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MADRAS RECORD OFFICE.

Government of Madras.

Public DEPARTMENT.

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*Proceedings of the Madras Government, Public Department,
1st December 1870.*

No. 4. Read the following letter from the Acting Chemical Examiner, to the Chief Secretary to Government, Fort Saint George, dated Madras, 11th March 1870, No. 89.

With reference to G.O. S. C., Public Department, No. 1654, of 2nd December 1869, I have the honour to forward a report on waters examined in this office from the 1st October 1864, to the 31st January 1870; and to express my regret at the delay which has occurred in its preparation. The examination of the records of the office for more than five years, and the extraction and arrangement of such portions of them as referred to water analysis involved much labour and occupied much time; while the ordinary duties of the Professorship of Chemistry and of the Chemical Examiner could neither be neglected nor postponed.

2. Paragraph 2 of the order directed the report to be "similar to the reports made by Dr. Macnamara in Bengal." I found that a large part of Dr. Macnamara's report is taken up with general remarks and suggestions on the storage, purification, &c, of water. I did not suppose it to be the wish of Government that I should go over the same ground which had been already carefully traversed by Professor Macnamara. As regards the remainder of that officer's report, containing detailed information upon the water supply of individual stations, I have the honour to point out that the difference of circumstances under which that report and mine were prepared accounts for their dissimilarity. Dr. Macnamara received reports from officers specially selected, who examined the waters at the localities; and supplied, along with the chemical results, detailed information upon the position and condition of the sources, and the topographical and geological features of the ground. This report refers only to analyses made in the office of the Chemical Examiner, and is based on records which supply in most cases very little information, in some instances none whatever, upon the sources of the water supply.

Report on Waters analysed in the Chemical Examiner's Office, Madras, from October 1st, 1864, to January 31st, 1870.

Having been called upon by the Inspector-General of the Indian Medical Department* to supply a list of analyses of water, performed by the Chemical Examiner, Fort Saint George, during the previous five years, I ascertained from the records of the office that 228 samples of water had been reported on in that period. In the following pages the results of most of these examinations have been arranged according to the alphabetical order of the stations from which the waters were sent I have omitted 102 analyses of water used by the inhabitants of the city of Madras, because the results have been already published in a readily accessible form; and two or three others have not appeared to me to be of sufficient importance to be noticed in this report. On the other hand I have added about thirty which were not included in the list above mentioned, the analyses having been made subsequently to September 1869.

2. The form in use in this office, during almost the whole of the period to which this report refers, is given on the next page; and I have appended in the form of notes such explanations as seemed necessary.

* Docket from Secretary Inspector General Indian Medical Department. No. 3277, of 1st September 1869.

Results of Analysis of Drinking Water received from

SENSIBLE PROPERTIES.	
Appearance...	...
Taste...	...
Odour...	...
CHEMICAL PROPERTIES.	
To test paper reaction.	
Solid matter in one gallon.	Organic and other volatile matters... ..
	Inorganic salts... ..
Total... (1) grs.	
Oxidizable matter by permanganate solution (relation of oxygen to organic matter 1:8) (2)	
Hardness to Soap Test (3)	Temporary... ..
	Permanent... ..
Total...	
Chlorides determined volumetrically as chloride of sodium in one gallon (4) ... grs...	
Carbonate of lime (5) ...	...
" magnesia... ..	...
" iron... ..	...
IN SOLUTION AFTER BOILING.	
Lime ..	...
Magnesia...	...
Chlorides...	...
Sulphates ..	...
Nitrates (6) ...	...
Ammonia (7) ...	...

REMARKS.

(1). Five grains of calcined sodium carbonate having been added to a deci-gallon of the water, the latter was evaporated to dryness in the usual way, and the residue ignited. Recently we have adopted the method suggested by Wanklyn and Chapman, and omitting the sodium carbonate, evaporate 70 c. c. in a platinum dish: One milligram of residue represents one grain per gallon.

(2). Ascertained by Dr. Miller's Permanganate solution—0.0395 grains of crystallized potassium permanganate dissolved in one litre of distilled water. One c. c. of this solution decolorized by one litre of the water under examination, (slightly acidulated with hydrochloric acid,) represents 0.0001 grm. of oxygen, or 0.0008 grm. of oxidizable organic matter. By this process only the "putrid" and "decoying readily" organic matter was estimated.

In later analyses Dr. Angus Smith's method and solution have been adopted.

(3). The soap solution was thus prepared. Sixteen grains of precipitated calcium carbonate were dissolved by means of hydrochloric acid in a gallon of water. Soft soap was dissolved in proof spirit, until twenty-two degrees of the graduated burette formed a permanent lather with $\frac{1}{10}$ centimeter of the standard solution. One degree of soap solution represents 0.727 grains calcium carbonate or 0.939 grains calcium sulphate per gallon.

(4). For quantitative determination of the chlorides, 16.997 grammes silver nitrate are dissolved in one litre of distilled water. A litre of the water under examination having been coloured by a few drops of a saturated solution of hydric potassium chromate, each c.c. of the silver solution required to convert the yellow colour to red represents 0.005846 grm. sodium chloride.

(5). This and the six following items are registered as "average," "above average," &c. The standard of comparison was the water of the Brahmans' Well, Egmore, considered the best in Madras. Its composition in the more important particulars is as follows:—

Chlorine.....	2.57 grs. per gallon.
Sulphuric acid.....	1.86 „ „
Lime.....	2.21 „ „
	(1.66 being carbonate.)
Soda.....	8.99 grs. per gallon.
Organic and volatile residue.....	2.00 „ „
Total residue	18.48 „ „

(6). An ounce of baryta solution is added to about twenty ounces of the water, and the mixture distilled. When about two ounces remain in the retort they are cleared of baryta, further concentrated to about an ounce and tested for nitric acid with ferrous sulphate.

(7.) The distillate obtained in the last process is examined by Nessler's test; and the presence or absence merely of ammonia ascertained.

The presence or absence of *nitriles* is occasionally mentioned, having been ascertained by the action of the permanganate test for oxidizable matter.

3. Although an examination conducted according to this form can scarcely be termed an "analysis,"—so little being quantitatively determined, and the amount of so many ordinary constituents of potable water being so vaguely indicated. I venture, nevertheless, to express my opinion that the method, with some alterations and additions, will be found to be sufficiently accurate for practical purposes. It will, I think, enable us to ascertain, to a high degree of probability, whether a given water is or is not fit for domestic use.

4. I have already stated that the oxidizable matter is now determined according to Dr. Angus Smith's method, and with greater accuracy than before. Clark's soap test is used now instead of the solution described above. I am not inclined to attach much importance to the quantitative estimation of ammonia; its presence at all, unless plainly traceable to accidental circumstances, being sufficient to condemn the water in which it is found. The rarity of its detection, even in decidedly bad waters, judging from these analyses, is noteworthy.

4. Microscopical appearances are, it will be seen, occasionally noted in the examinations. Until hydrologists have determined what microscopical forms indicate mischief and what do not, minute investigation into the living impurities of water will not assist those whose object is merely to ascertain whether the sample is fit for use. Freer use of the microscope, however, may lead to discovery in the direction indicated; and it is, therefore, desirable that the instrument should be used in all examinations of water, with a view to future rather than immediate advantage.

5. It will be seen that the presence of nitrates is not held to disqualify water for human use. With regard to chlorides I may remark in conclusion, that Dr. Angus Smith's view that "one grain of sodium chloride per gallon is too much," and that the presence of chlorine in water almost necessarily implies animal organic matter in the soil, is quite inapplicable to this country. Water excellent for all purposes, and altogether above suspicion of pollution with animal excreta, is found in India to contain a very much larger proportion of chlorides than one grain per gallon, and to produce no injurious effect whatever on the health of those who use it. The geological history of the greater part of the peninsula readily accounts for the presence of chlorides in the soil.*

6. ARCONUM.—The only sample of water to be noticed under this head is rather of medico-legal than of hygienic interest. In September 1863 nine or ten men stated that, after drinking

* In the following abstract I have thought it sufficient to particularize only the following qualities of water:—residue (organic and inorganic), oxidizable matter, hardness, chlorides, nitrates, and ammonia. When the last two are not mentioned their presence was not detected. Amounts are given in grains per gallon except in the case of these and hardness.

from a well near Arconum, they had been seized with vomiting and purging, and that some of them afterwards became insensible. The Medical Missionary in charge of the Civil Hospital at Rani-pett sent this remarkable specimen of water for examination. It was a "fair sample" of water, containing nothing likely to produce such formidable effects as were attributed to it. It smelt faintly of sulphuretted hydrogen, but the taste was agreeable. Organic residue was 4.3 out of a total of 39.24 grains; oxidizable matter, 0.448; hardness, 14° (3°5 temporary.) Chlorides amounted to 24.5 grains. The quantity sent was insufficient for the purpose of testing for ammonia or nitrates.

7. ARNEE.—It being contemplated to convert the old Infantry Barracks at this station into a Central Jail, four samples of water (and three of soil) were sent for examination in September 1869. One of these drawn from a well near the Pensioners' quarters was reported unfit for use, as containing 40.9 grains per gallon of chlorides, and 1.176 grains oxidizable matter. Nitrates were present and traces of nitrites but no ammonia. Besides these objections, the water was very hard (18°), and the amount of solid matter excessive (102 grains.)

The other three samples were pronounced to be very hard, but not unfit for use. The principal results of the examination were as follows :—

	Subsidiary Jail well.	Pagoda well.	River well.
Hardness...	14°	17°	17°
Oxidizable matter...	0.672	0.448	0.560
Chlorides...	11.5	4.4	8.2
Nitrates...	Present.	Present.	Present.

There were no nitrites or ammonia.

8. BANGALORE—ULSOOR TANK.—The water of this reservoir has undergone a great deal of analysis during the period under review. In September 1866 it was reported to be a "good soft water" except that it contained a large amount of oxidizable matter—2.576 grains per gallon—of which about half was "putrescent." Chlorides amounted to 7.6 grains, and the microscope revealed animal and vegetable life in abundance. Ammonia was present also. The Chemical Examiner was of opinion that the water might be rendered wholesome by filtering and other precautions. Four months subsequently a sample taken from the deepest part of the tank, at six inches from the surface, was reported to be purer than the last; the organic matter still in excess (1.344 grains), but not acting upon the permanganate so rapidly as before. Nitrates were present but no ammonia. There were much ferric oxide and clay in suspension. Of 12.35 grains of solid residue 2.05 were "organic and volatile." Chlorides had fallen to 3.8 grains.

In October 1867, some offensive scum from the surface of the water was sent up for examination, and pronounced to be essentially faecal; and in the following April four samples of the water (A. B. C. D.) from different parts of the tank, and two (E. F.) from neighbouring wells were examined. The principal results were as follows :—

	A.	B.	C.	D.	E.	F.
Organic and volatile residue.....	3.6	3.9	4.1	3.9	4.0	4.5
Inorganic residue.....	11.0	10.7	8.3	9.2	38.0	46.4
Oxidizable matter.....	0.144	0.224	1.688	1.456	1.760	1.792
Hardness.....	8°	8°5	8°	8°5	9°5	15°
Chlorides.....	7.6	8.8	6.4	7.3	10.5	17.5
Nitrates.....	Fair quantity.	Small quantity.	Traces.	Present.	Considerable quantity.	More than traces.

A., B. and C. were reported unfit for drinking on account of the large amount of organic matter contained and of their offensive odour. The only merit conceded to them was softness. The other three fared no better. D. was offensive too. E. drawn from a well quite close to the tank did not stink, but it contained traces of nitrites; F., from another more distant, but not far distant, well, did. It was remarked that E. was much harder than the others, and a large proportion of its hardness temporary.

The Ulsoor water has been distributed by pipes to the barracks (except the cook-rooms) and family quarters of the Cavalry and Artillery in the new Race-Course Barracks. The men, however, are forbidden to drink of it, and perhaps do not. During a recent sanitary investigation it was desirable to have this supply examined with special reference to contamination with organic matter, and the result was as follows. The examination was made in November 1869 :—

Oxygen for	Putrid matter ...	0
	Readily putrefying matter...	0.049
	Capable of putrefying in twenty-four hours ...	0.23695
	Chlorides ...	3.3
	Nitrates ...	Traces.

9. RACE-COURSE BARRACKS.—The Ulsoor water, which had been supplied to these barracks at some expense, having been declared unfit for drinking, the wells and tanks in the neighbourhood were brought into use and samples of their contents sent to the Chemical Examiner for analysis. In April 1868 the water of a small well behind the Apothecaries' Quarters, at the Hospital, was pronounced "very good," soft (4°), but requiring filtration before use, to remove suspended ferric oxide, &c.; oxidizable matter was 0.672 grains per gallon; chlorides, 2.9. Although the report was so favourable 4.2 grains, out of 13.3 residue after evaporation, were removed by incineration.

A well at the corner of the Third Range of Family Quarters having been thoroughly cleaned out, the water was examined in June 1868. It was pronounced unfit for use in consequence of the excessive quantity of chlorides contained,—35.1 grains per gallon. Organic and volatile residue amounted to 3.2 grains out of a total residue of 3.3; oxidizable matter was 0.448; hardness 14°, 10°5 being permanent.

In July of the same year four samples of water from the neighbourhood of the same barracks were examined; and in January 1869 the examination seems to have been repeated, judging from the descriptions of the wells, as given on the two occasions. The table below shows the principal results of the analyses, absolutely and comparatively :—

	A.		B.		C.		D.	
	1868.	1869.	1868.	1869.	1868.	1869.	1868.	1869.
Organic and volatile residue.....	2.8	3.0	3.71	3.6	2.81	2.6	4.02	4.2
Inorganic residue...	10.1	11.3	12.09	15.0	9.21	12.4	9.28	10.6
Oxidizable matter...	0.784	0.168	1.792	0.168	1.592	0.168	1.232	1.344
Hardness.....	7°	7°5	8°	5°	5°	5°	4°5	8°
Chlorides.....	4.9	4	4	6.7	2.4	2.5	2.4	5.8
Nitrates...	None.	None.	Traces.	None.	None.	None.	None.	None.
Nitrites...	None.	None.	None.	None.	None.	None.	None.	Present.
Ammonia ...	None.	None.	None.	None.	None.	None.	None.	Present.
Remarks...	Good soft water, requiring filtration.	Good for drinking and cooking.	Unfit for drinking. Permanent hardness greater (7°) than in others. Worst of the four.	Good for drinking and cooking.	Best of the four, a good soft water.	Good.	Unfit for drinking, 2 of 8 bottles smelt of sulphuretted hydrogen.	Bad.

The localities of the wells are thus described in 1868, and 1869, respectively. A. (1868), "one of Dhobies' wells, below Nulsendra tank;" (1869, "near Dhobies' well by Nulsendra tank. B. (1868) "a new well near Dhobies' well at Nulsendra tank, on higher ground, near the barracks, used by the Lancers" (1869), "well on border of Nulsendra tank, used by the Lancers." C. 1868 and 1869, "well at south-west corner of Dumloor tank." D. (1868 and 1869), "well at north-west corner of Dumloor tank." I must add that my information as to the positions of these wells is confused and uncertain.

In November 1869 Dumloor water was again analyzed. The Sanitary Commissioner's letter accompanying it stated that the sample was taken from a Horse Artillery well, and that water from the same source had been examined twice before: having been in the first instance declared to be possibly contaminated with sewage, and on the second occasion pronounced unobjectionable, the well having been cleaned out in the interval. None of the wells described above completely corresponds to this. However the result of the partial examination last made was as follows:—

Oxygen for	Putrid matter	0
	Readily putrefying matter... ..	0.021
	Putrefying in twenty-four hours	0.154
	Chlorides	4.1
	Ammonia	Traces.
	Nitrites	None.
	Nitrates	Traces.

The result of a similar examination of Dhobies' Well water, forwarded last December, was—

Oxygen for	Organic and volatile residue	Trace.
	Inorganic residue	20.
	Putrid matter	0.00350
	Readily putrefying matter... ..	0.00525
	Putrefying in twenty-four hours	0.06300
	Hardness	8° (5° perm.)
	Chlorides	2.25
Remarks		Good.

Two more wells supplying these barracks remain to be noticed. The samples are marked A. and B.: the former taken from a well sunk "in an old brick-field, near a top of trees, about 400 yards south-west of South Pavilion of Race-Course Hospital;" the latter from a well about thirty-five yards from A. Both wells are used by the Field Battery occupying part of the new barracks.

	A.	B.
Oxygen for	Organic and volatile residue... ..	Trace.
	Inorganic residue	9
	Putrid matter... ..	0.00875
	Readily putrefying... ..	0.01400
	Putrefying in twenty-four hours	0.06343
	Hardness (Clark)	8° 15.
	Chlorides... ..	2.5
Nitrites		Traces.
Nitrates		Traces.
Ammonia... ..		None.
Remarks... ..		None.
		More than traces.
		Same; but requires
		attention, ammo-
		nia being dis-
		tinctly present.

10. ARTILLERY BARRACKS.—Until very recently only two analyses appear to have been made with reference to these quarters; and those for the benefit of the horses. In August 1868, waters from the Sholay and Coravengalum tanks, both used by Artillery horses, were examined. The former was reported to contain much suspended matter, chiefly alumina and ferric oxide, and to

require, therefore, filtration before use. The microscope revealed animal and vegetable life in abundance. Of 26.2 grains of residue 4.9 were organic and volatile. Oxidizable matter was 0.784, and chlorides were 3.3. The other water was reported on more favourably, as clearing more readily on standing; but it also required filtration. Incineration removed 3.11 out of 18.34 grains; 0.896 was the oxidizable matter, and chlorides amounted to 7.4 grains per gallon.

In December last two waters, used by the Horse Artillery were examined, and the principal results are tabulated below:—

	3. Battery B. Brigade Royal Horse Artillery.	D. Battery 23rd Brigade Royal Horse Artillery.
Oxygen for	1	3
	12	16
	0.00875	0.02800
	0.02450	0.04900
	0.03500	0.41720
	4° 5 (2° 8 per.)	8° (4° 5 per.)
	3.3	2.25
	Traces.	Abundant.

The former was pronounced wholesome, the ammonia being probably accidental. The latter contained much suspended matter and became clear only after long standing. The abundance of ammonia and other indications showed its unsuitability for use.

11. CHOLERA ENCAMPING GROUNDS.—In 1867 three sites were selected for camps, to which troops should be moved in case of an outbreak of cholera; and twelve samples of water from wells and other sources in the neighbourhood were examined here. The results will be more easily shown by exhibiting them in a tabular form, after specifying the localities from which the various waters were obtained.

A. was taken from a tank which is dry in the hot season, and is situated half a mile east of No. 1 Site—that nearest to Cantonment.

B., from Muthakara tank, between No. 2 and No. 3 Sites; a quarter of a mile south of No. 2, and a few hundred yards east of No. 3—that further from Bangalore. This tank never dries completely.

C. from a small well at the foot of No. 3 Site, 100 yards west of the tank last mentioned. The water stood twenty-six feet from the surface.

D., from a well 100 yards from C. and nearer to the tank; water standing eighteen feet from the surface.

E., F., from "water holes" or ponds, fifty feet twelve, dug by the villagers for irrigation and never failing. They were about 300 yards from the tank. The water stood at seven feet from the surface of the surrounding ground.

G., from a small well south of No. 2 Site, 400 yards from the north-east corner of the tank; water twenty-four feet from the surface.

H., from a water-hole south of the valley below the tank, the water standing seven feet from the surface.

I., from a small well in the valley, east of No. 1 Site; the water standing nine feet from the surface.

L., M., N., (K. having been condemned,) from three small wells sunk for irrigation, between two little tanks, 500 yards south-east of No. 1 Site.

Finally, N. having been condemned apparently because the water supplied for examination was not genuine, a fresh sample was drawn with due precaution and sent for analysis. This I have called N.

	A.	B.	C.	D.	E.	F.	G.	H.	K.	L.	M.	N.	N.
Organic.....	4.35	2.25	2.25	1.85	1.05	1.35	3.2	3.4	4.0	4	4.2	3.9	2.7
Inorganic.....	13.00	7.20	7.80	2.45	5.20	5.45	15.4	12.6	13.2	15	21.8	24.1	21.1
Oxidizable.....	0.893	1.232	0.896	0.504	0.535	0.877	0.078	0.101	0.438	0.100	0.064	0.064	0.064
Hardness.....	5°	4° 5'	10°	6°	5°	6°	9°	9°	7°	10°	13°	17°	15°
Chlorides.....	8.8	5.8	71.9	1.2	0.6	0.9	12.9	3.5	4.7	2.0	2.9	2.9	2.3
Nitrates.....	None.	None.	Present.	Present.	Traces.	Traces.	None.	Traces.	More than traces.	None	None.	None.	None.
Ammonia.....	None.	None.	None.	None.	None.	None.	None.	None.	Very large amount.	None.	None.	None.	None.
Remarks.....	Much suspended iron and clay. Organic impurity large. Good soft waters, only requiring filtration.												
	Objectionable from large amount of chlorides, unusual in Bangalore water												
	Good altho' nitrates present, probably from temporary impurity.												
	{ Good wholesome drinking waters. Traces of nitrates, probably due to surface drainage and avoidable.												
	A fair specimen of drinking water, except for traces of nitrates.												
	Better than G.												
	Unfit for cooking or drinking, being very hard, and offensive to smell and taste.												
	A fair sample, requiring filtration.												
	Better than M. and N. Organic matter probably removable by filter.												

12. BELLARY.—With the exception of two comparatively recently made, I find but two analyses of water under this head—one from the cantonment itself and another from Aspery, in the district. In June 1866 water was sent up, drawn from “the small well close to the Bangalore road, near the site proposed for a new Central Jail.” The report was unfavourable. “A large proportion of organic [5.1 out of 52.75 grains, and oxidizable matter [4.368]; also more chlorides [18 grains] than usual. An unwholesome water not fitted for drinking use.” The sample was greenish, of disagreeable taste and offensive smell. No nitrates or ammonia were detected. Hardness was 13°, of which 8° 5' were temporary.

The other sample was from a well in a site selected for a rest-house. It was not considered sufficiently pure in its condition at that time for drinking. Nitrates were present. Chlorides amounted to 16.7 grains. Organic and volatile residue weighed 4.8 out of 43.85 grains. Oxidizable matter was 0.896. Hardness was considerable—31° 5', of which 21° 5' were temporary.

In October 1869 waters from the Upper and Lower Reservoirs of the Bellary Citadel were examined; the former pronounced pure, good and fit for use; the latter foul, containing much suspended and floating impurity, and not fit for use in its present condition. Particulars are given below:—

	Upper reservoir.	Lower reservoir.
Organic and volatile residue	Trace.	5
Inorganic residue	7	4
Oxidizable matter	0.896	2.240
Hardness	7°	6°
Chlorides	1.6	1.5
Nitrates	None.	Present.

13. CANNANORE.—In January 1867 water in the neighbourhood of this station was examined, the proposed Cholera Encamping-ground approved as “an excellent specimen of drinking water and well fitted for domestic use”—with one exception, the large amount of oxidizable matter (2.24). The quantity was found to vary in different bottles and was reported to be “evidently chiefly gaseous, and perhaps due to storage in impure bottles or use of old corks.” Boiling, and addition of Cond’s Fluid to the extent of imparting a faint pink colour, were suggested as certain to render the water perfectly wholesome. Organic and volatile residue amounted only to 0.75 out of a total residue of 2.35. Hardness was 6°; chlorides were 1.2 grains.

Six samples of water were received from Cannanore Central Jail in November 1869. One of these had been partially examined a short time previously, with special reference to sewage contamination, and found so impure that a fuller analysis of it with the others was not considered necessary. The results of five examinations are tabulated below. The Assistant Engineer’s letter (No. 748 of 27th October 1869) gives with the aid of a sketch map the localities of the wells; but I must content myself with a reference to it.

	No. 1.	No. 3.	No. 4.	No. 5.	No. 6.
Organic and volatile residue	0.5	1	1	1.5	1
Inorganic residue	5.5	8	6	3.5	4
Oxidizable matter	0.4	0.896	0.326	0.448	0.326
Hardness (Clark)	3.5	4° 2'	4° 9'	4° 5'	6° 3'
Chlorides	1.1	2.4	2.4	3.1	2.4
Remarks	All good waters except No. 5, which is slightly contaminated with organic matter and shows traces of nitrates.				

14. COIMBATORE.—In December 1865, water from "Coimbatore Jail" was reported on. The situation of the well is not specified in the records. The sensible properties were highly unsatisfactory. Organic and volatile matters amounted to 35·35 (sic) grains per gallon; inorganic to 76·31. Oxidizable matter is not recorded. Hardness was 18° temporary and 28° permanent. Chlorides were 39 grs.; nitrates "in large quantity."* No "remarks" are made in the report, but it may be inferred that the water was not approved.

In August 1866 water from the Central Jail was examined and condemned as containing nitrates, chlorides in excess (45·6 grains), and as being so *permanently* hard (30° out of 44°) as to be unfit for cooking or drinking. The examiner goes on to say: "The well is somewhat improved by having been cleared; the quantity of nitrates being considerably less." The well was probably the same in the two cases. On the latter occasion the taste was "somewhat saline," odour "nothing peculiar;" organic and volatile residue 10·7 (out of 100·6,) and oxidizable matter 1·008.

For comparison with the latter specimen, water from the Collector's well, supposed to be the best in the station, was sent up. The colour was "brownish green," the taste and odour "nothing remarkable." Organic residue was 4·2 out of 42·6 grains; oxidizable matter 1·232; hardness 22°, of which 10° were permanent; chlorides were 21·6. Nitrates were present, in "very small quantity." The examiner remarks upon the great difference in amount of nitrates between the two waters, but declares "the best water in Coimbatore" "not a good drinking water; organic impurity and chlorides in excess; probably greatly improvable by cleaning out the well and filtering the water through charcoal and sand; in other respects, for cooking and domestic use, not objectionable."

Again, in March 1867, water was sent from the same Jail; but whether from the same well or not is not specified by the Superintendent. It was pronounced "objectionable both for drinking and domestic use." It contained 14·6 (out of 102·45) grains of organic and volatile residue, 38 grains chlorides, and nitrates "in some quantity." Oxidizable matter was 1·232; hardness 48°, of which 30° were permanent. The taste was saline and the colour dirty.

15. FRENCH ROCKS.—A site for a Cholera Encamping-ground having been selected in the neighbourhood of this Cantonment, a sample of the water was sent up in May 1869. The water was pronounced too hard for cooking purposes—15°, of which 13° were temporary. All three carbonates were present in unusual quantity. Chlorides also were excessive, 32·7 grains. Oxidizable matter was 1·34. Of 34 grains of solid residue incineration removed three.

In the following September four samples from the same locality were examined. The water of which particulars are given above had, it was stated, "probably been stagnant for years," when it was sent up for analysis. The report having been unfavourable, the well was "baled out and a fresh specimen of it taken marked A."

"The water was allowed to collect again, and after a period of some days a fresh supply was taken marked B."

On making close inquiries it was found that the villagers considered the water good for drinking and cooking. "The bowry itself is on the roadside, with several footpaths leading past it; and travellers and passengers constantly use the water without experiencing any bad effects from it."

C. was taken from a similar well in the neighbourhood. The well was emptied, and after a few days D. was drawn from it.

* Nitro is obtained from the soil in Coimbatore.

The principal results of the examination are tabulated below:—

	A.	B.	C.	D.
Organic and volatile residue...	2·5	2	3	3
Inorganic...	16·5	17	65	45
Oxidizable matter...	2·688	2·464	4·032	4·928
Hardness...	12°	12°	7°	8°·5
Chlorides...	4·9	4·1	8·2	8·2
Nitrates...	None.	None.	None.	None.
Nitrites...	Present.	Present.	Present.	Present.
Ammonia...	More than traces in all.			
Remarks...	Some bottles offensive, others not.		Unfit for use on account of excess of organic and oxidizable matter.	
	Hard; with an undesirable amount of oxidizable and organic matter.			

16. GANJAM.—The Civil Surgeon of Berhampore sent water from this Station (or District) which was examined in September 1866. I have no information as to the locality from which the sample was obtained.

It was declared unfit for use on account of its "large amount of volatile impurities (7·1 grains in 29·4). Oxidizable matter also was large (1·538). Chlorides were 7 grains, with traces of nitrates. The microscope revealed "abundance of vegetable life." The water smelt and tasted of sulphuretted hydrogen.

17. MADRAS—FORT SAINT GEORGE.—A report upon the water supplied to the Fort, dated 15th July 1864, was sent to the President of the Sanitary Commission, and will be found in the Proceedings of that body.

In November 1864 and January 1865, analyses were made of six samples of "Seven Wells Water" with which the Fort was supplied, by Mr. Mayer and Professor Wyndowe. Their report was addressed to the Officer Commanding I. M.'s 76th Regiment "and Members of the Committee, Fort Saint George." In the following table the mean of two examinations of each water, separately made by the two analysts, is given; oxidizable matter is not noted:—

	Well No. 1.	Well No. 2.	Well No. 3.	Well No. 4.	Well No. 7.	Well No. 8.
Organic and volatile residue...	6·7	7·15	5·55	5·77	7·75	6·7
Inorganic...	28·2	24·60	32·07	41·75	22·42	28·2
Hardness...	14° (11° per.)	13° (9°·5 per.)	13°·5 (10°·75 per.)	18°·5 (11°·5 per.)	16°·25 (13°·5 per.)	16° (3° per.)
Chlorides...	12·9	10·3	14·6	19·5	8·6	9·2

No. 1 smelt like water from a ship's tank and was not agreeable to the taste. The microscope showed animal and vegetable life. No. 2 had no odour, tasted better than the other, though not agreeably, and contained infusorial life like No. 1. Neither was considered "suitable or safe for drinking or cooking."

Nos. 3 and 4 were considered "still more objectionable for internal use than Nos. 1 and 2." In No. 3 the total solids were somewhat more, and the organic residue somewhat less than in the first two samples, but microscopical forms of life were more advanced. In 1 and 2 "Oscillatorie, appearing only as masses or groups of ovoids capable of a certain kind of motion, could be detected; but here we have distinct animalcules moving in different directions across the field of observation, as also some specimens of Phytozoa, figured in Prichard's work on the Infusoria." No. 4 contained a much larger quantity of solids than No. 3.

No. 7 tasted "slightly saline;" No. 8 "slightly unpleasant." The latter showed "less microscopical life." Both were declared "unsuitable for internal use."

In August 1868, the Sanitary Commissioner asked for analyses of the same Seven Wells Water (which is supplied not only to the Fort but also to the General Hospital and other public institutions), before and after passing through the filtering beds; with a view to ascertaining the amount of organic and inorganic impurity removed by filtration. The result was as follows: the filtered water yielding the first figures. Total solids, 29.9, 69.7; of which incineration removed 5.6, 7.1. Oxidizable matter 0.28 in both. Total hardness, 20° in both, and ratio of permanent to temporary almost identical. Chlorides 24.55, 23.73. Neither nitrates nor ammonia were detected in either sample.

In connexion with the Fort one other water only remains to be noticed. In April 1867, "an impure brackish water quite unfit for use" was received from the Executive Engineer, Fort Saint George. Its taste was "foul and saline;" "odour, offensive." There were 208 grains of solids in the gallon, of which 7.3 were volatile. The permanganate test gave 3.136 grains organic matter. Hardness was 28° (10° permanent); and chlorides amounted to 95.3 grains. Both ammonia and nitrates were present. I have no information upon the site of the well, but I believe it was filled up in consequence of the report upon the water.

18. LYING-IN HOSPITAL.—The water of the large tank in the compound of this institution was examined in August 1868. It contained much clay and ferric oxide in suspension, and both odour and taste were characterized as "earthy." 9.1 (out of 25.53) grains of residue were volatile, and oxidizable matter was 1.568; chlorides amounted 8.2 grains; nitrates were distinctly present and the water was declared unfit for drinking. Hardness was 8° 5 (7° permanent).

19. MILITARY FEMALE ORPHAN ASYLUM.—Water from the well of this establishment was examined in August 1867, and pronounced "a fair specimen of water for drinking." Animal contamination, probably accidental and temporary, was indicated by faint traces of ammonia. Organic residue amounted to 2.3 (out of 25.3) grains; oxidizable matter was 0.784; hardness 12°; chlorides were 8.2 grains.

20. PERAMBORE LINES.—In March 1865, the water supply of the Native Infantry Regiment at Perambore was examined. There were two sources. No. 1 was drawn from a "tank near the Drummers' Lines, used by the men of the Right Wing." No. 2 was used by the men of the Left Wing. Both were pronounced "unfit for drinking, chiefly on account of organic impurity; the amount of salts being small and unimportant." A suggestion is added that the water supply should be obtained from wells rather than from tanks, the latter being incapable of complete protection from surface drainage. Below are the chief particulars of the analysis:—

	No. 1.	No. 2.
Organic and volatile residue	4.65	3.5
Inorganic residue	24.10	11.5
Oxidizable matter	Not stated.	Not stated.
Hardness	12° (10° per.)	13°
Chlorides	11.1	2.3
Remarks	Microscopical animals and vegetables abundant, alive and dead. Odour earthy. Taste not peculiar.	Taste and odour earthy.

21. GOVERNMENT BAKERY.—Water from a well on these premises was examined in October 1869. It smelt of sulphuretted hydrogen after remaining some days in bottle. Volatile residue was three grains out of 20; oxidizable matter 1.712; hardness 10° (6° 5 temporary). Chlorides were 4.6 grains. The oxidizable matter was declared excessive; and it was recommended that the well should be cleared out, and a layer of clean sand put at the bottom of it. In its present condition it was pronounced unfit for use.

22. A small quantity of water was received for examination from His Excellency the Governor in August 1869. I have no information as to the source from which it was obtained. It contained 3.1 grains volatile residue, out of 26.8; oxidizable matter was 0.348; hardness, 11° 5 (7° 9 temporary). Chlorides amounted to 10.6. The microscope showed animal life. The sample was pronounced to be, on the whole, a very fair one; and filtration and the addition of lime were suggested with a view to removing some of the organic matter and reducing the temporary hardness.

23. In September 1866 Professor Wyndove forwarded to the Sanitary Commission an elaborate and most valuable report upon the waters principally used by the inhabitants of the city of Madras. It includes 102 analyses, tabulated, and arranged according to Police Divisions. Eighty-seven of the samples were taken from wells and fifteen from tanks. It will be sufficient for me to refer to the Proceedings of the Sanitary Commissioners for September 1866, (page 297,) where the report will be found in full.

24. RED HILLS.—Water from the artificial lake at this place will soon, it is hoped, be brought into Madras for general use. A quantitative analysis of it was made in March 1865. I subjoin the results—the mean of two separate examinations—made by the Chemical Examiner and his Assistant. The water was drawn from the middle of the lake, which had been previously filled by freshes. It was free from odour and taste, but cloudy even after filtration; the suspended impurities being likely to subside after an uncertain period of rest. It was pronounced to be "chemically, the best specimen of water examined in Madras;" the amount of organic impurity being trifling and reducible by care and proper storage. A species of chara abundantly present in the lake was said to act beneficially by precipitating the carbonate of lime, but also to add to the proportion of organic impurity, and to generate a noxious gas "which still further deteriorates the water."

Tabular statement of the results of a quantitative analysis of water from the Red Hills Lake

SENSIBLE PROPERTIES.—Cloudy from suspended impurities. Free from odour or taste, re-action faintly acid. Sp. gr. 1004.

Solid ingredients in one imperial gallon.		Mean of two determinations.
		(Grains.)
INORGANIC matter as		0.242
Oxide of iron		1.650
Lime		0.541
Magnesia		1.168
Soda		1.340
Chlorine		0.990
Sulphuric acid		0.780
Silicic acid		1.290
ORGANIC matter		8.001
Total...		
Arranged as—		
Carbonate of lime		1.6850
D. of magnesia		0.9049
Sub. of lime		1.6240
Ch. of sodium		2.1900
Sul. of soda		Traces.
Silic. acid		0.7800
Oxide of iron		0.2420
Chloride of magnesium		Traces.
Organic matter		1.2900
Total...		8.7159
Determination for correction } Inorganic		6.9800
of total solids		1.2900
Total...		8.2700

In November 1866, two samples of water from the "Government wells" at the Red Hills were examined. "No. 1 East Well" was pronounced to yield "a good, pure, wholesome water, fit for drinking use." The total residue was only 7.2, of which 1.75 was volatile : oxidizable matter, 0.336; hardness 6.5. Chlorides were 1.75.

"No. 2, West Well" water was declared "objectionable," as containing a large proportion (99.7) of salts, notably chlorides, (10.5). Nitrates were present. Hardness amounted to 24°, of which 22.5 were permanent; 3.6 grains residue were volatile; and oxidizable matter was 0.56.

25. Fever of a severe type having prevailed at Allikoli, in the Madras district, eight bottles of water from eight wells were sent for examination. The results obtained are given below. The examination was necessarily imperfect, the material being insufficient :—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
Oxidizable matter ...	0.672	2.016	1.668	1.232	1.120	7.168	0.672	2.240
Chlorides ...	13.1	13.1	11.4	8.2	75.3	50.1	4.9	52.4
Nitrates ...	None.	Traces.	None.	Traces.	None.	Abundant.	None.	None.
Remarks ...	Oxidizable matter in excess in all these waters except Nos. 1 and 7, largely in excess in No. 6. The latter also contains nitrates in abundance, and a large quantity of chlorides. It is unfit for use. Nos. 5 and 8 also contain chlorides in excess.							

26. MYSORE.—Besides Bangalore water I find but two samples from the Mysore country. These were reported on in July 1865. The quantities of water sent were deficient, and the examination consequently incomplete. No. 1 was from the Coongul Cusbah, and No. 2 from Kunch Culpore. The object seems to have been to trace the cause of an epidemic of fever which prevailed at the time.

No. 1. contained much suspended matter and was earthy in taste and odour. The microscope revealed animal life to a slight extent and vegetation in abundance. Total solids 14 grains of which 6.4 were organic. No. 2 was better, containing but little life and only 4.8 (out of 12) grains organic residue.

27. NY-OUNGJOE.—A sample of water was examined in October 1868, taken from the river in the vicinity of a place in the Arracca Hills, named as above, and proposed as a sanitarium for the European Garrison in Burmah. The report pronounced it "a good soft water" (4°); sediment copious; total residue (probably after subsidence) 20.2 grains. Amount of organic residue was large—3.7 grains. Ammonia was present, probably accidentally. Oxidizable matter was 0.64 grains; chlorides 2.3. "Filtered through sand and charcoal could be used both for drinking and cooking purposes."

28. OOTACAMUND.—Water from the "lake" at this sanitarium was examined in June 1868. It was sent in six bottles, and the chemical and physical characters of the contents of the six are stated to have varied so widely that "could hardly be considered as samples of the same water." It appears that heavy rain had fallen after three bottles of the water had been drawn, and that the whole of the water had not been taken from the same part of the tank. "Some samples of the water were unfit for use for amount of readily oxidizable organic matter; others contained only a small proportion." was detected in some of the samples.

The odour is described as offensive in some bottles, assent mothers. Organic and volatile residue amounted to only 1.5 in 22.8 grains. Oxidizable matter is reported 0.384; chlorides were 5.3 grains; and hardness was 10°, of which 7° were temporary.

29. PALAVERAM.—One sample of water from this station was examined in February 1866, sent for the purpose by the Sanitary Commission. Two wells are mentioned in the Secretary's accompanying letter, both supplying the hospital; but I can find only one analysis. The water was pronounced potable, but objectionable for cooking on account of its temporary hardness (6.5 out of 14.5). Although the decision upon its merits was thus favourable, it contained 1.12 grains oxidizable matter, 5 (out of 37.6) grains organic and volatile, and 14.6 grains chlorides.

30. POONAMALLEE.—In January 1866 a sample of water from this station was sent by the Sanitary Commission for examination. I have no information as to the nature or position of the source. It was considered "a fair specimen of drinking water, if kept pure." It was clear and transparent, but the microscope revealed animal and vegetable life. The taste was faintly brackish. Solid residue was 31.6 grains, 3.6 being volatile. Oxidizable matter is not recorded. Hardness was 20°, (15° permanent); chlorides were 14.6 grains.

Four samples were examined in November of the same year, No. 1 was from the hospital, No. 2 from the Mess-house, No. 3 from the Depot Barracks, and No. 4 from the "French Barracks." The principal results are given below :—

	No. 1.	No. 2.	No. 3.	No. 4.
Organic residue...	5.05	3.8	2.7	2.3
Inorganic residue ...	34.35	45.3	27.7	11.3
Oxidizable matter ...	1.008	1.568	0.560	0.672
Hardness ...	16°	22°	15°	9°
Chlorides ...	9.9	22.2	10.5	4.7
Nitrates ...	Traces.	None.	Traces.	None.
Ammonia ...	None.	None.	None.	Traces.
Remarks ...	Neither wholesome for drinking : chlorides in excess and more organic and oxidizable matter than is desirable. Fit for domestic use after boiling.			
	Better than Nos. 1 and 2, four ; but animal contamination indicated by presence of ammonia.			

31. SALEM.—In 1867 three samples of water from the Central Jail at this station were examined. The source of the first, reported on in July, is not more particularly designated. It was declared "unfit for drinking, from the large quantity of organic matter, &c." It contained six grains (out of 27) volatile residue; 0.032 oxidizable matter; 7 chlorides, with traces of nitrates. Its great hardness, 25° (15° permanent) unfitted it for cooking.

Some tank water used for bathing was examined microscopically at the same time, with a view to ascertaining the cause of the prevalence of guinea worm among the prisoners. "The deposit obtained from the waters was carefully examined under the microscope. No trace of the "tank worm" described by Dr. Carter of Bombay, and which is considered to be the source of guinea worm, was discovered. The deposit consisted chiefly of vegetable matter and the forms of animal life more commonly to be obtained in tank waters."

The second sample was taken from the Jail Garden well, and was declared to be "a fair sample of drinking water." It contained 2.5 grains volatile residue out of a total of 19.6; oxidizable matter was 0.034; hardness, 17° (10° permanent); chlorides were only 2.6 grains.

The third sample was taken from "a well inside the jail," and was pronounced unfit for drinking or cooking. Organic and volatile residue 5.6 grains out of 38; oxidizable matter was 0.14; hardness 27° (17° permanent.)

In February 1869, another sample of water received, obtained from the neighbourhood of the same jail. The object of the examination was to ascertain whether the water of a certain well was fit for drinking after filtration, as it was contemplated to erect new Jail buildings in its vicinity. The water was reported good, though the temporary hardness was so great (10° of 15°) as to render it unsuitable for culinary purposes. Volatile residue was only one grain out of 28; oxidizable matter 0.1344 grains; chlorides amounted to 15.7. Much of the hardness was due to magnesium salt.

A new well was sunk on the Jail premises in June 1869, and the water found good for drinking, but rather hard for cooking. The total hardness was 21°, of which 10° were temporary and partly due to magnesium carbonate. Of 48 grains solid residue three were volatile. Oxidizable matter was 0.336, and chlorides amounted to 10.6 grains. Traces of nitric acid were present.

32. SECUNDERABAD.—During the period to which this report refers a greater number of samples of water from this important Cantonment were examined in this office than from any other station under the Madras Government. In May 1865, samples from two wells were sent up, but the records open to me give no information as to the positions. Neither was considered fit for drinking, owing to the quantity of organic impurity present. No. 1 (marked A.) was disagreeable to smell and taste. Volatile residue was 6.4 out of 29.2 grains. Hardness was 17° (10° permanent.) Chlorides were 8.2 grains. Neither nitrates nor ammonia were detected in either sample. No. 2 (unmarked) tasted "flat" and smelt "earthy." Contained 9 grains (out of 25.5) organic residue, and 7.5 grains chlorides. Its hardness was 15°, of which only 3° were temporary. The permanganate does not appear to have been used in either case.

33. TRIMULGHERRY.—I tabulate below the principal details of ten samples of water sent up from the European barracks at this part of the Secunderabad Cantonment.

A. was taken from "No. 1 Well, 108th Regiment," and examined in November 1866. Its hardness was not considered to render it unfit for drinking; but volatile residue and oxidizable matter were declared excessive. These and the presence of nitrates, indicated defective sanitation in the neighbourhood of the well.

The same remarks apply to B., examined at the same time, and drawn from "No. 2 well in front of Regimental parade ground, 2-21st Fusiliers." Nitrates were more abundant than in A.

C. and D. were examined in June 1868. They were labelled "North" and "South" Trimulgherry wells, respectively. C. was reported "soft." D. contained a good deal of suspended matter, but was pronounced "a good soft water."

E. and F. were labelled similarly to C. and D. and examined in September 1868. The former was further localized as "near Chotah Moulalli;" and the latter as "near C. O.'s Quarters, 2nd E. L. I." I have no means of knowing whether the same sources supplied the water in the two instances. E. was pronounced "a very good sample of drinking water." The amount of volatile and organic impurities did not exceed the average of Madras city waters. F. was pronounced calcareous and unfit for drinking or cooking. It was clear when drawn, but soon deposited carbonates on exposure. It tasted like lime water.

G. was from the "Present Supply Well 2-21st Fusiliers," examined in January 1869, and reported "not objectionable" with the exception of the undesirable large amount of volatile residue; which, it was suggested, might probably be reduced by clearing out the well. The absence of ammonia and nitrates was mentioned as justifying the favourable opinion given of the water in spite of the considerable quantity of organic matter contained.

H. was taken from the "Present Supply Well 2-10th Regiment" and examined in February 1869. It was pronounced unfit for drinking or cooking on account of the large quantity of organic matter and of temporary hardness. The addition of quick-lime was suggested.

Finally, in May of the same year I. and K. were reported on, drawn from one ("No. 1") well; but the former directly, the latter by a pump.

K. was found to be free from solid matter and organic impurities than I.

K.	I.	II.	G.	F.	E.	D.	C.	B.	A.
0.58 4.32 0.1680 11° (5° per.) None. Do.	3 5 0.3375 10° (8° per.) None. Do.	7 11 0.3584 16° (6° per.) Traces None.	6 11 0.672 18° (10° per.) None. Do.	5 62 30° (16° per.) None. Do.	3.0 25.7 0.224 11° (9° per.) None. Do.	1.8 16.2 0.255 10° (2° per.) None. Do.	2.5 13.5 0.192 8° (3° per.) None. Traces.	6.65 29.20 1.120 20° (19° per.) Present. None.	3.65 15.35 1.004 15° (1° per.) Present. None.
Organic residue ...									
Inorganic do.									
Oxidizable matter...									
Hardness									
Chlorides									
Nitrates									
Ammonia									

34. CAVALRY BARRACKS.—In connexion with these quarters seven analyses are recorded, and the more important results tabulated below:—

	West well Hussar Lines. April 1866.	Centre well Hussar Barracks. April 1866.	North-east well Hussar Barracks. August 1866.	Experimental wells, Cavalry Barracks.		
				No. 1, E.	No. 2, Middle.	No. 3, W.
				January 1867.		
Organic residue...	.....	.....	4.25	2.10	2.25	1.40
Inorganic do. ...	.....	.....	20.16	11.15	13.25	8.15
Oxidizable matter.	.....	.....	0.560	1.232	1.680	1.120
Hardness ... ..	.....	.....	16° (10° per.)	5° (3° per.)	15° (5° per.)	8° (6° per.)
Chlorides ... ..	.....	.....	7	0.9	1.7	1.2
Nitrates ... ..	.....	.....	None.	Traces.	None.	Faint traces.
Ammonia ... ..	.....	.....	Do.	Do.	Present.	None.
Remarks.....	Sent up in imperfectly cleaned wine bottles containing "crust" and fragments of old corks. Results of examination, therefore, without value.			Good wholesome drinking water, except for volatile impurity. Taste and odour "somewhat earthy." Clean out well and filter water through charcoal.		
				These waters are excellent for drinking and cooking except for amount of organic impurity: particularly Nos. 1. and 3. Organic impurity chiefly vegetable and resulting from surface drainage. If wells be <i>pakka</i> built and with low wall round them, supply would be confined to springs and kept pure. In present condition they are purer than many samples examined.		

In August 1867, the third of these waters, that from the north-east well, appears to have been again examined, and considered "a fair sample of drinking water;" although the amount of organic and volatile impurities was above the average, being 3.6 out of 30 grains. Oxidizable matter was 0.128, hardness 13°, of which 10° were permanent; and chlorides were 6.7 grains.

35. SAPPER LINES.—The waters used by the D. and F. Companies of Sappers and Miners, respectively, were examined in March 1869; with the following results:—

	D. Company.	F. Company.
Organic residue...	4	1
Inorganic residue...	52	33
Oxidizable matter...	0.45	0.39
Hardness	1° (10° per.)	15° (8° per.)
Chlorides	27	11.9
Nitrates	Considerable amount.	Traces.
Remarks... ..	Amount of chlorides and organic matter excessive.	.....

36. 4TH LIGHT CAVALRY.—In December 1867, two samples of waters were received which had been drawn from the Muhammedan Burial ground of this Regiment. Both were condemned as unfit for drinking on account of organic impurity and unfit for cooking on account of excessive temporary hardness. Neither taste nor odour was disagreeable. Organic residue was 4.6 (out of 28.6) and 4.5 (out of 35.5) grains, respectively; oxidizable matter was 0.096 and 0.112; hardness, 17° (equally divided), and 28° (15° permanent); and chlorides amounted to 2.9 and 5.8 grains.

Traces of nitrates were detected in No. 1. The locality of the wells would have led us to expect more unsatisfactory results from the examination.

37. 5TH NATIVE INFANTRY.—The water supply of this Regiment was examined in December 1868, with the following results:—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Organic residue...	8.3	10.4	7.5	8.4	3.5	3.2
Inorganic do.	31.3	35.2	60.4	47.2	16.5	12.5
Oxidizable matter...	0.256	0.160	0.240	0.320	0.160	0.257
Hardness... ..	14° (10° per.)	15° (12° per.)	12° (6° per.)	22° (16° per.)	22° (10° per.)	18° (8° per.)
Chlorides... ..	18.7	9.3	17.5	17.5	5.8	2.3
Remarks... ..	Unobjectionable for cooking except for excessive amount of chlorides. Unfit for drinking on account of large quantity of organic matter.	Soft [sic]. Unfit for drinking from large amount of organic matter.	Unfit for use from large amount of chlorides, and of solids. Contains also organic and inorganic.	Unwholesome from large amount of chlorides. Contains also large excess of organic and inorganic matter.	Good for drinking and cooking.	Good for drinking and cooking.

38. 24TH NATIVE INFANTRY.—The water “used exclusively for the purposes of drinking and cooking by the sepoys and families of” this Regiment was reported on in November 1868. Samples from three wells were sent, and the results of the examination are given below. Organic matter was declared to be not excessive in any of them. “All contain a large proportion of inorganic salts. The amount of permanent hardness renders all objectionable both for drinking and cooking purposes”:—

	No. 1.	No. 2.	No. 3.
Organic residue	4.2	3.5	3.12
Inorganic do.	35.5	37.8	35.40
Oxidizable matter... ..	0.320	0.224	0.224
Hardness... ..	2° (15° per.)	28° (19° per.)	23° (16° per.)
Chlorides	8.2	15.5	8.2
Nitrates... ..	None.	Traces.	None.
Ammonia... ..	None.	Traces.	None.

39. MISCELLANEOUS.—Three more Secunderabad waters remain to be noticed, not (I believe) immediately connected with any of the Regiments of the garrison. The first was from a “well behind the Arsenal near Hajee Karim and C.’s Shop,” and was examined in March 1869. One of the six bottles in which it was sent up contained much suspended organic matter. All included more than was desirable. Volatile residue amounted to five (out of 19) grains; oxidizable matter was 1.12; hardness 15° 5 (11.5 temporary); chlorides were 4.87, and traces of nitric acid were detected.

At the same time a sample from the “Inkorkhanah Lines” was examined. Organic matter was in excess, and nitrates were present in considerable quantity. Volatile residue was five grains out of 41; oxidizable matter 0.5; hardness 2° 5 (7° 5 permanent). Chlorides were 9.2 grains.

Finally, in October 1869, water from the “Nullagootlah well” (of the use or position of which no information was supplied) was reported on. The total residue was 46 grains; oxidizable matter 0.252; hardness 11° 5 (8° temporary), due, to a considerable extent, to magnesium

salts. Chlorides were 14.7, an unusually large proportion of which was magnesium chloride. The water was considered good, provided the chlorides were not traceable to animal contamination.

40. ST. THOMAS’ MOUNT.—I find three analyses of “Hospital” (presumably the Garrison Hospital,) compound at this station which I tabulate for comparison:—

	January 1866.	February.	June 1866.
Organic residue... ..	35.05	27.45	21.75
Inorganic do.	54.85	61.05	70.75
Oxidizable matter ... ..	.....	1.008	1.4112
Hardness... ..	38° (28° per.)	38° 5 (33° per.)	41° (36° per.)
Chlorides... ..	31.6	32.7	20.4
Nitrates... ..	Large quantity.	Large quantity.	.....
Remarks... ..	Colour faintly green. Taste not refreshing. Excessive nitrates and chlorides. Unfit for use.	Unfit for use. Amount of nitrates so large that ignited residue evolved copious fumes of nitrous acid.	Magnesium chloride contributed, largely to chlorides.

In June 1866 three other waters from the Mount were examined and declared unfit for human use. Much of the chlorides present appears to have been magnesian. The principal results of the examination were as follow:—

	Well near Family Quarters behind Soldiers’ Institute.	Rear of North Barracks.	Rear of South Barracks.
Organic residue	21.20	22.25	14.5
Inorganic do.	50.25	58.40	95.3
Oxidizable matter... ..	0.824	0.739	0.560
Hardness... ..	36° (32° per.)	42° 5 (38° per.)	47° (43° per.)
Chlorides	14.0	18.7	25.7
Nitrates... ..	Large quantity.	Large quantity.	Large quantity.

41. THAYETMYOO.—Water from a well near the Canteen at this station was examined in October 1869. It contained four grains of volatile residue out of fifty-four; and oxidizable matter 0.336. It was very hard — 20° (17° 5 temporary) — but “not otherwise objectionable.” The presence of nitrates indicated probable animal contamination to a slight extent, but the nitrogen was completely oxidized. The water seems to have been sent up chiefly with a view to ascertaining whether it contained “cholera germs;” but the Chemical Examiner declined to express an opinion on this point.

42. TRICHINOPOLY—CENTRAL JAIL.—I give below, in tabular form, the principal results of five analyses of water from this site. A. was examined in May 1866. The source is not more precisely indicated. It tasted and smelt of sulphuretted hydrogen, and was pronounced “an impure sulphuretted water, unfit for drinking; soft, and otherwise fit for washing, &c., &c.” It was opaque and yellowish green in colour.

B., “No. 2,” was tried in August, and pronounced to be “a good soft water free from sulphuretted compounds.” There was a good deal of suspended impurities. Complete subsidence of these and filtration upwards through gravel, sand and charcoal were suggested as likely to render the water perfectly wholesome. C. and D. were examined in July 1867; the former taken from the “S. W. angle well, thirty-one feet from surface,” the latter from the “N. W. angle well, 16½ feet from surface. C. was pronounced a good, soft water, fit for drinking and cooking.

The large amount of organic and volatile residue was partly attributable to the use of old corks. D. was considered to be a good soft water, but unfit for drinking on account of the presence of sulphuretted hydrogen, of which four bottles out of six smelt.

E. was taken from the same source as D., and examined in May 1868. It was then pronounced good for drinking and the solid matter in solution and oxidizable matter small. A good deal of foreign matter in suspension, removable by subsidence and filtration:—

	A.	B.	C.	D.	E.
Organic residue ...	3.25	4.3	3.4	4	3
Inorganic do. ...	24.25	23.5	13.6	25	12
Oxidizable matter ...	3.47	1.792	0.064	0.720	0.160
Hardness ...	6° (5° per.)	4° 5 (2° 5 per.)	10° (8° per.)	13° (7° 5 per.)	8° (6° per.)
Chlorides ...	3.2	2.0	2.6	3.5	2.9

43. CHOLERA ENCAMPING GROUND.—In June 1866, the first of the waters in the table below was examined and reported to be impure from organic pollution. Its odour was "earthy," but during evaporation "decidedly feculent." In other respects it was considered "a very good water." It contained neither nitrates nor ammonia. The second and third samples were examined in November 1869, and pronounced good, requiring filtration. No. 3 contained traces of ammonia:—

	No. 1.	No. 2.	No. 3.
Organic residue ...	4.15	3.3	3.1
Inorganic do. ...	15.35	11.4	9.3
Oxidizable matter ...	2.240	0.672	0.336
Hardness (Clark's Scale in Nos. 2 and 3) ...	4° (2° 5 per.)	8° 7 (5° 9 per.)	4° 5 (2° 8 per.)
Chlorides ...	1.7	2.7	1.7

44. VELLORE.—Three analyses of water from this station are recorded, the results of which were as follows:—

	Civil Dispensary well.	Sooria Coolum tank in front of Hospital 6 M. Ns.	Well in jail compound.
Organic residue ...	6.25	4.45	11.50
Inorganic do. ...	26.40	18.50	36.95
Oxidizable matter ...	5.152	3.360	1.264
Hardness ...	15° (4° per.)	11° (5° per.)	44° (27° per.)
Chlorides ...	6.1	5.8	38.0
Remarks ...	Much organic impurity, chiefly putrescent. Can be rendered wholesome by attention to cleanliness and filtration.	Best of the three. Nothing objectionable except organic and oxidizable matter in state of decomposition. Subsidence and filtration recommended.	Objectionable for drinking or domestic use: hard, volatile and organic matter in great excess.

MADRAS,
28th February 1870.

(Signed) HENRY KING, A.B., M.B.,
Actg. Chemical Examiner.

No. 5. ORDER THEREON, 1st December 1870, No. 1549.

Resolved that copies of the foregoing report on waters analysed in the Chemical Examiner's Office, Madras, from 1st October 1864 to 31st January 1870, together with copies of the Proceedings of Government, dated the 25th October 1870, No. 1366, be forwarded to the Secretary of State for India, and to the Government of India.

2. Resolved, also, that copies of the report be forwarded to the Inspector-General, Indian Medical Department, and to the Sanitary Commissioner, Madras.
(True Extract.)

Chief Secretary.

To the Inspector-General, Indian Medical Department,
Sanitary Commissioner.

Exd. J. Wright.

desp^d of 12 with 3 copies of this of
25 October 1870 of this of
1st December 1870.

(Sanitary)
Public Department.

No. 1550

To

The Secretary to the Government
of India.

Military Department.

Sir,

I am directed to transmit,
for the information of His Excellency
the Governor General in Council, copies
of the Proceedings of this Government
dated the 25th October 1870 Nos. 187 & 188,
and of a Report on Waters analysed
in the Chemical Examiners Office,
Madras, from 1st October 1864 to
31st January 1870.

For Lt Genl
1st December 1870

187

Pro

1870. 11 (1870) 1870

PUBLIC.

To

THE INSPECTOR-GENERAL,
INDIAN MEDICAL DEPARTMENT.

By, Secy.

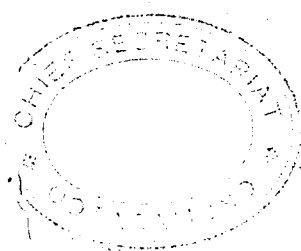
Dated December, 1st.

Recd.

G. O., 1st December 1870, No. 1549.

RECEIVED
NOV. 4-6.

Directing that copies of the report on water
analysed in the Chemical Examiners Office, Madras
from 1st October 1864 to 31st January 187
together with copies of Proceedings, dated 25
October 1870, No. 188, be forwarded to the Secy
of State and the Government of India, a
copy of the report be sent also to the Inspe
tor-General, Indian Medical Department, and to t
Sanitary Commissioner, Madras.



Public Department

PROCEEDINGS of the MADRAS GOVERNMENT.

Read the following letter from the
Chemical Examiner dated 11th March
1870 N^o 1329 -
Order thereon. 1st Decr. 1870 N^o 1329 -

Resolved that copies of the
foregoing Report on waters analysed
in the Chemical Examiner's Office
Madras from 1st October 1864 to 31st
January 1870 together with copies
of the Pro. of Government dated the
25th October 1870 N^o 1366, be forwarded
to the Secretary of State for India, and
to the Government of India.

2. Resolved also that copies
of the Report be forwarded to the
Inspector General Indian Medical
Department and to the Sanitary
Commissioner, Madras.

P. H.

Mr. The Inspr. Genl. Ind. Medl
Department
-a- Sanitary Commissioner-
{*done*

*Public (Sanitary) Deptt
to Inspr. Genl. Ind. Medl
1870 N^o 33.*

18th Department

No.

To

The Secretary to the
Government of
Department

Dated 187 .

Boat of 1870 & Gunners

Public

To
The Capt. Genl. 83rd Regt. 24th
Jan.

Dated Dec. 1. }
Recd. 1870, No. 1579.

Nos. 4. 5

Respecting that copy of report
on boats analyzed in the
Chemical Engineer's Office
forwarded from 14 Dec. 1864 to 31.
January 1870 together with copies
of those of 25 Oct. 1860 No. 1366
be forwarded to the Army of
the 1st Div. of India, and
that copies of the report also
be forwarded to the Army of the
1st Div. of India, and 15th
Feb. 1871 to the Indian Comd.