[L. & M. / 5,000—5-4-99.]

E

Local & Munl. (1899) Department.

MISCELLANEOUS.

G.O., No. 798 M.

DATED 6-6-99

INDEXED.

DESPATCHED

[Despatch Abstract.]

Water-Supply. Requesting the Sanitary Engineer to carry out without delay the investigation suggested by Colonel Smart regarding the — of Ootacamund and also to prepare and submit an estimate for filtering the Marlimund water by means of Andersons Rollers

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.
No. 1459 Order 3-10-99							

[L. & M. / 2]
500—19-12-98.

LOCAL AND MUNICIPAL DEPARTMENT.

C. NoS. 1279 & 1293 in /99

SUBJECT.

Marlimund Reservoir - Ootacamund

June 6 vi 99

Misc

ORDER. No. 798 Muni's 6/6/99

The Sanitary Engineer is requested to Carry out without delay the investigation suggested by Col. Smart in para. 2 of his minute dated 30th April 1899 and report the result to Government.

A.

2. He is also requested to prepare and submit an Estimate of the Cost of filtering the Marlimund water by means of Anderson's Rollers.

(From orders)

V.R.
26/5/99

29 v 99

Madras office
Despatch orders. Return the papers soon please. The file is retained here.
VB 2-6-99

The Sanitary Engineer
Thro' the Sanl Board, with a copy of Col. Smart's minute of 30th April 99 — Ltd
Chairman, Mc O, Ootacamund
Thro' the Coll. of the Nilgiris — Ltd
Desp. 6/6/99

Note

With reference to the A-M's remarks marked A, in the note for orders below, it is submitted that the proposal of the Municipal Council to acquire the Catchment area of the Dodabetta Reservoir

...servoir, has been approved in G.o No.
...63 M. dated 29th March 1899 and the
...Council's application for a loan of Rs 37,500
...for this purpose has been ordered to be
...published in the local official gazette.

Local & Munl. (1899) Department.

CURRENT No. 1277

RECEIVED TO BE RETURNED
9 MAY 1899
LOCAL MUNICIPAL & LEG. DEPT.

From The Secretary, Sanitary Board

Order.

No. 240/5

Dated 6th May 1899.

Received 9th ——

Registered 10th ——

Enclosures 8.

Spare copies nil

SUBJECT.

The system of Revolving Purifiers adopted by the Agra Municipality:—

Submitting with remarks certain papers regarding ——.

...lter is 4'--6" and the other ... The

BACK PAPERS.

G.O.	No.	Department.	Date.
memo	152/99		
fo	132	[illegible]	30-1-99
fo	1705-6	[illegible]	5-10-98
fo	2156	[illegible]	2-10-97
fo	318	[illegible]	15-3-94
fo	273-74	[illegible]	8-3-94

FURTHER PAPERS.

G.O.	No.	Department.	Date.
fo	681	[illegible]	24-4-96
fo	1817	[illegible]	1-11-95
fo	1809A	[illegible]	1-11-95
fo	1081	[illegible]	8-7-95
fo	924	[illegible]	3-6-95
fo	971	[illegible]	12-6-95

PROVINCIAL SANITARY BOARD.

N.-W. PROVINCES AND OUDH.

Minutes of the Fourth Meeting of the Board held at Naini Tal on the 23rd June 1898.

Present:

The Hon'ble Mr. C. W. Odling, C. S. I., Secretary to Government, and Chief Engineer, Public Works Department, North-Western Provinces and Oudh ... ... *Member.*

Surgeon-Lieutenant-Colonel S. J. Thomson, C. I. E., Sanitary Commissioner, North-Western Provinces and Oudh ... ... *Member.*

Mr. C. Perrin, M. I. C. E., Sanitary Engineer to Government, North-Western Provinces and Oudh ... ... *Secretary.*

1. *Review on the quality of water supplied from municipal works in 1896-97.*—G. O. No. $\frac{172}{XI-212B}$, dated 26th January 1898, was read, and the report by the Sanitary Engineer on the quality of the water supplied by the various municipal waterworks in these provinces during 1896-97 considered by the Board. A note by the Secretary showing the reduction in the amount of organic matter effected by filtration at each of the water-works was also read.

Resolved—that the Board are of opinion that the water supplied from municipal water-works during the year under review was generally of good quality, and that the reduction of organic matter effected shows that careful attention has been paid to process of filtration. In regard to the general question of the examination of the water, the Board consider the water as it leaves the water-works—a sample being taken, say, from the pump well of the filtered water engines—should be examined once a month with a view to determining the character, pathogenic or otherwise, of the micro-organisms which it may contain. The Board are further of opinion that copies of all reports of examination of water supplied from municipal water-works, whether taken from within municipal limits or not, and sent to the Government Analyst for examination, should be forwarded by him to the Municipal Board concerned and to the Sanitary Board, in order that immediate steps may be taken to investigate the cause of any supposed contamination of the supply.

2. *Extra clerical establishment for Civil Surgeons*—G. O. No. $\frac{268}{XVI\text{-}401B\text{-}1}$, dated 19th March 1898, in regard to the appointment of an additional clerk was read, and the Sanitary Commissioner asked to submit at the next meeting a list of the offices which most seem to need assistance and the cost involved.

3. *Rules for the preparation and execution of municipal works.*—The rules framed under Act XV of 1883 and Act I of 1891, published under Notifications Nos. $\frac{1522}{XI-495A}$, and $\frac{1526}{XI-495A}$, dated 7th June 1898, regarding the preparation of plans and estimates of works which it is proposed to carry out wholly or partly at the expense of Municipal Board, were read and noted.

4. *Cawnpore sewerage scheme.*—Letter No. $\frac{653}{XI\text{-}237A\text{-}317}$, dated 4th April 1898, from the Government to the Commissioner of the Allahabad Division, conveying the decision of His Honor the Lieutenant-Governor to abandon the sewerage project for the city of Cawnpore, a copy of which was sent to the Board for information, was read and ordered to be recorded.

5. *Maps for Civil Surgeons.*—Letter No. $\frac{272}{XVI-401B}$, dated 19th March 1898, from the Secretary to Government to the Inspector General of Civil Hospitals, sanctioning the supply of maps to Civil Surgeons to enable them to conveniently divide these districts into sub-circles for registration purposes, was read and recorded.

6. *Sanitary condition of Baghpat, Meerut district.*—Letter No. $\frac{6024}{XIX\text{-}116}$, from the Commissioner of the Meerut Division, forwarding the District Magistrate's

report on the sanitary condition of the town of Baghpat, was considered by the Board.

Resolved—that the Board are glad to observe that any spare funds at the disposal of the Municipality will be expended in drainage and improving the sanitary condition of the town, and trust the growth of a belt of "nim" trees recommended in the joint report by the Sanitary Commissioner and Sanitary Engineer will be encouraged and maintained. The Sanitary Board fully recognise the fact that the finances of the municipality will not at present permit of any extensive scheme of drainage or water-supply being at present carried out.

7. *Clerk for the office of Secretary to the Sanitary Board.*—Letter No. $\frac{321}{XVI-44B}$, dated 7th April, informing the Board that the Government cannot at present sanction the entertainment of a clerk for the office of the Secretary was read.

Resolved—that in recording the decision of the Government, the Board consider that as soon as the duties of the Board are increased, a clerk for the Board, independent of the Sanitary Engineer's office, will be absolutely necessary.

C. PERRIN,
Secy. to the Sanitary Board, N.-W. P. & Oudh.

Note on the quality of the water supplied from the Municipal Water-Works, N.-W. P. and Oudh, by C. PERRIN, ESQ., M. I. C. E., *Secretary to the Sanitary Board, N.-W. P. and Oudh*

Agra.—Water of a fairly high standard of purity was supplied throughout the year. The analyses of the river wrter near the intake showed that it contained on an average ·008 of free and ·16 parts of albuminoid ammonia. The filter water on no occasion showed any trace of free ammonia, and the albuminoid ammonia was reduced to ·07 parts per million, a very satisfactory result. The water was also constantly examined biologically with satisfactory results.

Allahabad.—The water taken from the Jumna near the intake contained on an average ·04 of free and ·09 of albuminoid ammonia per million parts, while the corresponding quantities in the filtered water taken from the municipal standposts contained ·001 and ·04, respectively, clearly showing the efficiency of the filtration. Much dependence cannot be placed on the results of the bacteriological examination of the supply, as it had only lately been introduced at Agra and the Superintendent was not thoroughly acquainted with the method of taking the samples. Several of the tubes supplied during the rains also went bad and gave misleading results.

Benares.—The water supplied to the town was throughout the year of excellent quality, the average quantity of ammonia being ·036 per million parts. The examination for microbes showed equally good result. On one or two occasions during the rains the number of microbes in one or other of the filters was very high, but this was attributed by the Chemical Examiner to be tubes being affected by the damp weather.

Cawnpore.—Only one sample of filtered water showed any trace of free ammonia, while the average quantity of albuminoid ammonia was ·03 per million parts. The river water contained ·07 and ·10 parts per million of free and albuminoid ammonia, respectively. The reduction in the quantity of organic matter by means of filtration was exceptionally large. The examination for microbes, on the whole, showed equally good results.

Lucknow.—The chemical analyses show that after passing through the filters the quantity of ammonia in the Gumti water was reduced from ·09 to ·052 per million parts. The biological examination also shows that while the maximum and minimum numbers of microbes found in the river was 15,000 and 1,000, respectively, corresponding numbers in the filtered supply were 200 and 4.

Meerut.—The average quantity of free and albuminoid ammonia in the canal water from which the supply is taken was found to be ·05 and ·06, respectively. In the town supply no free ammonia was discovered and the albuminoid ammonia was reduced in quantity to ·0266 parts per million, a highly satisfactory result.

The biological tests were, on the whole, satisfactory, but are not to be relied on, as the Superintendent had at the time very little experience in making this kind of test.

General results.—The general results are decidedly satisfactory, and show that a supply of potable water of a high standard of purity was maintained at all the municipal water-works throughout the year.

(Sd.) C. PERRIN, M. I. C. E.,
Secy. to the Sanitary Board, N.-W. P. & Oudh.

NOTE FOR THE Asstt office

The Go has been dispatched
& is returned to the asstt office as
requested.

8.6.99

The file was sent to
them on the 7th inst.

WS
10.6.99

Please keep a copy of this
& send it
D.O. & put up a draft
(1) order -

(a) I am not certain in what
state are the papers about the
Dodabetta lands please
make that clear -

(b) The Asst Secy says that Col
Smart's idea about Spring 8th
to be irrigated - I suppose
this had better be done by the
Sanitary Engr. through the
Sanitary Bd & the same
appears to submit estimates
for filtration.

WS
15.V.99

(1) Put up.

No. 130
IV-3 P.S.B.

OFFICE OF SANITARY ENGINEER, N.-W. P. & OUDH.

Dated Allahabad, the 15th September *1898.*

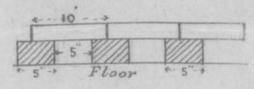
To

THE SECRETARY

Sanitary Board

MADRAS.

SIR,

In reply to your letter No: 439/5 dated 30th July 1898, I have the honor to inform you that the filters in use at the water-works in these Provinces are ordinary sand filters, the beds being arranged as follows:- Dry bricks to form drains are laid on the floor in rows five inches apart and covered with a second course of bricks laid close together thus:- 

on the top of the dry bricks the filtering media are laid. The first layer consists of well washed pebble screened to the size of peas, the second layer of well washed coarse sand 4 inches in depth. The third or top layer consists of 2½ feet of well washed river sand. All the media are washed with filtered water. So far practicable the rate of filteration is not allowed to exceed 40 gallons per square foot of filtering area in 24 hours. As soon as the thickness of the fine river sand is reduced by scraping to one foot the whole of filtering media is removed, washed and replaced and the sand made up to the full depth.

I have the honor to be
Sir
Your most obedient servant

Benin Supg. Engr.
Secretary to the Sanitary Board N.W.P. & O.

S.E.'s No. 5. 1,000 of 1897. } P. No. 3683. 7-I-98—P.D.

Enc 2163
18 OCT. 98

Sanitary Current No 543
Recd: 22-9-98

OFFICE OF SURGEON-GENERAL WITH GOVT. OF MADRAS. 30 SEP. 1898

OFFICE OF SANITARY COMMISSIONER WITH THE GOVERNMENT OF MADRAS No. 3265 S. 1 OCT. 98

Filters in use at the Water works in the N. W. P & Oudh

~~The President~~

Circulated to
The Surgeon General ✓ (1).
The Sanitary Commissioner ✓ (2)
The Sanitary Engineer ✓. (3)
please return to me

The results of these filtering media seem so satisfactory that it might be well to copy them in this Presidency. The greater depth of sand & the absence of large pebbles seem to be the principal features as compared with our filters

[illegible]
27. 9. 98

Immediately. Place this file again after the Sanitary Commissioner & Sanitary Engineer have remarked on it. 30. 9. 98 C. S.

I have since seen the attached remarks of the S. C. & S. E. and think that we have little to learn from the above but in our own plans we might adopt their suggestions
19. 10. 98 C S

7

No 2327/S

Note by the Sanitary Commissioner for Madras dated
15. 10. 98.

SANITARY Reg. No. 2163. 18 OCT. 98 THE GOVERNMENT OF MADRAS

I have no plans of filter-beds projected for this Presidency. So far as I remember, plans hitherto adopted by the Sanitary Board do not depart from usually recognized practice. In limiting the sand layer to 2 feet 10 inches in the case of the North West Provinces, there is adopted less depth than usual, namely 3 feet; although with some Engineers 2.6 is a favourite depth.

2. The nature of the underlying layer seems to make little difference to results from filtration, - provided it is not such as will permit of settlement at any point of the superimposed sand layer.

3. Within limits, the thickness of the sand layer has been found from experiment to effect results but little- even where organic matter is concerned, as both nitrification and arrest of microbes occur within the upper few inches. A reduction to 11 inches of the sand layer is permissible- provided the rate of filtration is regulated correctly. Indeed, little practical difference in results has been found in filters 3 feet thick as against those of 5 feet thickness.

4. Within the minimum of 11 inches and preferably a depth of from 2-6 to 3 feet, the depth of sand is not a factor of importance. The "effective size" of the sand grains is, however of

of moment, and regulations as to filtration should embrace this subject.

5. In this country, automatic regulators would be of the very greatest aid in securing correct filtration. Mr: Jones, the Sanitary Engineer to Government, used to hold views that were at least much opposed to my suggestion for introducing then existing automatic arrangements for regulating speed. I understand he has now invented his own. I think its efficacy should be ascertained by the Sanitary Board early, and if really a "good thing" as it is probable it is it should be adopted universally in such works.

6. The extent of purification in sanitary works in this Presidency, which is really the item remarkable from organic matter in the Agra previous treatment of the water with"And filter employed but to the due not solely to the action of the sable in the list circulated, is further be really correctly effected in all works by Anderson's revolvers". The remarkable point is that the rate of filtration used-40 gallons, if it by Koch, who is supposed to have fixed its, is lower than that advised namely 3.75 inches, per hour, or 46.7 gallons at an awkwardly small rate, This slow rate of filtration is advantageous, but it means expense in respect to size of filters.

Lieut-Colonel, I.M.S.
Sanitary Commissioner for Madras.

TO

The Secretary, Sanitary Board, Madras.

Through The Sanitary Engineer to Govt.

The water is drawn off by means of glazed tiles laid on

than

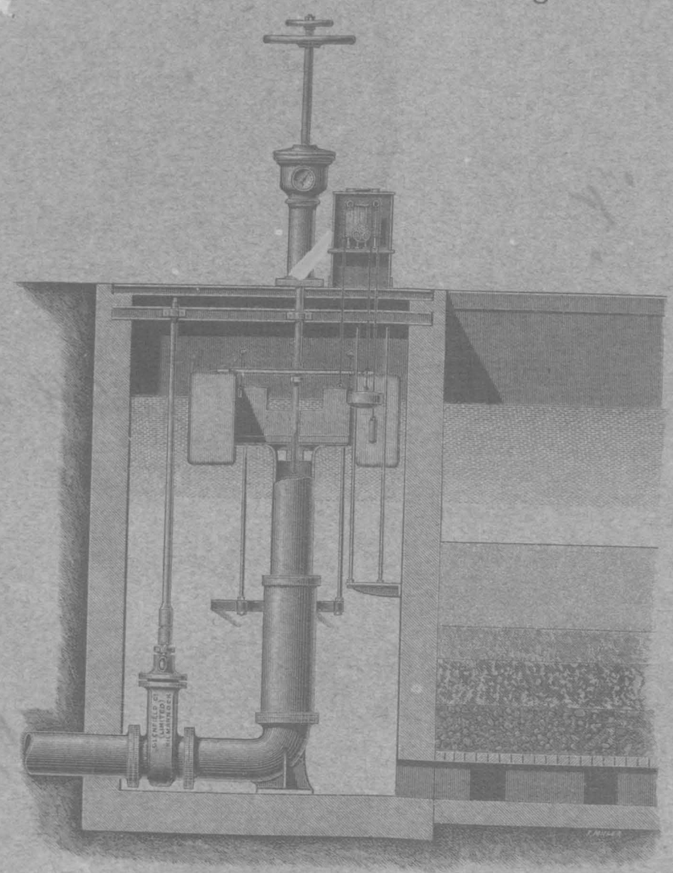
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ate of filtrati
ces is the lowe
ever brought to the writer's notice and
its advantage is doubtful-all the later
designs from filters in this Presidency
are based on a maximum rate of 450 gallo
per sq.yd per 24 hours = 50 gallons per
sq.ft per 24 hours which is very little
more than recommended by Koch a rate co
sidered by Engineers as very low-To

2. The ... West Provinces do not seem in any way superior or even equal to the designs for Madras and the works at Adoni and Kurnool have given satisfaction-the filter depth at Adoni is only 2 ft of sand but at Kurnool the design was improved and it is 3 ft. At Adoni the depth of gravel is 2'-6"; at Kurnool 2 feet so that the total depth of one filter is 4'--6" and the other 5 feet-The

Glenfield-Jones Filter Outlet Regulator.



Telescopic Tube is carried by Floats, allowing it to rise and fall with the variation of the water level.
The Box has notches or weirs for measuring the water discharged.
The weir box is raised or lowered by Screw and small Hand Wheel, so as to increase or diminish the overflow at pleasure.
An Index is fitted to side of Pillar showing the depth or quantity of water flowing over weir.
The large Wheel is for raising the whole arrangement, and to act as a stopper at the desired limit of low draw-off.
Thus the Outlet automatically adjusts itself to the condition of the filter bed, as, when the sand becomes partially clogged, the water level in Outlet Well will fall and thus increase the working head on filter till permissible maximum is reached.
A Recording Apparatus can be fixed if desired, giving a record of the depth flowing over weir.
Prices furnished on receipt of particulars giving size of Outlet Pipe, depth of water in Well, &c.

No 4.

S. E. 33. 50—18-3-97.

GOVERNMENT OF MADRAS,

Office of Sanitary Engineer to Govt.,
Poonamallee Road, (Park Town)
Fort St. George, 189 .
No 88 Madras, 18th.October 1898.

OFFICE NOTE

BY

THE SANITARY ENGINEER.

The undersigned concurs with the Sanitary Commissioner in the views he expresses in paras 1,2,3,& 4.In regard however, to a reduction in depth of sand being permissible (para3) the undersigned would say that there is convenience in having a somewhat great depth of sand say 3 feet because the filter can be scraped ~~for~~ many times without having to replace sand whereas if there is a reduced depth the sand would have to be often replaced and washed & replaced sand is not of the same value as that in the filter which gets in time into the state called " ripe "-when sand is washed it is always so with filtered water.

2. The arrangements in the North-West Provinces do not seem in any way superior or even equal to the designs for Madras and the works at Adoni and Kurnool have given satisfaction-the filter depth at Adoni is only 2 ft of sand but at Kurnool the design was improved and it is 3 ft.At Adoni the depth of gravel is 2'-6";at Kurnool 2 feet so that the total depth of one filter is 4'--6" and the other 5 feet-The water is drawn off by means of ~~tiles~~ open jointed ∩ glazed tiles laid on bed of filters a better design than bricks laid across others which are liable to soften & break.

3. As to para 5 of the Sanitary Commissioner's note the undersigned was not in favor of Gills arrangement for regulating the flow from filters for it was not automatic,that is,it required regulating from time to time as the water level rose or fell;it was introduced in the Vizagapatam designs because of Dr. Kings strong views on the matter,but being dissatisfied with the arrangement because it was non-automatic & expensive the undersigned invented an automatic arrangement which is constructed by the Glenfield Company who are one of the foremost firms of Hydraulic Engineers in Britain-a lithograph of the invention is enclosed for the information of the Sanitary Board; its return is requested. The undersigned would be glad to see this substituted for Gills arrangement at Vizagapatam-it would be less expensive and do away with some ten or twelve valves in that design.

4. The maximum rate of filtration in the North West Provinces is the lowest ever brought to the writer's notice and its advantage is doubtful-all the later designs from filters in this Presidency are based on a maximum rate of 450 gallons per sq.yd per 24 hours = 50 gallons per sq.ft per 24 hours which is very little more than recommended by Koch a rate considered by Engineers as very low-To

...ce the rate from 50 to 40 would mean
...ding the filters 25 % larger and the ex-
...se would be little less than 25 % more.

Sanitary Engineer to Government.

To

The Secretary, Sanitary Board.

Through

The Surgeon-General. Seen

The President
W. H. Crawshaw Esqr } 21 Oct 98.

C 3

No 5.

Note on some experiments in filtration carried out at Agra during the cold weather of 1893-94.

THE inferior quality of the Jumna sand procurable at Agra has long been recognised; so, with a view to determining whether a better filtering medium could not be obtained, I directed the Municipal Engineer, when inspecting the water-works in July 1893, to construct an experimental filter and to carry out a series of trials with different descriptions of sand. The object of the experiments was twofold:—

(1) To compare the Jumna, Utangan and Chambal sands as filtering media.

(2) To ascertain what benefit was derived from the use of Anderson's revolving purifiers. (This part of the experiment was undertaken chiefly with a view to seeing whether it would be advisable to introduce revolvers at Lucknow.)

2. The method of carrying out the experiments is described in Mr. Crawshaw's report. The first set of experiments made was with Utangan nadi sand in the experimental filter. The results as regards the improvement in the quality of the water by being passed through Utangan sand are *most* satisfactory, but unfortunately the extreme slowness of filtration makes its use quite impracticable.

3. In the next experiment, Chambal sand was placed in the experimental filter and the result compared with the filtration through Jumna sand in the large filter; the water in each case having been passed direct to the filters without passing through the revolvers. It must, however, be remembered that though the surface of the large filters was scraped before the experiments were commenced, still the Jumna sand must, to a certain extent, have been impregnated with oxide of iron from previous use of the revolvers, and this to a slight degree gave it an advantage over the sand used in the experimental filter. Mr. Crawshaw, too, in comparing the clarifying effect of the different sands, merely compares the purity of the water in the filter wells. This is hardly a fair test, as the state of the pipes leading to the experimental filter is unknown; that they must have been both dirty and rusty is shown by the analysis of 4th November 1893, (*vide* appendix I of Mr. Crawshaw's report). For in comparing the analysis of the water on top of the filters with that in the settling tank, it will be seen that in passing to the large filter No. 2, the total solids decreased from 200 to 180, while in passing to the experimental filter they increased to 360.: the rust is shown by the extr ordinary purity of the water on the surface of the filter as regards freedom from organic contamination.

1

S. C. No. 666 of '98.

4. Comparing the analyses of the water on the surface of the old filters, which had passed through old pipes that had been in use for years, with those of the water on the surface of the experimental filter, it will be noticed that considerable differences occur. The best test of the efficiency of the different filtering media will therefore be to compare the percentage differences between the constituents of the water as taken from the surface of the filter beds and of the samples taken from the filter wells. The averages of the analyses taken on the 20th and 27th November are given below :—

	Jumna sand.			Chambal sand.		
Parts per million.	Top of filter.	Filter well.	Percentage decrease.	Top of filter.	Filter well.	Percentage decrease.
Total solids ...	190	170	10·5	190	160	16
Chlorine ...	19	19	*Nil.*	21	21	*Nil.*
Free ammonia ...	·12	·026	78·3	·126	·033	73·9
Albuminoid ammonia ...	·205	·11	41·4	·23	·115	50
Permanent hardness (Clarke's scale) ...	2·8	2·8	*Nil.*	2·8	2·8	*Nil.*
Nitrates ...	·55	·345	38·2	·47	·42	10·6
Sulphates ...	2·65	2·53	4·5	2·59	2·53	2·3
Microbes per C. C.	740	940	−27	1,440	28	80·6

Compared in this way it will be seen that the Chambal sand is the better medium for removing the total solids and albuminoid ammonia, but its greatest advantage is in its power to reduce the number of micro-organisms. In passing through the Jumna sand the microbes per C. C. in one case increased by 122 per cent. and in the other case decreased by 63 per cent., the net result of the two analyses being an increase of 27 per cent.; while in passing through the Chambal sand the number of microbes in one case was reduced by 79·2 per cent. and in the other by 81·2 per cent.; the average for the two analyses being 80·6 per cent. With the Jumna sand there is a greater percentage reduction of nitrates and sulphates. The former is probably to be accounted for by the Chambal sand having a greater chemical effect on the water passing through it in converting the organic impurities into nitrates.

5. In comparing the results of simple sand filtration with the effect of sand filtration aided by the Anderson's revolvers, Mr. Crawshaw, to avoid the unknown purifying effect of the iron oxide, which was undoubtedly in the sand of the old filters, compares only the results obtained in the experimental filters. In doing so, he takes the average analysis of the four samples of the Jumna taken between the 4th and 27th November. But as the Jumna water was much purer while the experiments with the Chambal sand were being made, this is not a fair test, and a fairer comparison will be to compare the percentage reductions of the average analysis of river water with the average analyses of the water taken from the filter wells.

The following statement shows the effect of the revolvers both with the Jumna and Chambal sands :—

	Jumna sand.		Chambal sand.		Remarks.
	Percentage reduction.		Percentage reduction.		
	Without revolvers.	With revolvers.	Without revolvers.	With revolvers.	
Total sclids ...	54	45	45	41	The figures in columns 2, 3 and 5 are worked out from the mean of 4 analyses; those in column 4 of 2 analyses.
Chlorine ...	10	0	12	2	
Free ammonia ...	25	36	38	47	
Albuminoid ammonia	42	42	50	58	
Microbes ...	22	60	53	70	

The value of the purifiers is shown in the increased reduction of organic impurities and in sterilising micro-organisms. It also shows that simple filtration through Chambal sand produces as good results as filtration through Jumna sand aided by the Anderson process.

The advantage derived from the revolvers was not so great as might have been expected, and might possibly be explained by the fact that the filters with Jumna sand work at too low a rate, and that owing to the rapidity with which they clog under a low head of water, it is necessary to scrape them every few days. This scraping removes the fine film of ferric oxide which is deposited on the surface, and must partially destroy the efficiency of the process for some 12 to 24 hours after each cleaning has taken place.

Mr. Crawshaw was therefore directed to make some further experiments with the old filters, which are filled with Jumna sand, to see what effect would be produced by increasing the rate of filtration by allowing the filters to be worked at different heads up to a limit of 9 inches.

6. The results of these experiments will be found in Mr. Crawshaw's second report dated March 24th. The percentage reduction of impurities in passing through the sand with varying heads is compared with the results of the previous experiments in the statement below :—

Head on filters.	Percentage reduction of impurities in passing through the filter bed.				
	Total solids.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Microbes.
1″ head	42	0	33	58	60
3″ „	36	17	75	62	49
5″ „	42	0	75	54	52
7″ „	33	0	63	57	64
9″ „	33	14	50	62	65
Average of previous experiments with a head of 1·5 to 3 inches	14	4	29	44	62

The above shows very clearly that there is a distinct gain in working the filters for a longer period by gradually increasing the head of water on them, and that there is no deterioration in the quality of the water, even if worked to a head of 9″ inch with Jumna sand. This is, I consider, the limit to which they should be allowed to work; the rate of filtration being limited to 50 gallons per square foot in 24 hours.

7. Briefly, the experiments tend to show—

(1) That the Utangan nadi sand, though an excellent filtering medium, is unsuitable owing to its density and the consequent slowness of filtration through it.

(2) That the Chambal sand is, both with and without the revolvers, much superior to the Jamna sand now in use.

(3) That the effect of the revolvers with slow filtration is not very marked, and that to get the full benefit of the process, the rate of filtration must be increased.

(4) That no deterioration in the quality of the water results if the head on the filters is increased gradually to as much as 9 inches.

8. The Revolving Purifier Co., in a letter dated 30th June 1892, lay great stress on the fact that the rate of filtration, after treatment with iron, which they consider best, is not less than 70 gallons per square foot in 24 hours. This rate cannot be obtained with Jumna sand as the head necessary to obtain it would in all probability cause "blow holes" to form through which water would pass direct without filtration. With Chambal sand, on the other hand, a rate of 70 gallons per square foot would probably be obtained with a head of less than 6 inches, and it would be possible to work the revolvers under the conditions which the makers consider to be most favourable for obtaining satisfactory results.

9. I am distinctly of opinion that better water at less cost would in the long run be obtained by substituting Chambal sand for the Jamna sand now used. The saving in maintenance charges would alone more than cover the interest charges on the initial outlay necessary; while the saving in water required for sand washing would be still greater. I would therefore strongly recommend the Board to at once obtain enough of Chambal sand for one filter, and to gradually replace the Jumna sand in the other two filters as the existing stock of sand is used up. This would probably mean a capital outlay of Rs. 8,000 in 1894-95 and a similar expenditure in 1895-96 and 1896-97.

10. With regard to the question of erecting revolvers at Lucknow, it appears to me that the advantage to be derived from them requires to be more clearly proved before the Board can be advised to go to the expense of introducing them. I have ordered two filters there to be filled, one with Ganges sand

from Cawnpore, and the other with sand to be obtained from the river Gumti, some two miles above the water-works intake, and am arranging with Mr. Hankin that as soon as both filters are in proper working order, he shall visit Lucknow and personally make a number of experiments on the spot to test the filtered water for bacteria. Samples will at the same time be sent for analytical examination. If the results show that the quality of the water is at all doubtful, or inferior in any degree to the water provided at the other works, the question of introducing revolvers can then be taken up.

C. PERRIN,

Superintending Engineer,

Sanitary Engineer to Government,

N.-W. P. and Oudh.

5th April 1894.

No 6.

Report from the Municipal Engineer, Agra.

No. 298, dated the 24th March 1894.

From—S. CRAWSHAW, ESQ., *Municipal Engineer, Agra,*

To—The Sanitary Engineer to Government, N.-W. Provinces and Oudh.

DEAR SIR,—In compliance with your suggestions conveyed in your Inspection Notes dated January 1894, and the Board's orders, I beg to forward the results of the filter experiment carried out with varying heads. Nos. 1 and 2 filters were used throughout, having both been cleaned before commencing the experiment on the 7th March 1894.

It was intended to work with one inch of head as long as possible, but at 10 P.M. on the 7th it was found that the filtration was too slow to give the necessary supply in the reservoir. I therefore ordered the head on one filter to be increased to three inches, the other to be kept steady at one inch until I could take samples.

On visiting the works in the morning, samples of water from No. 1 were taken, and the filter stopped to see if one filter with three inches of head would keep up the supply.

This was done until 4-15 P.M. on the 9th, when the Superintendent, finding his water was running short in the reservoir, increased the head to nine inches without referring to me.

On visiting the works on the 10th, I determined to bring No. 1 filter into work again, and, after recharging, both filters were worked from 6 P M. with five inches of head.

11th the filters were kept at five inches;
12th ditto ditto;
13th ditto ditto; but as they were beginning to show signs of stopping, I ordered the head to be increased to seven inches on the morning of the 14th instant.

This was accordingly done. Samples were taken whilst with that head, and on the 15th, as No. 2 filter showed signs of stopping, I ordered the head to be increased and only No. 1 filter to be used.

On the 16th I took samples of the water, and as the filter No. 1 showed that it was stopped I ordered the Superintendent to charge No. 3 and stop the experiment.

During the time the experiment lasted—that is, from the 7th to 16th March—observations were taken every two hours, and the average results are given in Appendix No. I.

The samples for analysis were taken when the head on filter well was 1, 3, 5, 7, and 9 inches. On the 10th and 13th samples from the river and standposts at water-works were taken and examined for bacteria as a check and for comparison with the other water. The results are given in Appendix No. II.

I think the results clearly prove that there is not the slightest deterioration in the quality of the water. On the other hand, it shows that there is a marked improvement up to seven inches of head. The results of this experiment clearly show that the late Supervising Engineer's theory in fixing the maximum head on the filter at 1½ inches was a wrong one.

The filters ran for nine days, the average duration of working during the past year being 5½ days. This alone means a saving in sand of 9⅜ inches, taking that ⅜ of an inch is removed each time (as a matter of fact this is often exceeded) or 15,600 cubic feet, which at Rs. 2-12 per cent. equals Rs. 429 per annum. This is exclusive of the water used for washing sand.

The sand, as I have repeatedly reported, is very bad, and is, to say the best of it, an indifferent filtering medium. It is almost impossible to wash it clean. An experiment conducted between the 1st and 15th of March shows that 2,752 cubic feet was washed at a cost of 10·7 annas per 100 cubic feet, the sand being kept in the washer under pressure for 2½ days, and even then was far from being clean. The

quantity of water used to wash this amount was 83,490 gallons per diem, or a total of 1,252,350 gallons in the 15 days. This, at 3 annas per 1,000 gallons, equals Rs. 234-13, or Rs. 8-8-6 per cent. of sand washed.

These figures are the results of a number of experiments which gave the average surface velocity in the 9″ waste water-pipe from washers at 3 feet per second running ¾ full.

The sand washers in use are of very inferior type, and I think it would be advisable for the Board to obtain one of Walker's patent sand washers and give it a trial. The cost of one free on board, London, is £14. The water, instead of running to waste into the canal, could be utilized for irrigating the gardens and grounds. I think the question of obtaining Chambal sand for the filters instead of the fine sand from the Jumna is one that might be considered by you.

Under our present arrangements two filters are charged with two feet of sand annually and worked down to 10 inches. This last 10 inches is then removed, and, after being washed, is again used, the remaining 1′ 2″ of sand as removed is thrown to spoil.

The total quantity of sand required may be taken at 80,000 cubic feet and the cost is, as before stated, Rs. 2-12-0 per cent.

Chambal sand would cost at site about Rs. 18 per cent., or to recharge the three filters Rs. 21,400, and allowing for washing and placing in filters Rs. 24,000. Interest and Sinking Fund on this amount, if obtained by loan repayable in 30 years, would be Rs. 1,500 per annum. Against this there would be a saving, as the sand could be washed and rewashed.

During the experiment in November and December last it was found that the experimental filter charged with Chambal sand ran for an average of 13 days with an average head of 1·26 inches, and filtered at the rate of 29·85 gallons per square foot of filter.

It may be assumed that, if worked up to nine inches, each filter would work for 20 days and filter 50 gallons per square foot in 24 hours or 1,000,000 gallons per diem; or, allowing that two filters were kept working, this means that the three filters would have to be cleaned 18 times in all. And as with Chambal sand with using stiff brushes the removal of ¼ inch would suffice, or 7,500 cubic feet, or in round numbers 8,000 cubic feet, of this, say 20 per cent. would be lost. The cost of renewals would be—

		Rs.
1,600 cubic feet Chambal sand at Rs. 20	...	...
Repairs to tramway and wagons	...	...
Labour and tools in cleaning and working	...	...
	Total	...

Against present estimate.

Repairs to tramway, &c.	...	...
Cleaning and working-labour and tools	...	...
Sand for renewals	...	...
	Total	...

Rs.
320
200
728
1,248
...
200
1,308
2,400
3,908

This would be a saving of Rs. 2,660 per annum, or, deducting interest charges, Rs. 1,160.

This saving might be further increased by using the sand washers recommended above. As there would be little or no loss of sand, and the cost of labour and water would be very materially decreased, a batting of six washers would be ample for our requirements. I estimate the cost to be as follows:—

		Rs. a. p.
Six washers at £79-10-0 at 1s. 2d.	...	... 1,362 12 0
Freight and other charges at Rs. 25 per cent.	...	... 340 8 0
	Total	... 1,703 4 0

APPENDIX I.

Results of Filtration Experiments.

Date.	Number of filters.	Depth of fine sand.	Depth of water on sand.	Head on filter.	Gallons filtered.	Gallons per square foot in 24 hours.	Gallons pumped.	Remarks.
	No. 1	1′ 2½″	...	...	...	...	...	
7th March ...	„ 2	1′ 6½″	2′ 0″	1″	211,812	7·02	791,438	At 10 P.M., the head on No. 2 was increased to 3″ as filtration was too slow.
...	...	...	...	2″	259,250	17·28		
8th March ...	...	...	...	2″	105,861	33·52	783,518	At 9 A.M. No. 1 filter, which had been kept at 1 inch head, was stopped and No. 2 only worked at 4-15 P.M. The Superintendent, finding that the filtration was too slow, increased the head to 9 inches.
...	No. 2	1′ 6½″	...	3″	617,525	33·68		
9th March ...	...	...	...	3″	142,604	34·22	735,705	
...	...	1′ 6½″	...	9″	459,195	38·54		
10th March ...	...	1′ 6½″	...	9″	381,988	57·29	...	
10th „ ...	Nos. 1 & 2	1′ 2½″ / 1′ 6½″	...	5″	646,075	29·82	804,832	At 6 P.M. No. 2 filter was worked and head in both fixed at 5 inches.
11th „ ...	...	...	...	5″	1,046,030	26·15	817,633	
12th „ ...	...	...	...	5″	814,289	20·36	839,890	
13th „ ...	...	...	...	5″	789,622	19·74	882,016	
14th „ ...	...	...	...	7″	936,499	23·41	867,512	
15th „ ...	...	...	...	7″	64,015	19·70	...	
15th „ ...	No. 1	1′ 2½″	...	9″	865,059	51·93	886,197	At 9 A.M., the head was increased to 9 inches and filter No. 2 stopped for cleaning at 9-30. I stopped the experiment and took final samples.
16th „ ...	„ 1	...	...	9″	71,717	37·28	479,685	

Enclosure to No. 298 of 24th March 1894.

S. CRAWSHAW,
Municipal Engineer, Agra.

APPENDIX II.

Results of Analyses on Filtered Water.

Date.	R. L. of river.	Source of samples.	Total solids per million.	Chlorine per million.	Free ammonia per million.	Albuminoid ammonia per million.	Total hardness.	Fixed hardness.	Microbes per C. C.	Remarks.
8th March	...	Top of Filter No. 1.	240	12	·03	·19	5·95	2·80	102	1" head.
"	487·70	Filter Well No. 1.	140	12	·02	·08	4·90	2·80	40	
9th March	...	Top of Filter No. 2.	220	12	·04	·16	5·60	2·80	240	3" head.
"	487·70	Filter Well No. 2.	140	10	·01	·06	4·90	2·80	122	
10th March	...	Jumna River ...	...	...	...	...	...	...	152	
"	487·60	Standpost Water-works	...	...	...	...	...	...	12	
13th March	...	Top of Filter No. 2.	240	12	·08	·13	5·95	3·15	160	5" head.
"	...	Filter Well No. 2.	140	12	·02	·06	4·90	3·15	76	
"	489·30	Jumna River ...	...	...	...	...	...	...	344	
"	...	Standpost Water-works	...	...	...	...	...	...	44	
15th March	488·35	Top of Filter No. 1.	240	12	·08	·14	5·60	3·15	428	7" head.
"	...	Filter Well No. 1.	160	12	·03	·06	4·90	3·15	156	
16th March	488·00	Top of Filter No. 1.	240	14	·04	·16	5·60	3·15	636	9" head.
"	...	Filter Well No. 1.	160	12	·02	·06	4·90	3·15	222	

S. CRAWSHAW,
Municipal Engineer, Agra.

Enclosure to No. 298 of 24th March 1894.

No. 114, dated 5th February 1894.

From—The Secretary, Municipal Board, Agra,

To—The Sanitary Engineer, North-Western Provinces and Oudh.

SIR,—I have the honor, as directed by the Chairman, to forward the Municipal Engineer's report on the recent experiments on filtration carried out at the Board's Water-works for your information, with the remark that the result would hardly seem to justify the increase of expenditure necessary, if Chambal sand be used instead of Jumna sand as a filtering medium.

2. With reference to the cost of the experiment, the Board hopes that it may be found feasible to relieve this impecunious Municipal Board of Agra of a part of the cost.

AGRA MUNICIPALITY.

Report on the experiments conducted at the Agra Water-works between the 28th October 1893 and the 3rd January 1894, by MR. S. CRAWSHAW, *Municipal Engineer.*

Object.—The object of the experiment was to ascertain what action the Anderson's Revolving Purifiers had in reducing organic and other matter in the Jumna water, and also upon microbes as compared with ordinary sand filtration; and also to test the quality of the Utangan and Chambal nadi sands with the Jumna sand as a filtering material.

Filters.—The filters used were 200 by 100 feet, and formed of two layers of bricks, 3 inches of broken stone, 9 inches of Chambal sand, and an average thickness of 1 foot 7 inches of Jumna sand.

The experimental filter was 10 by 10 feet and formed of two layers of bricks, 3 inches of broken stone, 9 inches of Chambal sand covered in the first part of the experiment with 1·8 of fine sand from the Utangan nadi and in the second part with 2 feet of Chambal sand. A meter was fixed at the outlet to register the quantity of water filtered.

Purifiers.—The purifiers in use are three in number, 14 feet 3 inches long by 5 feet in diameter, with a net capacity of 1,689 gallons. These were each charged with 2 tons of W. iron punchings, in size varying from $\frac{1}{4}$ to $\frac{5}{8}$ inch in diameter. The average rate of contact was 3 minutes and the quantity dissolved $\frac{1}{8}$ grains per gallon.

Observations.—Observations were taken during the day at stated hours, *viz.*, 2 A.M., 6 A.M., 8 A.M., 10 A.M., 12 noon, 2 P.M., 4. P.M., 6 P.M. and 10 P.M.

Utangan nadi sand.—The first part of the experiment, sand filtration, lasted from the 20th October to the 11th November, when the Utangan sand was removed. During the 15 days the experimental filter was working it was cleaned twice, and the old filters were changed and cleaned twice also in the same time. The average head with the Utangan sand was 4 feet 11 inches, filtering 14·41 gallons per square foot of filter against the old filters, with 3·23 inches and 37·67 gallons per square foot of filter.

These results clearly show that it is useless as a quick filtering medium, although its action on the water was superior to the old filters in the reduction of organic matter, as shown in the filter wells—

	Old filters.	Experimental filter.
Total solids	150·	160
Chlorine	15·	14·
Free ammonia	·053	·023
Albuminoid ammonia	·145	·095
Nitrates	·125	·160
Sulphates	1·58	1·16

filtration being 3·5 gallons per inch of head in 24 hours against 11·66 gallons per inch.

Chambal sand.—On the Utangaan sand being removed it was replaced by 2 feet of Chambal sand, and the second test lasted from the 12th to 27th November. The experimental filter ran 13 days without stopping, while the old filters were changed twice in the same time. The average head being 1·14 inches, filtering 38·65 gallons per square foot against 2·86 inches and 37·66 gallons per square foot in 24 hours, or 33·73 gallons per inch of head as against 13·15 gallons with the Jumna sand.

The reduction of organic matter is given below—

	Jumna sand.	Chambal sand.
Total solids	170·	160
Chlorine	19·	21·
Free ammonia	·026	·033
Albuminoid ammonia	·11	·115
Nitrates	·345	0·42
Sulphates	·253	2·53
Microbes per C.C.	·940	280·

The result of this experiment shows that, while the Chambal sand is a much quicker filtering medium than the Jumna sand now in use, it is in no way more efficient. It also proves, I think, most conclusively that filters may be worked with safety to a much greater head than that fixed by Mr. Hughes, *viz.*, 1½ inches. For Agra, I think it would be advisable to experiment on the maximum head at which filters using the Jumna sand with the revolving purifiers might be worked to without reducing the quality of the water, as the experience gained here shows that they have a tendency to clog the filters more rapidly than with simple filtration. The filters running 6 days under simple filtration against 5 days with the revolvers, and as each time the filters are cleaned ½ inch of sand is removed, this means 833 cubic feet of sand at Rs. 3 being thrown to spoil as the sand cannot be rewashed. The Chambal sand in experimental filter ran an average of 13 days without stopping; the limit of head being fixed at 2 inches.

Results of Purification. Sand filtration.—As the iron oxide in the sand filters plays a very large part in the reduction of organic matter, I think, for the purposes of comparasion between simple sand purification and that supplemented with purifiers, that only the results obtained in the experimental filters should be taken into account, as there is no doubt that a large amount of oxide was present in the sand of old filters; and I therefore give the average of the four analyses. During the first experiment the river fell 1·30 feet.

	River Jumna.	Filter well.
Total solids	350·	160
Chlorine	28·5	17·5
Free ammonia	·053	0·028
Albuminoid ammonia	0·222	0·105
Nitrates	0·360	0·230
Sulphates	3·300	1·845
Iron	Slight traces.	Slight traces.
Microbes	1,200	280·

These results speak for themselves.

Results of Purification using Revolvers.—The 2nd part of the experiment with the revolving purifiers lasted from the 28th November 1893 to the 3rd January 1894, and the river fell 1·10 feet during the time. But the quality of the water in the river remained about the same, with the exception of free ammonia which showed an average increase of ·020 and the microbes a reduction, of 495 per C. C.

The results are given in Appendix No. III and show a greater efficiency than simple sand filtration.

The rate of filtration fell off somewhat, and the head increased from 2·94 to 3·20 inches in the old filters. And in the experimental filter there was also a falling off in the gallons filtered and a similar increase in head.

Comparing the results with those of the experiments in February 1893, we do not find in any single case that increase of solids which was observed between the river and the surface of the filters during the revolvers experiment. In the sand filtration an increase in the free ammonia is very marked between the river and the surface of this filter, the increase being 100 per cent. This, however, was removed by the filters.

Settlement.—Analysis for microbes was taken to see if any benefit was derived from longer settlement during the revolver experiment.

The results are given below—

River	1,144	Microbes per C. C.
No settlement	84	„ „
21 hours	192	„ „
69 „	68	„ „
River	512	„ „
No settlement	236	„ „
24 hours	148	„ „
71 „	244	„ „
River Jumna	460	„ „
No settlement	520	„ „
34 hours	120	„ „
96½ „	96	„ „
Jumna	664	„ „
No settlement	272	„ „
96 hours	524	„ „
67 „	640	„ „

Nothing can be gained from the figures.

Cost.—The total cost of these experiments was Rs. 1,142-5-1, the analysis costing Rs. 745, and the building and working of the experimental filter, Rs. 397-5-1. As these experiments were carried out on behalf of the Local Government, I think at least the cost of analysis should be refunded to this Board.

I furthur beg to report that E. H. Hankin, Esq., M.A., Chemical Examiner, North-Western Provinces and Oudh, and Central Provinces, carried out the chemical and bacteriological analyses.

Further, he has kindly offered to make free of charge two bacteriological analyses weekly, one of the river and one from the standposts at the water-works.

I give the results below :—

Date.	River Jumna.	Standpost.
10th January	152.	8
17th „	1,372.	32
26th „	1,312.	60.

The Examiner reports that as the agar was old it may account for the low figures on the 10th.

S. CRAWSHAW,

Municipal Engineer, Agra.

APPENDIX No. I.

Results of Filter Experiment without the Revolving Purifier.

Date.	Description of sample.	Appearance.	Parts per million.		Parts per million.		Hardness, Clarke's scale.		Qualitative tests.		Microbes.	Head.	Rate of			
			Total solids.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Before boiling.	After boiling.	Nitrites, parts per million.	Nitrates, parts per million.	S. O. 4 Sulphates grains per gallon	Metallic impurities.	Iron.	Per C. C.	On filter inches.	Filtration gallons per s. ft.	Depth of fine sand on filter.	R. L. of river.
4th November.	River Jumna ...	Turbid ...	560	50	·08	·23	8·05	2·8	*Nil* ...	·08	4·12	Traces of alumina.	Traces ...	82,240	...	...	...	487·60
	Settling Tank No. 3 ...	Slightly turbid	200	14	·08	·21	4·9	2·8	" ...	·04	1·29	*Nil* ...	" ...	30,240	...	...	...	...
	Surface Filter No. 2 ...	" ...	180	14	·132	·19	4·9	2·8	" ...	·03	1·73	" ...	" ...	14,000	...	...	...	...
	Filter well No. 2 ...	Clear ...	180	14	·066	·17	4·9	2·8	" ...	·04	1·44	" ...	" ...	10,400	3·09	34·9	1′ 8½″	...
	Surface of experimental filter.	" ...	360	14	·026	·11	5·95	2·8	" ...	·04	2·01	" ...	" ...	13,120	...	...	...	...
	Well " ...	" ...	180	14	·026	·08	4·9	2·8	" ...	·01	1·29	" ...	" ...	8,560	3·44	13·01	1′·7½″	...
11th November.	River Jumna ...	Turbid ...	260	16	·026	·20	6·3	2·8	" ...	·22	2·53	" ...	" ...	2,240	...	...	...	486·30
	Settling Tank No. 3 ...	" ...	160	16	·052	·18	4·9	2·8	" ...	·20	2·65	" ...	" ...	440	...	...	...	...
	Surface Filter No. 3 ...	" ...	140	16	·052	·16	5·6	2·8	" ...	·16	1·15	" ...	" ...	8,000	...	...	...	...
	Filter Well No. 3 ...	Clear ...	120	16	·04	·12	5·6	2·8	" ...	·21	1·73	" ...	" ...	6,800	3·01	41·83	1′·5½″	...
	Surface of experimental filter.	Turbid ...	140	16	·052	·17	5·6	2·8	" ...	·20	1·03	" ...	" ...	640	...	...	...	...
	Well " ...	Clear ...	140	14	·02	·11	5·95	2·8	" ...	·31	1·03	" ...	" ...	94,400	4·79	15·82	1′·7½″	...
20th November.	River Jumna ...	Turbid ...	220	28	·026	·23	6·3	3·85	" ...	·55	2·88	" ...	" ...	1,200	...	...	...	486·30
	Settling Tank No. 2 ...	" ...	160	22	·04	·22	5·6	2·8	" ...	·46	2·65	" ...	" ...	240	...	...	...	...
	Top Filter No. 2 ...	" ...	160	22	·08	·22	5·6	2·8	" ...	·59	2·53	" ...	" ...	720	...	...	...	...
	Filter Well No. 2 ...	Clear ...	140	24	·026	·13	4·9	2·8	" ...	·30	2·42	" ...	" ...	1,600	3·18	41·78	1′·8″	...
	Surface of experimental filter.	Turbid ...	160	22	·092	·30	5·6	2·8	" ...	·50	2·53	" ...	" ...	1,920	...	...	...	...
	Well " ...	Clear ...	140	22	·04	·14	4·9	2·8	" ...	·37	2·65	" ...	" ...	400	1·04	42·90	2′·9″	...
27th November.	River Jumna ...	Turbid ...	360	20	·08	·23	7·0	2·8	" ...	·59	3·69	" ...	" ...	1,200	...	...	...	486·30
	Settling Tank No. 3 ...	" ...	220	16	·106	·20	6·3	2·8	" ...	·48	2·88	" ...	" ...	400	...	...	...	...
	Surface Filter No. 3 ...	" ...	220	16	·16	·19	5·95	2·8	" ...	·52	2·76	" ...	" ...	760	...	...	...	...
	Well of " ...	Clear ...	200	14	·026	·09	5·25	2·8	" ...	·39	2·65	" ...	" ...	280	2·59	31·91	1′·9″	...
	Surface of experimental filters.	Turbid ...	220	20	·16	·16	6·3	2·8	" ...	·44	2·65	" ...	" ...	960	...	...	...	...
	Well " ...	Clear ...	180	20	·026	·09	5·95	2·8	" ...	·47	2·42	" ...	" ...	160	1·24	34·41	2′·8½″	...

The bacteriological examination is not to be depended on as the water was taken for testing after being in the bottles from 4 to 6 days.

In these tests sterilized one ounce bottles were used.

S. CRAWSHAW,

Municipal Engineer, Agra.

APPENDIX No. II.

Results of Experiments with Revolvers working.

Date.	Description of sample.	Appearance.	Parts per million.		Parts per million.		Grains per gallon, Clarke's scale.		Qualitative tests.			Microbes.	Head on—	Rate of—	Depth of—	R. Level.	Remarks.
			Total solids.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Total hardness.	Permanent hardness.	Nitrites parts per million.	Nitrates parts per million.	S. O. 4 sulphates grains per gallons.	Metallic impurities.	Iron.	Per C. C.	Filter inches.	Filtration gallons per square foot.	Fine sand on filter.	Of river.	
5th December.	River Jumna ...	Turbid ...	320	22	·04	·31	6·65	3·5	*Nil* ...	·46	3·11	*Nil* ...	*Nil* ...	1,144	...	...	...	486·20	60 hour's settlement.
	Settling Tank No. 1 ...	" ...	220	20	·052	·26	5·6	3·5	" ...	·33	2·42	" ...	" ...	68	...	...	...	...	
	Surface Filter No. 1 ...	" ...	220	20	·052	·26	5·6	3·5	" ...	·29	2·42	" ...	" ...	32	...	...	...	...	
	Well of Filter No. 2 ...	Clear ...	180	18	·04	·10	2·25	3·5	" ...	·29	2·07	" ...	" ...	24	3·11	36·55	1′·7½″	...	
	Surface of Experimental Filter.	Turbid ...	220	20	·08	·27	5·6	3·5	" ...	·26	2·30	" ...	" ...	40	...	...	...	...	
	Well of Experimental Filter.	Clear ...	180	18	·04	·11	5·6	3·5	" ...	·29	2·07	" ...	" ...	Not *reliable.*	1·08	32·65	2′·8½″	...	All Chambal sand.
11th December.	River Jumna ...	Turbid ...	340	28	·026	·23	6·65	3·15	" ...	·43	2·88	" ...	" ...	512	...	...	...	485·80	
	Settling Tank No. 1 ...	" ...	200	26	·04	·22	5·6	3·15	" ...	·34	2·65	" ...	" ...	244	...	...	...	...	71 hour's settlement.
	Surface Filter No. 1 ...	" ...	200	26	·04	·18	5·6	3·15	" ...	·34	2·42	" ...	" ...	120	...	...	...	...	
	Well of Ditto ...	Clear ...	160	26	·08	·12	5·25	3·15	" ...	·26	2·30	" ...	" ...	44	3·38	37·57	1′·5″	...	
	Surface of Experimental Filter.	Turbid ...	200	26	·095	·17	5·6	3·15	" ...	·37	2·53	" ...	" ...	184	...	...	...	...	
	Well of Experimental Filter.	Clear ...	180	26	·026	·09	5·25	3·15	" ...	·31	2·53	" ...	" ...	124	1·41	25·58	2′·8½″	...	
18th December.	River Jumna ...	Turbid ...	380	26	·13	·15	7·35	2·8	" ...	·43	2·77	" ...	" ...	460	...	...	...	485·90	
	Settling Tank No. 1 ...	" ...	240	24	·13	·13	6·3	2·8	" ...	·39	2·65	" ...	" ...	96	...	...	...	...	96½ hour's settlement.
	Surface of Filter No. 3	" ...	220	24	·13	·12	6·3	2·8	" ...	·31	2·42	" ...	" ...	112	...	...	...	...	
	Well of Ditto ...	Clear ...	200	24	·04	·08	5·6	2·8	" ...	·21	2·07	" ...	" ...	84	3·06	32·80	1′·8½″	...	
	Surface of Experimental Filter.	" ...	260	24	·17	·11	6·3	2·8	" ...	·27	2·53	" ...	" ...	556	...	...	...	...	
	Well of Experimental Filter.	" ...	220	24	·026	·08	5·95	2·8	" ...	·14	2·07	" ...	" ...	104	1·62	22·29	2·8	...	
3rd January.	River Jumna ...	Turbid ...	280	32	·096	·18	6·65	2·8	" ...	·33	2·07	" ...	" ...	664	...	...	...	485·10	
	Settling Tank, No. 2 ...	" ...	200	40	·052	·12	5·6	2·8	" ...	·25	1·96	" ...	" ...	524	...	...	...	...	86 hour's settlement.
	Surface of Filter No. 3 ...	" ...	200	40	·04	·12	5·6	2·8	" ...	·25	1·84	" ...	" ...	2,664	...	...	...	...	
	Well of Ditto ...	Clear ...	180	38	·026	·08	4·9	2·8	" ...	·22	1·50	" ...	" ...	960	3·27	30·67	1·7	...	
	Surface of Experimental Filter.	Turbid ...	220	40	·08	·12	5·95	2·8	" ...	·26	1·96	" ...	" ...	880	...	...	...	...	
	Well of Experimental Filter.	Clear ...	200	38	·066	·09	5·6	2·8	" ...	·23	1·61	" ...	" ...	372	1·24	25·50	2·8	...	

S. CRAWSHAW,

Municipal Engineer, Agra.

APPEN

Statement showing averages

Number.	Description.	Appearance.	Parts per million. Total solids.	Parts per million. Chlorine.	Parts per million. Free ammonia.	Parts per million. Albuminoid ammonia.	Grains per gallon. Total hardness.	Grains per gallon. Permanent hardness.	Qualitative Nitrites parts per million.	Qualitative Nitrates parts per million.
										Experiment without Puri
1	River Jumna ...	Turbid ...	350	28·5	·053	·222	6·91	3·06	*Nil* ...	0·360
2	Setling Tanks ...	" ...	185	17·0	·069	·202	5·42	2·80	" ...	0·295
3	Surface of Filter ...	" ...	175	17·0	·106	·190	5·51	2·80	" ...	0·325
4	Filter well ...	Clear ...	160	17·0	·039	·127	5·16	2·80	" ...	0·235
	Difference between Nos. 4 and 1 samples ...		190	11·5	·014	·095	1·75	0·26	...	0·115
										Experimental Filter
5	Surface of Filter ...	Turbid ...	200	15·0	·039	·140	5·77	2·80	*Nil* ...	0·120
6	Filter well ...	Clear ...	160	14·0	·023	·095	5·42	2·80	" ...	0·160
	Difference between Nos. 6 and 1 samples ...		190	14·5	·030	·127	1·49	0·26	*Nil* ...	0·200
7	Surface of Filter ...	Turbid ...	190	21·0	·126	·230	5·95	2·80	*Nil* ...	0·470
8	Filter well ...	Clear ...	160	21·0	·033	·115	5·42	2·80	" ...	0·420
	Difference between Nos. 8 and 1 samples ...		190	7·5	·020	·107	1·49	0·26	*Nil* ...	+0.060
	Average difference of Nos. 6 and 8 with No. 1 sample		190	11·5	·025	·117	1·49	0·26	*Nil* ...	0·070
										Experiment with Puri
1	River Jumna ...	Turbid ...	330	27·0	·073	·217	6·82	3·06	*Nil* ...	0·412
2	Settling Tanks ...	" ...	215	27·5	·068	·182	5·77	3·06	" ...	0·327
3	Surface of Filters ...	" ...	210	27·5	·065	·170	5·77	3·06	" ...	0·297
4	Filter well ...	Clear ...	180	26·5	·046	·095	5·25	3·06	" ...	0·245
	Difference between Nos. 4 and 1 samples ...		150	0·5	·027	·122	1·57	*Nil* ...	*Nil* ...	0·167
										Experimental Filter
5	Surface of Filter ...	Turbid ...	225	27·5	·106	·167	5·77	3·06	*Nil* ...	0·290
6	Filter well ...	Clear ...	195	26·5	·039	·092	5·60	3·06	" ...	0·242
	Difference between Nos. 6 and 1 samples ...		135	0·5	·034	·125	1·22	*Nil* ...	*Nil* ...	0·170

DIX No. III.

of Nos. 1 and 2 statements.

tests. S. O. 4 grains per gallon.	Metallic impurities.	Iron.	Microbes. Per C. C.	Head on Filter. Inches.	Filtration. Gallons per square foot.	Fine sand. Depth.	Jumna. Reduced level	Remarks.
fiers.—*Old Filters.*								
3·300	*Nil* ...	Slight Traces.	1,200					
2.367	" ...	"	320					
2·040	" ...	"	740					
2·060	" ...	"	940	2·96	37·61	1′·7½″	486·37	Only the last 2 tests for microbes have been taken, as the two first are very doubtful owing to the water having been kept from 4 to 6 days before examination. The bottles were not sterilized.
1·24	...	...	360					
without Purifiers.								
1·520	*Nil* ...	Slight Traces.	Not reliable					
1·160	" ...	"	"	4·11	14·41	1′·7½″	486·37	Sand from the Utangan nadi was used on 9 inches of Chumbal sand.
1·140	*Nil* ...	*Nil* ...	*Nil* ...					
2·590	*Nil* ...	Slight Traces.	1,440					
2·530	" ...	"	280	1·14	38·65	2′·8¾″	486·37	2 feet 8¾ inches of Chumbal sand was used on top of pebble.
0·770	*Nil* ...	*Nil* ...	920					
1·355	*Nil* ...	*Nil* ...	920					
fiers.—*Old Filters.*								
2707	*Nil* ...	*Nil* ...	705					
2·420	" ...	" ...	136					
2·275	" ...	" ...	88					
1·985	" ...	" ...	50	3·20	34·39	1′·7″	485·75	Only the average of three examinations for microbes have been taken, as in the last set of samples it was found that the stoppers had fallen out of the bottles.
0·722	*Nil* ...	*Nil* ...	655					
with Purifiers.								
2·330	*Nil* ...	*Nil* ...	260					
2·070	" ...	" ...	114	1·34	26·58	2′·8¼″	...	Chumbal sand on pebbles.
0·637	*Nil* ...	*Nil* ...	591					

S. CRAWSHAW,

Municipal Engineer, Agra.

No. 8.

No. 7.

PROVINCIAL SANITARY BOARD,
N.-W. PROVINCES AND OUDH.

Minutes of the *Fifth Meeting* of the Board held at *Naini Tal* on the 23rd September 1898.

Present:

COLONEL G. C. HALL, I.M.S., Inspector-General of Civil Hospitals, North-Western Provinces and Oudh ... ... *President.*

The Hon'ble MR. C. W. ODLING, C.S.I., Secretary to Government and Chief Engineer, Public Works Department, North-Western Provinces and Oudh.

LIEUTENANT-COLONEL S. J. THOMSON, I.M.S., C.I.E., Sanitary Commissioner, North-Western Provinces and Oudh. } *Members.*

C. PERRIN ESQ., M.I.C.E., Sanitary Engineer to Government, North-Western Provinces and Oudh ... ... *Secretary.*

1. *The insanitary condition of the town of Deoband, Saháranpur district.*—Letter No. 1319M., dated the 23rd June 1898, from the Manager, North-Western Railway, was read:

Resolved—that the Chief Engineer and the Secretary to the Board be asked to note on the liability of the Railway authorities in regard to the construction of a new bridge under the railway to carry off the drainage of the town.

2. *Quality of the water supplied from Municipal water-works during the year* 1897-98.—The Sanitary Engineer's report on the above (printed as an appendix) was laid before the Board.

Resolved—that the Board considers that the water supplied from the Municipal water-works during the year under review was on the whole of a very high standard of purity, the only exception being Agra, where, owing to the insufficiency of the filtering area, a higher rate of filtration than is desirable had to be maintained at times, with the result that on those occasions the filtered water was not up to the standard usually preserved at the other water-works in these Provinces.

3. *The bacteriological examination of water supplied from Municipal water-works.*—Letter No. $\frac{2199}{XI-212B}$, dated 3rd September 1898, from the Secretary to Government, Municipal Department, was read:

Resolved—that the Board is of opinion that the orders which have been issued by the Government to the Chairmen of Municipalities and to the Inspector-General of Civil Hospitals fully meet the recommendation of the Board.

4. *Insanitary condition of the town of Kosi in the Muttra district.*—G. O. No. $\frac{1933}{XI-466B}$, dated 1st August 1898, and the accompanying papers regarding the insanitary condition of the town were laid before the Board:

Resolved—that the Board understands that the Deputy Sanitary Commissioner's recommendations for the improvement of the sanitation of the town are receiving the attention of the Municipal Board, but that further inquiries will be made on the subject.

5. The Sanitary Commissioner's report for the year 1897 was laid before the Board and ordered to be recorded.

6. *Sanitary Engineer's fees.*—Letter No. $\frac{1980}{XI-561B}$, dated 8th August 1898, from the Secretary to Government and the correspondence regarding the fees payable by the Municipal Board of Allahabad on account of certain projects carried out during the year 1897-98 were laid before the Board:

Resolved—that the Board agrees with the Sanitary Engineer to Government that the fees for the supervision of the work in connection with the extension of the water-supply to Dáraganj and the *Mágh Mela* may be remitted, but that the full fees for the work at Karela Bágh should be paid by the Municipality.

7. *Extra clerical establishment for Civil Surgeons.*—Letter No. 3383, dated 25th July 1898, from the Sanitary Commissioner, was read:

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Resolved—that the Government be asked to sanction the appointment of an extra clerk to the Civil Surgeons of Meerut, Agra, Allahabad, Lucknow, Jhánsi and Cawnpore at once, and further that the Board trusts the Government will see its way to carrying out the proposals made in the Board's Resolution No. 3, dated 23rd November 1896, at an early date.

8. *Provision for sanitary improvements during* 1898-99.—Letter No. $\frac{629}{XVI-414}$ dated 8th July 1898, from the Secretary to Government, Sanitation Department, intimating that Rs. 30,750 has been provided in the District Boards' budgets for 1898-99 for village sanitary improvements, was read, and it was noted that as the provision in any district does not exceed Rs. 1,000 no action by the Sanitary Board is necessary.

9. *Working of the Village Sanitation Act (No. II of* 1892*) during* 1897-98.—The reports from seven districts were laid before the Board:

Resolved—that the Board notice with interest that special attention appears to be paid by the district officials in protecting wells from contamination and to the general improvement of the sanitary conditions of the villages to which the Act has been applied.

10. *Water-supply project for the city of Jhánsi.*—The Sanitary Engineer's report and estimate was laid before the Board:

Resolved—that the report be circulated amongst the members of the Board and brought up at the next meeting.

C. PERRIN, M. Inst. C.E.,
Secretary, Sanitary Board, N.-W. P. and Oudh.

No. 8.

[Appendix to the Minutes of the Fifth Meeting of the Provincial Sanitary Board, North-Western Provinces and Oudh, held at Naini Tal on the 23rd September 1898.]

Note by C. Perrin, Esq., M. Inst. C.E., *Sanitary Engineer to Government, North-Western Provinces and Oudh, on the quality of the water supplied from the Municipal Water-Works of the North-Western Provinces and Oudh during the year* 1897-98.

Allahabad.—Monthly samples taken of the river water at the intake showed it to contain on an average 2·05 parts of chlorine, ·02 of free and ·07 parts of albuminoid ammonia. Weekly samples taken from standposts in the city were also analysed chemically. Two samples only showed a trace of free ammonia, while the amount of chlorine and albuminoid ammonia was reduced to 1·01 and ·02 parts per million respectively. These results are even more satisfactory than in the previous year, and show how effectively the filters worked.

One hundred and ninety-six samples of water taken from the filter wells were examined for micro-organisms; the average number of microbes in each sample was 87. This is a somewhat high figure, and is attributable, I believe, partly to old tubes having been used at times and to sufficient care not having been taken in collecting the samples. I found when inspecting the works at the end of the cold weather that proper precautions were not taken to thoroughly sterilize the collecting apparatus, and explained to the Superintendent how they should be taken, and since then the results have been much more satisfactory. A microbe said to resemble the enteric microbe was reported by the Chemical Examiner to have been found in a sample of filtered water collected on the 23rd June 1897; but in the next sample, examined qualitatively a week later, it was not found to be present.

Cawnpore.—Two samples only of water from the river were taken during the year; the average quantities of chlorine, free and albuminoid ammonia being ·84, ·08 and ·095 parts per million respectively. After filtration these amounts were reduced to ·002 of free and ·03 of albuminoid ammonia per million parts. The results of the bacteriological examination of the water were equally satisfactory, the average number of microbes in the 54 samples collected from the filter wells being only 30. No microbe resembling enteric was discovered during the year in the water supplied to the town.

Meerut.—Water of very remarkable purity was supplied throughout the year. Of the 32 samples taken from the standposts in the city three only showed a faint trace of free ammonia, while the average quantity of albuminoid ammonia was only ·015 parts per million. One hundred and sixty-five samples were examined bacteriologically; of these 12 were found to be absolutely free of microbes, while the average of the samples taken throughout the year was only 12. Better results than these it would be impossible to obtain.

Agra.—The water supplied from the water-works was on the whole of good quality; but during the hot weather months the chemical analyses showed that the quality was not up to the standard of water supplied from other works in these Provinces. This is undoubtedly due to the high rate of filtration and to the frequent change in the rate of filtration which has a disturbing influence on the beds. On the 1st April the river water contained only ·05 of albuminoid ammonia, while the quantity found to be present in the water from the collecting reservoir was ·06. The rate of filtration at the time was 70 gallons per square foot of filter beds. On the 20th May there was ·07 of albuminoid ammonia, the rate of filtration being 52·65. The biological examination showed only two to eight microbes in the filtered water. Again, on the 10th June water taken from a standpost in the city gave ·04 of free and ·09 of albuminoid ammonia, while in filter No. 2 50 microbes were

found per cubic centimetre, and in filter No. 3 only 2, the rate of filtration being 53 gallons. On the 17th June the filtered water again contained ·09 of albuminoid ammonia; one hundred microbes were found in filter well No. 2. The rate of filtration on that date was 82·60.

From the first week in July the rate of filtration fell below 40 gallons, and a marked improvement in the quality of the water was observable, the quantity of albuminoid ammonia at once falling to ·02 and did not rise above this amount until the 28th August, when only one filter was at work and the rate of filtration rose to 62 gallons. It again fell directly the second filter was in operation; the rate at once fell below 40, and remained at ·02 to ·04 during the remainder of the year.

The results of the quantitative examination for microbes are very conflicting. In several instances the large number of microbes discovered in the filtered water was undoubtedly due to the use of old agar-agar tubes which had gone bad in damp weather. For instance, three samples were taken in tubes ten days old, on the 11th February 1898, the number of microbes found present being 500, 800 and 110.

By chance Dr. Ghadially happened to take samples from the same source within a few hours with tubes brought direct from Mr. Hankin's laboratory, and in these samples only 32 and 10 microbes were detected. Mr. Hankin at the foot of the report remarks: "The results therefore suggest that the agar-agar supplied has gone bad. This occasionally occurs in damp weather, such as exists at present."

A sample taken on the 11th March 1898 with agar-agar ten days old showed 4,400 microbes per cubic centimetre. Fresh tubes were procured and another sample taken from the same filter well four days later, with the result that only 20 microbes were found per cubic centimetre.

So far as possible to prevent this happening I have arranged with Mr. Hankin to have a batch of fresh tubes sent to each of the water-works the same day each week, and have instructed the Municipal Engineers to take their samples as soon after the receipt of the tubes as possible, and I hope that more reliable results will be forthcoming next year.

A microbe resembling enteric was discovered in the Agra water on several occasions during the year. This has been the subject of a special report by the Sanitary Commissioner in connection with the outbreak of enteric fever which occurred amongst the European troops in 1897.

Benares.—Water of a very high standard of purity was supplied throughout the year. Of 50 samples of water taken from standposts in the city and submitted to the Chemical Analyst the average quantity of albuminoid ammonia found in it was ·022 parts per million, while the worst sample examined contained only ·05 parts per million.

The biological examination showed on the whole equally good results. On the 8th September 12,000 microbes were detected in a sample taken from filter well No. 1. This high figure is in undoubtedly due to the agar-agar in the tube having gone bad. Two or three other bad results in the other filters occurred about the same time and are probably due to the same cause. In calculating the average number of microbes in each sample, the sample in which 12,000 microbes were discovered has been neglected.

Lucknow.—The average of six analyses made of the Gumti water at the intake showed it to contain ·02 of free and ·13 of albuminoid ammonia per million. Of 49 samples of water taken from the city standposts only two showed any trace of free ammonia, while the average quantity of albuminoid ammonia was reduced to ·04. This large reduction in organic matter proves how successful the filtration was in removing impurities. The comparatively small number of microbes found in the filtered water is also satisfactory. It is not to be expected that it would be as low as at Benares or Meerut, where the supply is drawn from much larger streams.

The average number of microbes in the Gumti water samples was found to be 4,890, while in the Ganges water at Benares it was only 155. In filters Nos. 1 and 4 on the 10th February 1898 a microbe was detected having the character of the

enteric microbe, except that it gave a slightly visible growth on potato. Measures were at once taken to thoroughly disinfect the filter wells, the clear water reservoir, and the raised reservoir.

General results.—With the exception of Agra, where, owing to the excessively high rate at which water had at times to be filtered the water was occasionally not up to the standard usually maintained, the water supplied from the water-works in these Provinces was throughout the year of a very high standard of purity.

C. PERRIN,

Sanitary Engineer to Government, N.-W. Provinces and Oudh.

Report on the quality of the water supplied by the Agra Municipality during 1897-98.

	Water analysed chemically.																
	Standposts.				Jumna river.				Reservoir.				Well.				Remarks.
	Parts per million.				Parts per million.				Parts per million.				Parts per million.				
	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	
Average quantity	40	4·33	·001	·03	6	3·05	·01	·06	10	3·30	...	·03	4	10·15	·02	·04	
Worst sample	...	15·40	·04	·09	...	1·54	·04	0·16	...	11·9	...	·06	...	12·60	...	·07	
Best sample	...	·56	...	·01	...	·84	...	·04	...	·70	...	·02	...	8·40	·02	·03	

	Analysed bacteriologically.																	
	Filter No. 1.		Filter No. 2.		Filter No. 3.		Standpost.		River.		Settling tank.		Reservoir.					
	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.			Remarks.	
Total number of samples tested and the highest number of microbes found.	40	4,400	49	200	13	150	63	1,048	54	30,000	1	8	1	...				
Average number of microbes ...	...	229	...	40	...	22	...	58	...	3,113	...	8	...	...				

C. PERRIN, Superintending Engineer,
Sanitary Engineer to Government, N.-W. P. and Oudh.

Report on the quality of the water supplied by the Allahabad Municipality during 1897-98.

	Water analysed chemically.												
	Standpost.				Intake.				Clear water reservoir.				Remarks.
	Parts per million.				Parts per million.				Parts per million.				
	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chorine.	Free ammonia.	Albuminoid ammonia.	
Average quantity	51	1·01	·0003	·02	12	2·05	·02	·07	12	2·05	·008	·03	
Worst sample	...	1·68	...	·06	...	4·20	·08	·12	...	2 80	·04	·05	
Best sample...	...	·56	...	·01	...	1·12	...	·05	...	·56	...	·02	

	Analysed bacteriologically.										
	Filter No. 1.		Filter No. 2.		Filter No. 3.		Filter No. 4.		Settling tank.		Remarks.
	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	
Total number of samples tested and the highest number of microbes found	36	350	53	600	55	560	52	800	1	210	
Average number of microbes...	...	55	...	104	...	75	...	103	...	210	

C. PERRIN, Superintending Engineer,
Sanitary Engineer to Government, N.-W. P. and Oudh.

Report on the quality of the water supplied by the Benares Municipal Water-Works during 1897-98.

Water analysed chemically.

	Standposts. Parts per million.				Intake. Parts per million.				Clear water reservoir. Parts per million.				Remarks.
	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	
Average quantity	50	1·25	·022	·022	12	1·31	·016	·06	12	1·23	·01	·03	
Worst sample	...	2·52	...	·05	...	2·80	·03	·08	...	·56	·03	·06	
Best sample	...	·56	...	·01	...	·84	...	·03	...	·56	...	·01	

Analysed bacteriologically.

	Filter No. 1.		Filter No. 2.		Filter No. 3.		Filter No. 4.		Filter No. 5.		Filter No. 7.		Intake.		Clear water reservior.		Remarks.
	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	
Total number of samples tested and the highest number of microbes found.	47	12,000	48	115	50	26	49	254	2	6	46	800	13	640	17	35	
Average number of microbes ...	...	11	...	10	...	5	...	13	...	4	...	36	...	155	...	7	

Report on the quality of the water supplied by the Cawnpore Municipal Water-Works during 1897-98.

Water analysed chemically.

	Standpost. Parts per million.				Clear water reservoir. Parts per million.				Intake. Parts per million.				Settling tank. Parts per million.				Canal. Parts per million.			
	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Number of samples tested.	Chlorine.	Free ammonia.	Albuminoid ammonia.
Average quantity ...	31	·93	·002	·03	10	·88	·01	·03	2	·84	·08	·095	2	·98	·12	·09	1	·7	...	·12
Worst sample	...	1·812	...	·07	...	1·12	·03	·06	...	1·12	·16	·11	...	1·12	·16	·12	...	...	...	...
Best sample	...	·56	...	·01	...	·70	·03	·01	...	·56	...	·08	...	·84	·08	·06	...	...	...	...

Analysed bacteriologically.

	Filter No. 1.		Filter No. 2.		Filter No. 3.		Filter No. 5.		Clear water reservoir.		Settling tank.		River.		Pump well.	
	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.	Number of samples tested.	Highest number of microbes per c. c.
Total number of samples tested and the highest number of microbes found.	12	250	14	84	10	34	18	180	17	260	19	700	1	18	1	40
Average number of microbes ...	...	39	...	27	...	14	...	35	...	49	...	77	...	18	...	40

C. Perrin, Superintending Engineer,
Sanitary Engineer to Government, N.-W. P. and Oudh.

No. 6.

No. 176
IV 3. P.S.B.

OFFICE OF SANITARY ENGINEER, N.-W. P. & OUDH.

Dated Allahabad, the 12th December 1898.

To

The Secretary
Sanitary Board
Madras.

Sir,

I have the honor to acknowledge the receipt of your letter No. 653/8 dated 2d November 1898 which I delayed answering until the proceedings of the 3rd meeting of the Sanitary Board of these Provinces had been received from the Press, as they contained a review of the Quality of the water supplied from municipal water Works during 1897-8. I now enclose a copy of the proceedings and a note on some experiments I had made at Agra a few years ago as the question & the value of the Anderson process is discussed in it.

The purity of the water supplies to the towns having water-works is undoubtedly due for the most part to the excellent sources

S. E.'s No. 5. 2,000 of 1893. P. No. 01223—17-9-98.—P.D.

urces of supply available in these Provinces
d to the fact that at all the works except
Agra it is possible to maintain a slow
ate of filtration. The rate of filtration
in my opinion cannot be too slow and should
ot I consider with the same equally obtainable
in these Provinces be allowed to exceed 100
gallons per square foot of filtering area
per diem. The cost of the necessary
filters to maintain this rate is not
excessive and to maintain a larger
number of filters working at a slow
rate is probably less expensive than
working a smaller number more rapidly;
for they have to be scraped less frequently
and less water has to be run to waste.
At Benares and Meerut the rate of
filtration at present is less than 30
gallons per square foot and no one
could wish for better results than have
been obtained at those two places. At
Agra, on the other hand, the consumption is
greater than the filters were designed to treat
and notwithstanding the assistance of
the Anderson Revolvers the quality of the
water has invariably fallen off when the
rate

rate of filtration rose above 50 gallons per
square foot. The results of recent years have
certainly led me to modify the views I ex-
-pressed in the note on the Agra experiments
in regard to the rate of filtration which may
safely be maintained even with the Anderson
process. —

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

Lewis M. Inst. C.E.,

Secretary, Sanitary Board
N.-W.P. & Oudh

HK
9/12/94

~~The President~~
~~The Surgeon General~~
~~JHA Sumner-Kerr Esq~~
Sany Commissioner 26/1/99
Sany Engineer 10.3.99

LHC 11.1.99 (el)

Sanitary Current No 666.
Received. 16th Dec 98.
Enclo 8 & 2.

Circulated in continuation of C.No: 655 - Circled file.

OFFICE OF SURGEON-GENERAL
16 JAN. 1899
WITH GOVT. OF MADRAS.

OFFICE OF SANITARY COMMISSIONER
No. 370 - S
20 JAN. 99
WITH THE GOVERNMENT OF MADRAS.

C.J. 7 Jan 99

Sec el 10/1/99

18/1/99

LOCAL MUNL. EDL. & LEG. DEPT.
13 JAN 1899
ASSIST. SECY TO GOVT.

SANITARY ENGINEER
Reg. No. 492
10 MAR. 99
TO THE GOVERNMENT OF MADRAS.

1279/M/99

Government of Madras.

SANITARY BOARD OFFICE.

PROCEEDINGS OF THE SANITARY BOARD, No. 240/S, DATED 6 May 1899

LOCAL & MUNICIPAL DEPT.
CURRENT No. 1279 M

READ the following:—

Memorandum from the Secretary to Government, Local and Municipal Department, No. 152 dated 14: February 1899.

Memorandum from the Secretary to Government, Local and Municipal Department, No. 470, dated 26: April 1899.

Resolution

In the memorandum read above from the Secretary to Government, Local and Municipal Department, the Sanitary Board is requested to state

(i) whether it has any information regarding the system of Revolving Purifier, as adopted by the Agra Municipality.

(ii) the way in which it works, and

(iii) the cost of constructing and maintaining it.

2. The following papers on the subject of experiments at Agra with the Revolving Purifier

(are

Sanitary Current No 666.

are on record in the Sanitary Board's office and will be submitted for the information of Government:—

(1) Minutes of the 4th meeting of the Provincial Sanitary Board, North West Provinces and Oudh held on the 23rd June 1898 (copy)

(2) Letter from the Secretary to the Sanitary Board, North West Provinces and Oudh, No $\frac{130}{IV.3.P.S.B}$ dated 15th September 1898 (original)

(3) Note by the Sanitary Commissioner, Madras, No $\frac{2327}{S}$, dated 13th October, 1898 (original)

(4) Note by the Sanitary Engineer, Madras, No 88, dated 18th October 1898 (original)

(5) Notes on some experiments in filtration carried out at Agra during the cold weather of 1893—94. (copy)

(6) Report from the Municipal Engineer, Agra No 298, dated 24th March 1894 (copy)

(7) Minutes of the fifth meeting of the Provincial Sanitary Board, North-West Provinces and Oudh, held on the 23rd September 1898 (Copy).

(8) Letter from the Secretary Sanitary Board, North West Provinces and Oudh No $\frac{176}{IV.3.P.S.B}$, dated 12th December 1898 (original)

3. These documents do not contain a (clear

clear description of Revolving Purifiers. But Mr. Jones' Manual of Hygiene, Sanitation and Sanitary Engineering contains a description of these arrangements which is extracted below for ready reference:—

"There are systems of purification other than that of filtration referred to above, one of the chief systems being purification by what are known as revolving purifiers. These are large cylinders which are caused to revolve. The cylinders are partly filled with spongy iron or cast iron borings, the latter being preferable. The water is introduced into the cylinders at one end and drawn off at the other after a contact of about $3\frac{1}{2}$ minutes with the iron. It is stated that impure waters purified by means of iron will prove safer for dietetic purposes than even good deep well or spring water; because after treatment, the water can be preserved in covered reservoirs, whereas wells or springs may become contaminated."

4. The following extract is from Burn (& Co's catalogue

of Co's catalogue :—

"The principle of the Anderson's Patent Revolving Purifier consists in the production of an intimate contact between metallic iron and the liquid to be purified, by the showering down of finely divided particles of the metal through an onward flowing stream of the liquid.

The apparatus consists of a cylinder supported in a horizontal position by hollow trunnions revolving in pedestal bearings placed one at each of its extremeties. Within the cylinder are a series of short curved shelves arranged in steps at equal distances round its circumference and reaching from end to end. In the place of a sixth row of curved shelves is a line of small square plates, which, by means of nuts outside the cylinder, can be set at an angle with the axis of the purifier. These plates serve to direct the shower of iron back towards the inlet end of the apparatus, and so to counteract the tendency of the current of water to carry the purifying material forward. Through the hollow trunnions which are provided with stuffing boxes, pass the ends of inlet and outlet pipes,

(which

which bring and which carry off the water to be purified. Facing the inlet pipe is a circular distributing plate secured at a distance of $\frac{5}{8}$ inch or $\frac{3}{4}$ inch from the ends of the cylinder, serving to distribute the water radially on its entering the cylinder and prevent its flowing in a direct current along the axis of the apparatus. The inner end of the outlet pipe is fitted with an inverted bell-mouth carried down as near to the bottom of the cylinder as the shelves will allow and intended to prevent the finer particles of iron from being carried out by the current of water. A rotary motion is given to the cylinder through gearing working into an annular spur-wheel surrounding one end of the cylinder. Water can be drawn from the nearest supply without regard to its purity as water from a bathing ghat or tank is converted into a healthy pure water."

5. There are three Purifiers in use at Agra each 14 feet 3 inches long by 5 feet in diameter, with a net capacity of 1689 gallons. These were each charged with two tons of

(wrought iron

wrought iron punchings, in size varying from 1/4 to 5/8 inch in diameter. The average rate of contact was 3 minutes and the quantity dissolved 1/8 grains per gallon.

6. The results of purification by Revolvers are given in appendix No III to the Agra Municipal Engineers' report – paper no. 5 – on the list. The results are said to show a greater efficiency than simple sand filtration. Vide page 6, paper no. 5 on the list.

7. As to the cost of constructing and maintaining the Revolving Purifiers, attention is invited to Appendix A of G. O. No 2156 m dated 2d October 1897.

(True Extract)

A. Parsons.
Secretary, Sanitary Board.

To

The Secretary to Government, Local and Municipal Dept.
with papers for favour of return.
Enclos. 8.

Confidential

Local & Municipal (1897) Department.

CURRENT No. 1293 P.D.

SECRETARY TO GOVERNMENT * LOCAL & MUNICIPAL DEPARTMENT * 1899

From The Secretary,
Sanitary Board

No. 234/S

Dated 4 May 1899
Received 10th —
Registered —
Enclosures 4 (1 plan)
Spare copies nil

SUBJECT.

Maxlemund Reservoir

Stating with remarks, that the acquisition of a narrow strip of land round the — would be of no utility

BACK PAPERS.

G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.

Statement of Private lands lying within the Settlement Area of the Madimund Reservoir with their respective Areas &c:

Settlement Numbers	Areas Acres	Cents	Extent whether part or whole	Names of Pattadars
C/E99A	0	98	Part	Mr. A. S. Lowndes
C/129	0	91	do	do A. Friend.
C/130	43	18	do	do J. Oehlerking
C/131	3	46	whole	do Sabhapathy Iyer
C/132	"	13	do	do Goolam Mahomed Sait
C/133	7	56	do	do Sabhapathy Iyer
C/134	"	08	do	do Goolam Mahomed Sait
C/135	"	15	do	do ——— do ———
C/136	"	24	do	do ——— do ———
C/137	2	42	do	Todas
C/138	2	2	do	Mr. Sabhapathy Iyer
C/139	16	99	do	do ——— do ———
C/140	2	00	do	do ——— do ———
C/141	1	48	do	do ——— do ———
C/142	4	05	do	do ——— do ———
C/143	2	50	do	do Taylor ———
C/144	1	90	Part	do Sabhapathy Iyer ———
C/145	9	72	Whole	do ——— do ———
C/146	9	70	do	do ——— do ———
C/147	5	03	Part	do ——— do ———
C/148	76	94	Whole	do ——— do ———
C/150	25	22	Part	do ——— do ———
	247	72		

J. Ritchie
District Surveyor
Nilgiris
28.4.99.

BACK PAPERS.

G.O.	No.	Department.	Date.

Statement of Private lands lying within the Catchment Area of the Madimund Reservoir with their respective Areas Etc:

Settlement Numbers	Areas Acres	Areas Cents	Extent whether Part or whole	Names of Pattadars
129 A	0	98	Part	Mr. A. S. Lowdell
129	0	97	do	do A. Friend
130	43	18	do	do J. Ochterlony
131	3	46	Whole	do Subbapatty Iyer
132	–	13	do	do Rod Mahomed Sait
133	7	56	do	do Subbapatty Iyer
134	–	08	do	do Rod Mahomed Sait
135	–	15	do	do do
136	–	24	do	do do
137	2	42	do	Todas
138	2	2	do	Mr. Subbapatty Iyer
139	16	99	do	do do
140	2	00	do	do do
141	1	48	do	do do
142	4	05	do	do do
143	2	50	do	do Taylor
144	1	90	Part	do Subbapatty Iyer
145	9	72	Whole	do do
146	9	70	do	do do
147	5	03	Part	do do
148	76	94	Whole	do do
150	26	22	Part	do do

[illegible]
District Engineer
Nilgiris
28.4.99.

Statement of Government lands lying within the Catchment Area of the Marlimund Reservoir with their respective areas &c:

Settlement Numbers	Areas Acres	Areas Cents	Extent whether part or whole	Remarks
C/99	0	47	Part	
C/338	9	12	Whole	
C/344	13	20	do	Occupied by the Municipality
C/359	34	00	Part	
C/360A	4	30	Part	
A/143	1	30	do	Aramby Forest Reserve
A/144A	4	62	do	do ——— do ———
A/159	0	22	do	do ——— do ———
	58	23		

[signature]
District Surveyor
Nilgiris
28.4.99

Minute by the Ag. President Sanitary Board —

Marlemund Reservoir

1. I doubt if even the owners were willing, the advisability of buying the Solales; the cost is enormous & even if we got rid of contamination from the manure used on the Solales, are there not almost as bad other sources of contamination. If filtering is required, how much land will be lost, and what effect will this have on higher levels now supplied?

2. I would recommend a careful examination of some of the larger valleys to ascertain if Kolacammd cannot be supplied wholly from Springwater. In the Kodapammud valley for instance, besides the spring to which a head has been recently built I noticed numerous other springs.

It is possible that a Contour spring channel with pipes 3 or 4 feet below ground leading to a cistern or well

2
1293/my99.

would give all the supply required - or that by pumping from a lower level for the 3 dry months the spring supply might be supplemented.

If there is sufficient water available Ootacamund could be supplied with excellent spring water at a cost of about 1 lakh. I would recommend an expenditure of say Rs 5000 to ascertain the possibility of this scheme - If successful it will solve many of the difficulties of the present situation.

The owners of Tudor Hall, I may mention, informed me that there are numerous springs in the Marlimund valley above the reservoir, and it appears to me, from observation in several directions, that in the hill basin round Ootacamund there is a very large amount of spring water close to the surface.

Am I
30/4/99

Confidential

Government of Madras.

SANITARY BOARD OFFICE.

PROCEEDINGS OF THE SANITARY BOARD, No. 234/5, DATED 4 May 1899

LOCAL & MUNICIPAL DEPT. 1293 M

READ the following:—

G.O. No. 400 M. Mis. dated 20 March 1899.

Resolution.—

In the order of Government read above, the Sanitary Board is requested to meet at Ootacamund after Government goes up there, to go over the Catchment-area of the Mardimund Reservoir, and then to report whether the acquisition of a narrow strip of land round the Reservoir instead of the whole area would be of real utility.

2. In accordance with this order the Board met on Saturday the 29th April 1899 and went over the Catchment-area. The Board is of opinion that it is quite impracticable to cut off the tea Estates, &c, which form the major part of this area, and that the acquisition of a narrow strip of land round the Reservoir would be of no utility.

3. The Board would suggest further inquiry

inquiry into the existence of Spring water in the hill round Kotacamund, as proposed by the Acting President in the minute which accompanies these Proceedings.

4 A map and Statement of in the catchment area private holdings furnished by the Collector, are also Submitted.

(True Extract)

R. Sartorius
Secretary Sanitary Board.

xd 11/6

To

The Secretary to Govt. Local and Municipal Department,

with minute by the Ag: President map and statement of private holdings

given for copying ____
copied ____
examined ____
signed 6/6
189

AGAIN G.O., No. , DATED
189 .

RENT No.

ENCLOSURES TO C. No.

ORDER OF GOVERNMENT	A	A	A	A	A	A	A	
LETTER OF GOVERNMENT.								
STATEMENT WITH DITTO.								
PAPERS NOT FILED UP; BEING MEANT FOR DESPATCH IN ORIGINAL.								

N.B.—
A = Copy in full.
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