mons. deClosets to sink a well 60 feet deep at the approved site, on the understanding that the total cost will not exceed Rs. 400 in addition to the incidental expenses mentioned in the 2nd, 3rd, 5th, and 6th clauses of his letter. With advertence to the 4th clause, it must be understood that if rock be met with, such as is likely to prolong the work, further operations must be stayed pending receipt of the orders of Government.

3. Monsieur deClosets' letter referred to in paragraph 1 will be forwarded to the Superintending Engineer, V Circle, in view to an agreement being drawn up in communication with Mons. deClosets, based on the terms given in his letter. The draft agreement will be submitted for approval.

4. The following letter will be addressed to Mons. deClosets.

(Here enter No. 1129 W., dated 5th May 1886.)

(True Extract.)

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

To the Superintending Engineer, V Circle, with enclosures.
To Dr. W. King, Superintendent, Geological Survey of India.
„ R. Bruce Foote, Esq., F.G.S., Superintendent, Geological Survey of India.

Exd. A. Aubert.
Spare Copies

BUILDINGS AND ROADS.
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Govt. of {1886} Madras.
PUBLIC WORKS.

Dated May, 5th.

Recd.

Encl.

G.O., 5th May 1886, No. 1128 W.

MAY.

Artesian Well Boring

Orders for an experimental — in the
Kortalayár basin being carried out by
Monsieur A. P. deClosets.

5TH MAY 1886, No. 1129 W., PUBLIC WORKS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

LETTER—from

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

Secretary to the Government of Madras,

Public Works Department,

To

MONSIEUR A. P. DECLOSETS.

SIR,

With reference to your letter, dated 20th March 1886, I have the honor to inform you that the Superintending Engineer, V Circle, has been directed to arrange with you for making a trial boring 60 feet deep. Please place yourself in communication with the Superintending Engineer on the subject.

I have the honor to be,

Sir,

Your most obedient servant,

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

FORT ST. GEORGE,
5th May 1886.

Exd. A. Aubert.
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PUBLIC WORKS.

Dated May, 5th.

Recd.

Encl.

5th May 1886, No. 1129 W.

MAY.

Artesian Well Boring

Monsieur A. P. DeClossets requested to place himself in communication with Superintending Engineer, V Circle, to arrange for making a trial — in the Kortalayár basin.

15TH NOVEMBER 1887, No. 2179 L., LOCAL AND MUNICIPAL.

GOVERNMENT OF MADRAS.
LOCAL AND MUNICIPAL DEPARTMENT.

READ—the following paper :—

From J. P. HEWETT, Esq., Officiating Under Secretary to the Government of India, Home Department (Municipalities), to the Chief Secretary to the Government of Madras, dated Simla, the 14th October 1887, No. 4—140.

I am directed to invite attention to the articles in the "Indian Engineering," dated the 30th July and 13th August 1887, on the artesian boring in the Sunderbunds, in which a suggestion is made for the extension of such borings generally in India. They might, in the opinion of the Government of India, be usefully brought to the notice of the Committees of some of the larger Municipalities and of Local Boards.

ORDER—dated 15th November 1887, No. 2179 L., Local and Municipal.

Communicated, with a reprint of the articles referred to, to all Presidents of District Boards and Chairmen of Municipal Councils, and to the President of the Municipal Commission, Madras.

(True Extract.)

W. P. Meyer
for Chief Secretary.

To all Presidents of District Boards.
" Chairmen of Municipal Councils,
through the Collectors concerned.
To the President of the Municipal Commission, Madras.
" Public Works Department.
" Sanitary Commissioner for Madras.

Exd. E. Fernandez.

[Appendix.

APPENDIX.

ARTESIAN BORING IN THE SUNDERBUNDS.

By FRANK J. AGABEG, M.E., Superintending Engineer, Port Canning and Land Improvement Co.

("Indian Engineering," 30th July 1887.)

The marshy and unhealthy country to the south-east of Calcutta, known as the Sunderbunds, has been formed, as most of your readers are aware, from the washings of Upper Hindustan, brought down in pre-historic times by pre-historic rivers and streams, which used to empty themselves into the sea at present known as the Bay of Bengal, and, geologically speaking, is only of recent formation. It is thickly overgrown with jungle and is intersected by innumerable small nullahs and khals of salt water, all of which have their connection with the sea in one way or another. In some places the land is so low that it is only with the aid of bunds and dams that the large tracts which have been reclaimed and under cultivation are prevented from being submerged during the flood tides, and the utmost care has to be taken in keeping them in order.

The soil generally is fertile and yields good crops of rice yearly, but the greatest drawback that the inhabitants find is the want of fresh water. At times the villagers have to walk miles before they can get a drop either for drinking or culinary purposes, and what water they do get is not of the very best kind, and far from wholesome. During the hot weather most of the fresh water tanks are dry, and should there be a little water left it turns quite brackish.

The Port Canning and Land Improvement Co. (Ltd.), the largest Zemindary Company in Bengal, have an estate of over 100,000 acres in these parts. This Company, who take a lively interest in the welfare of their tenants, have, from time to time, gone to a great deal of expense in excavating tanks on different parts of their holdings for their benefit, but with all this, still the want of good water is badly felt. I may mention here that in digging a tank in this district you can only go to a certain depth, say, 8 or 9 feet; for if you go too deep you come upon clays impregnated with salt and which allow the brackish water of the innumerable khals to percolate through it.

Mr. Cowasjee Eduljee, the Company's Agent at Canning, having heard of the good results obtained from artesian wells in Europe and elsewhere, proposed to his Directors at Bombay that they should try an experimental well in some part of their estate which might lead to favorable results. The Directors, after consideration, agreed to the proposal and the necessary plant was sent for from England.

Many who heard of what the Company intended doing were of opinion that the result would be a failure, as the probabilities were that any water met with in the alluvium below would be nothing more than the percolation from the sea. The only information that I could get in regard to the geological formation of the country was that the alluvium was supposed to extend to a depth of 700 feet; therefore, the country being flat and the geological section not known, it was quite unnecessary to select any particular spot for the well. But for convenience sake the site chosen was in the compound of the Agent's residence at Canning and about 200 yards from the Mutla river (*vide* Plate I).

It was agreed that the diameter of the boring for the first 100 feet should be 5 inches; then reduced to 4 inches below; and tubed from top to bottom with wrought-iron tubes 10 feet long flush joints both inside and outside, screwed into each other (Fig. 1, Plate II). The depth was to be 250 feet, and as this was not very great, steam power was not required. The work was started by sinking a pit 12 feet deep 7'6" inside diameter, and lined with brickwork. Into this was fixed the necessary tackle for lowering down the tubes (Fig. 2, Plate II). On top of the pit was erected a wooden platform on which the men worked the rods. By this arrangement both operations of boring and forcing down the tubes could be proceeded with simultaneously.

The method carried out for forcing the tubes was as follows:—In the well A (Fig. 2, Plate II) at about 4'6" from the bottom, were fixed horizontally two rail girders, *b, b*, set into brickwork and bolted down; on these girders, with their heads downward, were clamped two screw-jacks, *c, c*, capable of exerting together a power of about 18 tons. The tube was inserted into the hole and passed between the two girders, *b, b*, and on it was fixed a driving clamp made of flat iron, 6" x $\frac{3}{4}$ " x 1'10". The pressure brought to bear on the clamps *d*, by the screw jacks drove the pipe down, and as the pipe got to within one foot of the bottom another one was screwed on, the clamps raised, and the same operation performed as before. The rods were worked up and down by tillers attached at a convenient height. At first 8 men were employed in the work, but as the boring progressed, extra 3 were taken on. At 100 feet the tillers were dispensed with as the rods became rather heavy to lift and another method used. This was by attaching to the top rod a rope carried over a pulley in the sheer legs and coiled with three turns round the drum of a crab winch, the end of the rope being held by a man. The handles of the winch were turned and the rope held taut till the rods were raised a sufficient height when the rope was slackened and slipped, whereupon the rods fell and struck the required blow. In this work, the chisel was discarded altogether, the clays being so soft that an ordinary shell pump tipped with steel was used, which did the work of cutting and digging at the same time.

PLATE II. PORT CANNING BORING.

METHOD USED FOR FORCING DOWN THE TUBES

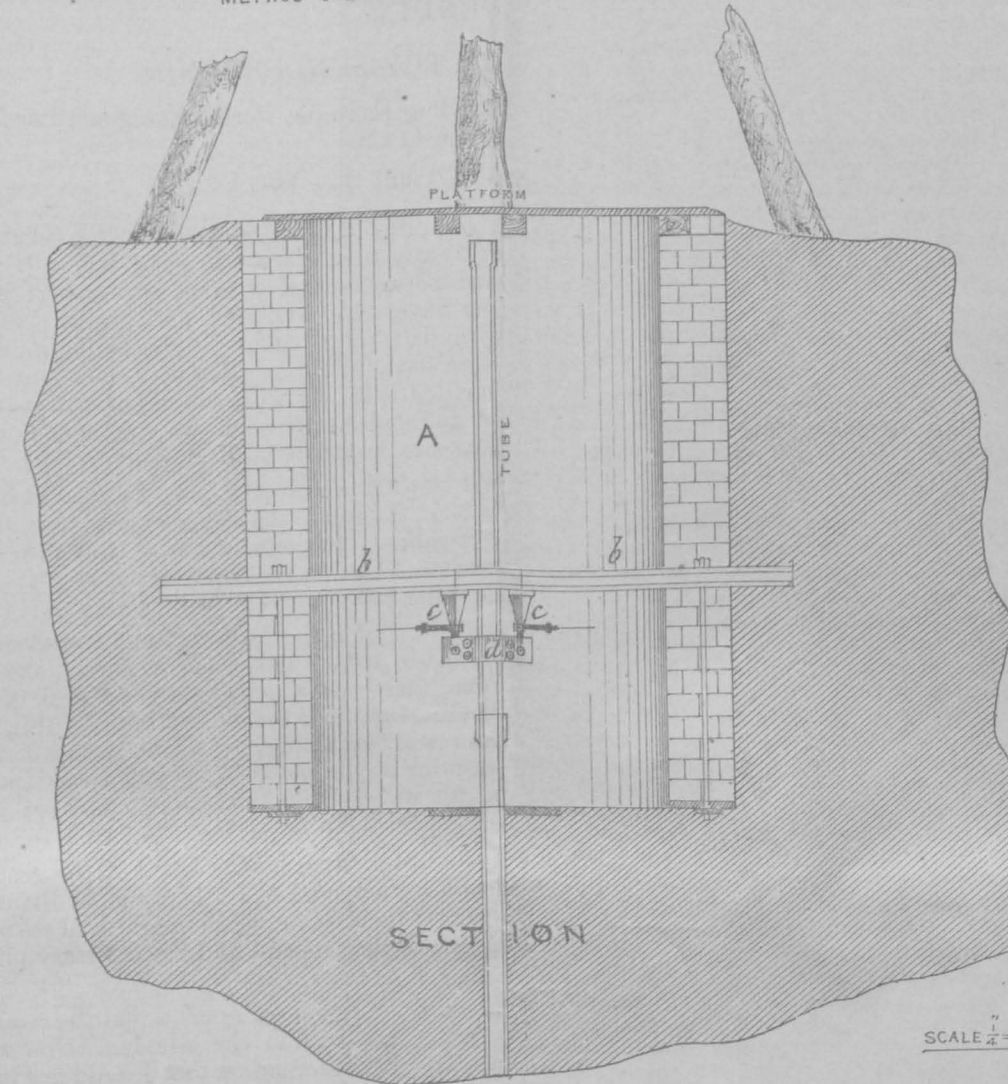


FIG. 2.

WROUGHT IRON TUBE FLUSH JOINTED

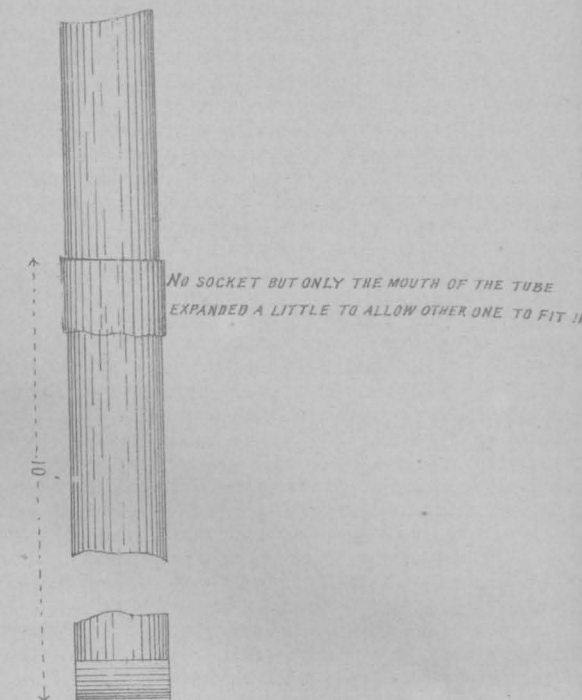


FIG. 1.

PLATE I.

SECTION OF ALLUVIUM GONE THROUGH AT PORT CANNING ARTESIAN WELL BORING

VERTICAL SCALE ADAPT TO THE INCH.

("Indian Engineering," 13th August 1887.)

The work proceeded rapidly to the depth of 55 feet, when dark grey micaceous sand, very watery (salt), was struck. In cutting the first 20 feet of this the silting was not of much consequence, but after this depth it became so great that sometimes it was impossible to progress even six inches after a hard day's work and it was only by forcing the tubes every time the blow was struck that any headway could be made. The silting at times used to be as much as 30 and 40 feet and one day it rose to 50 feet. The greatest care had to be taken in this sand to prevent the rods jamming, so much so that if they were allowed to remain stationary for over three minutes, it took 6 men at the crab winch to lift them again; this was owing to the sand closing over the pump below. When it was required to raise the tillers the rods had to be hoisted 5 and 6 feet and then the tillers adjusted.

This sand was passed through at 126 feet, when the tool struck dark grey clay mixed with sand.

At 130 feet it struck green clay with streaks of salt in it.

At 135 feet mottled clay yellow and blue mixed with broken shingle.

At 138 feet blue clay.

At 140 feet yellow clay mixed with broken shingle. The clay here becomes sweet, and salt seems to disappear.

At 145 feet yellow clay with bands of blue and ochre. The water which used to stand at about 12 feet from ground level gradually begins to get lower showing that the top water had been jammed off by the tubing.

At 150 feet light grey clay, very stiff mottled with yellow.

At 156 feet yellow clay, very loamy. Water in hole loses about 90% of its salt and stands 80 feet below ground level.

At 166 feet yellow earth.

At 173 feet yellow sand (micaceous). Water rises in the boring to within 8 feet of top and perfectly fresh.

From 173 feet to the present depth, viz., 235 feet, the boring is still in this sand which is very watery (fresh) and rich in yellow mica; when washed it looks like gold dust, but unfortunately, as your readers are aware, "all is not gold that glitters."

The work is still progressing, and the deeper the boring goes the higher the water rises in the hole. The silting in this sand is very great, as much as 40 feet at times. I have not been able up to the present to get a satisfactory idea of the volume of water, but hope to give the necessary information later on.

Although the proposed depth of the boring is only to be 250 feet, and notwithstanding the fact that we have come upon fresh water, still it would be advisable to go deeper down and strike a lower porous stratum, the water in which I am sanguine would have a greater hydrostatic pressure, and which we are bound to get. I have come to this conclusion from the section of alluvium already passed through, which up to the present has proved that it is composed of alternate layers of permeable and impermeable strata, and I have advised the Company accordingly.

The idea that the water in the alluvium below would be salt has exploded by the results obtained from this boring, and no one, I think, knowing anything about the laws that govern hydraulics would ever have expressed such an opinion.

It is very evident that any porous stratum which is fed by water from a higher level than the sea would naturally eject a greater pressure than the sea-water, and would remain fresh till it had passed out of the stratum and mingled with the waters of the same, as water follows the same laws underground as it does on the surface.

The benefits derived from fresh water in a country like India are incalculable, and it is worth all the time and expense in putting down wells. There may be a good many failures, but I am sanguine the majority would be successful.

In all future borings, never mind by whom undertaken, a correct record of the section passed through in each well should be forwarded to the Superintendent of the Geological Department for reference; by doing this, not only would we be able to get a thorough knowledge of the formation of different parts of the country, but the records would act as a guide for new operations.

Borings of any importance ought to be placed under the supervision of a really competent Engineer, who must be well up in the work and understand the laws of hydraulics and know something about geology. No engineering operations require so much skill and ingenuity at times as boring work. A well placed in charge of a man of no resources may be lost and thousands of rupees wasted, while if the same had been under an Engineer who was never at a loss for an idea, it would have been a success.

The tackle must be carefully examined daily and any suspicious looking places rectified at once, for, by the want of this care, a whole year's labor and expense may be lost. How many wells have been abandoned through sheer carelessness!

In conclusion, I beg to suggest that the advisability of pushing on boring work in India not only requires the consideration of Government but all Public Boards who are interested in the supply of water in the different towns. A good supply of wholesome water from wells in all parts of the country during the hot months would greatly lessen the annual mortality from cholera, *et hoc genus omne*.

Mccl 10244

Govt. of (1887) Madras.

LOCAL AND MUNICIPAL.

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Works Department.

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G.O., 15th Nov. 1887, No. 2179 L.

NOVEMBER.

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