(No. 32.)

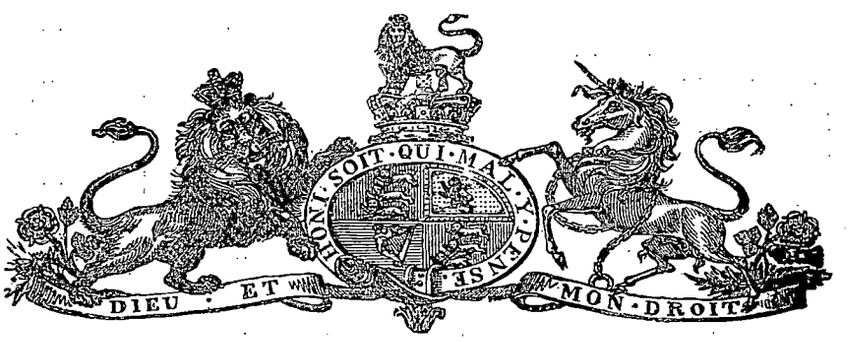
1885.

PARLIAMENT OF TASMANIA.

GOVERNMENT ANALYST:

REPORT FOR **1884.**

Presented to both Houses of Parliament by His Excellency's Command



Government Laboratory, Hobart, 1st June, 1885.

SIR,

I HAVE the honor to enclose Report on the work of the Government Laboratory for 1884, and to point out that the total number of samples of various substances examined shows a very marked increase on that for the previous year.

Attention has lately been drawn both in London and Melbourne to the question of the consumption of raw or recently prepared Spirits, a bill having been introduced in the Imperial Parliament to prohibit distribution within a certain time after preparation; while in Melbourne the Chairman of the Chamber of Commerce in his annual address strongly advocated the compulsory storage for two years of all Colonial-made spirit.

There is no doubt that the effects of drinking raw spirit are more injurious and far more widely spread than those produced by most of the adulterations practised; and the remedy, in the shape of compulsory bonding for a sufficiently long period, of all importations, appears to be easily applicable in this Colony.

The examination of drinking water, and its relation to the spread of disease, has, in view of the importance of the subject, been considered at some length in the Report.

I would again direct attention to the absence of restriction on the sale of poisons.

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

W. F. WARD,
Associate Royal School of Mines,
Government Analyst.

The Hon. the Chief Secretary.

RETURN showing number of Analyses and Examinations made in the Government Laboratory during the Year 1884.

Substance examined.	*For the Government.*	*For Municipal Districts.*	*For Private Individuals.*	TOTAL.
Tea	678	...	...	678
Brandy	5	28	1	34
Rum	1	42	...	43
Gin	2	1	1	4
Whisky	...	4	...	4
Wine	1	1	...	2
Ale and Beer	...	8	...	8
Dandelion Beer	7	...	...	7
Hop Bitters	1	...	...	1
Spirits of Wine	1	...	...	1
Tobacco	12	...	...	12
Beef and Beef Tea	4	...	...	4
Brawn	...	...	1	1
Bread	1	...	...	1
Oatmeal	2	...	...	2
Sugar	...	...	2	2
Pepper	2	...	...	2
Milk	...	6	1	7
Water	2	7	4	13
Broth	...	...	1	1
Stomach	2	...	1	3
Pills, Patent	1	...	...	1
Medicinal Solution	3	...	...	3
Calculus	...	...	1	1
Tin and Tin Ore	...	...	11	11
Ore for Gold and Silver	7	...	11	18
Gold and Amalgam	4	...	1	5
Coal	...	...	1	1
Brick and Clay	...	...	2	2
"Core" from diamond drill	...	...	1	1
Soil	...	...	3	3
Guano	...	...	4	4
Tonite (Cotton Powder)	1	...	...	1
Kerosene	1	...	...	1
Clothing	...	7	...	7
Shot	1	...	...	1
Various	...	...	5	5
	739	104	52	895

[NOTE.—The figures in parentheses show the total number of examinations made in each case.]

TEA. (678.)

Fifty-four samples were found to be more or less adulterated; the added matter in the inferior teas consisted of exhausted or decayed leaves, broken-up twigs, &c.; some of the fancy teas containing in addition much "Lie Tea" and mineral matter, the mixture being artificially coloured with the usual facing powders. The broken-up twigs in one case amounted to twenty-three per cent. of the whole.

BRANDY. (34.)

Seven samples were found to have a lower alcoholic strength than twenty-five per cent. under proof, the lowest legal limit; burnt sugar and sugar had in some cases been added to restore colour and flavour.

RUM. (43.)

Nine samples had been illegally watered; three others were variously adulterated. In one instance the amount of dirt and refuse was sufficient to render the spirit unfit for consumption.

GIN. (4.)

One sample contained an unusually large quantity of Sulphate of Copper.

PORT. (2.)

These were the usual heavily brandied and strongly sweetened mixtures so frequently sold as Port Wine.

DANDELION ALE AND BEER. (7.)

The alcohol found in these samples ranged in amount from one and a half to four and a half per cent.

HOP BITTERS. (1.)

Found to contain twenty-five per cent. of proof spirit.

SPIRITS OF WINE. (1.)

Entered at the Custom House as Methylated Spirit.

TOBACCO. (14.)

Samples forwarded with tenders for supply of Government Institutions; two were found to be artificially coloured and flavoured, to contain an excess of water, and in one case to be weighted with sand to the amount of six per cent.

BEEF. (2.) BEEF TEA. (2.)

Portions of the meat supplied under contract to the General Hospital, Hobart, and of the beef tea prepared from it, were compared with beef obtained for the purpose from a butcher, and with the extract yielded by it; the results obtained showed that the terms of contract had not been fulfilled.

BREAD. (1.)

Supplied under contract to the Invalid Depôt, Launceston.

The bread was of bad colour, sodden, heavy, and insufficiently baked; it contained an excessive quantity of salt (more than two per cent), and was considered unfit for human food.

The character of the bread, and the excess of salt found indicate the probable use of carbonate of soda and hydrochloric acid in the place of yeast.

PEPPER. (2.)

Both samples were mixed with mineral matter, in one case to the extent of ten per cent., rendering it unfit for consumption.

MILK. (7.)

Three samples were found to contain added water, one of them being apparently a mixture of two parts of milk and one of water. A fourth sample contained "beastings," and was unfit for food.

STOMACH AND CONTENTS. (3.)

1. Human. Examined together with patent pills taken shortly before death; no poisonons substance could be detected.
2. Cow's. Considerable quantity of arsenic found.
3. Dog's. No poison detected.

COAL. (1.)

This was an anthracite of splendid quality, but only a thin seam was found.

BRICK AND CLAY. (2.)

Examined for cause of defects in bricks, and experiments made as to best method for treatment of clay.

CLOTHING AND SHOT.

These were examined in connection with various criminal prosecutions.

WATER. (13.)

Seven samples taken during his investigation into the cause of an outbreak of Typhoid Fever at Cressy were received from Mr. J. G. Bushman, Sanitary Officer of Launceston, and four others collected in a similar enquiry at Evandale, have lately been examined. In view of the prevalence of this Fever, which has well been described as a "filth disease," I append the leading results obtained, with others for comparison, and have summarised the main points to be considered in connection with this most important subject of water supply for drinking purposes.

Definition of good Water.

Water for human consumption ought to fulfil all, or at least as many as possible, of the following conditions.

It should be almost, if not entirely, free from—

(a) Floating matter, whether finely divided earth or organic matter, either animal or vegetable, living or dead and decaying.

(b) Dissolved animal or vegetable matter, or more than a moderate quantity of dissolved mineral matter.

(c) More or less injurious or poisonous metals in appreciable quantity, such as Lead, Copper, Zinc, Arsenic, or Iron. It should have no corroding or dissolving effect on the first-named metal.

It should be free from the slightest suspicion or possibility of contamination with sewage or drainage or foul gases of any kind, from houses, cesspools, church-yards, slaughter-yards, tanneries, farm-yards, manured fields, &c.

No sediment should form on standing, and only a moderate amount on boiling.

It should be moderately cool and well aerated, containing seven or eight cubic inches of dissolved gases per gallon, two cubic inches at least being oxygen.

Such water will be entirely free from taste, smell, and colour; soft, clear, bright, and transparent, and entirely wholesome and palatable.

Impurities and Purification of Water.

Rain-water in falling takes from the air traces of nitric acid, ammonia, mineral and organic matter, including the germs of animals and plants; and if collected from the roof of a house, will sweep into the tank much additional impurity, as the droppings of birds, dust, decayed leaves, zinc from gutters, &c. Some of these germs are the producers of fermentation and putrefaction.

Springs may contain excess of mineral or vegetable matter, or poisonous metals.

Lakes and ponds or water-holes will contain various impurities according to position and the source from which they are fed.

Rivers may receive drainage from manured land, pastures, houses, farm-yards, &c., and thus contain the germs of various diseases of men and animals, and of intestinal worms and other parasites, or sheep may have been washed in them.

Wells frequently receive leakage from cesspools, farm-yards, &c., and may be much polluted, although the water remains perfectly clear and bright.

Marsh water usually contains much vegetable matter.

Tanks and barrels used for storing, and filled from any of these sources, are liable, if not frequently emptied and cleaned out, to become foul from the accumulation of sediment, and the possible presence of drowned rats, mice, and insects, and the absorption of foul gases from neighbouring cesspools, pig-styes, stables, &c.; water in this condition also dissolving greater quantities of harmful metals, as lead, copper, and zinc (from galvanised iron) with which it may come in contact.

Good drinking water should not contain more than two parts of iron or zinc, or one part of lead or copper, in a million parts of water.

In addition to frequent cleansing of store tanks and barrels it is always advisable to use a filter, which, if efficient, will retain suspended matter and the larger organisms, including the ova of fluke, tape and other intestinal worms, and some of the dissolved albuminous matter will be oxidised; but many of the minuter forms of life, including the dangerous ones, will pass through an ordinary filter.

Boiling for some time, either without, or better, with the addition of a very small quantity of permanganate of potash, is necessary if the quality be doubtful; but it is much safer to obtain, if possible, a supply quite free from suspicion, as it is not certain that all dangerous germs will be destroyed even by boiling.

Filtering, especially through a dripstone, will re-aerate the water after boiling, and so remove its insipid flavour. The dripstone should of course be out of reach of noxious gases from ill-kept yards, &c.

Filters should be cleansed every two months by pouring through a quart of pure water containing thirty grains of permanganate of potash, and ten drops of strong sulphuric acid (oil of vitriol), then two to four gallons of pure water containing a quarter to half an ounce of pure hydrochloric acid (spirits of salt), and followed by a like quantity of pure water only; the filter is then again fit for use.

If the filter contain charcoal which can be taken out, this may be first boiled in water containing a little permanganate of potash, and then baked in an oven.

Unless cleansing be regularly carried out, the organic matter accumulated on the filter may render the water of worse quality than it was originally.

Water containing large quantities of lime and magnesia salts may be rendered more fit for drinking by boiling, with the addition of a very small quantity of carbonate of soda.

Results of Analyses.

SOURCE OF SUPPLY.	GRAINS PER GALLON.		PARTS PER MILLION.		
	Total Solids.	Chlorine.	Free Ammonia.	Albuminoid Ammonia.	Nitrogen as Nitric and Nitrous Acids.
Cressy.					
1. Creek supplying Cressy	6·02	0·42	0·10	0·19	
2. Ditto	5·60	0·52	0·12	0·18	
3. Marsh draining into Creek	6·72	0·59	0·29	0·37	
4. Tank of house (fever case) Filled	10·50*	0·77	0·61	2·20	
5. Barrel (next door to No. 4) from	7·70	0·35	3·20	3·14	
6. Tank in neighbourhood .... Creek	4·06	0·77	0·69	0·27	
7. Lake River	7·00	1·68	0·21	0·13	
*Sediment, in addition to dissolved solids	51·8 mineral matter. 11·2 organic matter.				
Evandale.					
1. South Esk River	6·5	1·08	0·01	0·13	0·25
2. Nile Creek, (Gutteridge's)	14·5	0·46	0·10	0·13	0·11
3. Ditto, (common supply)	5·5	0·46	0·07	0·09	0·10
4. Well near graveyard	33·0	10·80	0·08	0·26	21·41
For comparison:					
A. Dr. Hassall's proposed Standard for greatest allowable impurity	14 - 17	—	0·05	0·10	0·90
B. London Water Supply, (Thames)	18·5	1·2	0·01	0·06	3·50
C. Thames, London Bridge	—	—	1·02	0·59	—
D. Effluent from sewage	—	9·9	16·20	0·90	—
E. Hobart supply, taken the day after heavy rain had succeeded drought	7·28	0·70	0·02	0·11	—
F. Cascade Brewery Reservoir	3·92	0·56	0·01	0·09	—
G. Ditto, Diamond Drill	65·03	23·82	Trace.	Trace.	Traces.
H. Well near Green Ponds	86·80	29·00	—	—	—
I. Well near Emu Bay	6·02	1·02	0·40	0·23	—
K. Rain Water, (Tank near drain)	3·92	0·21	0·12	0·16	—

Explanatory Notes to Table of Analyses.

Nitrogen is present in considerable quantity in every part of the bodies of animals, and in smaller quantity in plants, chiefly in the fruits and seeds; consequently the estimation of nitrogen, found in the three forms of free ammonia, nitrogenous, or albuminous organic matter, and nitrous and nitric acids, forms the most important part of the analysis of drinking water.

Free ammonia, present in larger proportion than 0·08 part per million of water, is usually due to the decomposition of urea, showing that admixture with urine has occurred. The average amount of free ammonia in river waters is 0·01 part per million, but this is subject to some variation. Albuminoid ammonia is formed in the process of analysis employed, and represents approximately ten times as much nitrogenous organic matter. A water yielding more than 0·15 part of albuminoid ammonia is considered to be unfit for drinking purposes. Imperfectly filtered water yielding 0·10 - 0·20 part per million is stated to frequently produce diarrhœa. Nitrous and nitric acids are formed by the oxidation of nitrogenous matter, and have been described as the "Skeleton of Sewage," and as representing "previous sewage contamination;" but the term "old organic matter" seems more appropriate, the nitrogen not being of necessity originally derived from sewage, but possibly from other contaminating matter. The admixture of sewage, &c. may, however, have been quite recent. A good water will contain no nitrous acid. In ordinary cases the total solids consist chiefly of dissolved mineral matter, which in small proportion is unobjectionable; but in some spring and well waters are found excessive quantities of lime, magnesia, and soda salts (chlorides and sulphates), which render them wholly unfit for every-day use. Water containing more than eight grains per gallon of lime and magnesia salts is stated to be injurious to many persons.

The proportion of chlorine in natural waters varies greatly, but as it is always found in some quantity in urine and sewage, the knowledge of the amount, considered with the other results of analysis, may be of some assistance in forming an opinion as to purity.

Notes on Samples examined.

CRESSY.

Samples 1 and 2, taken from creek supplying Cressy. Colour brownish, from finely divided matter in suspension; living organisms present.

Sample 3, taken from marsh draining into creek about 100 yards above spot where Nos. 1 and 2 were taken. Milky, from the presence of much suspended matter, the quantity being sufficient to render the water opaque when seen in a layer of about nine inches in depth. A farm-yard and privy drained into the creek near the point where the marsh joins the creek.

Sample 4, taken from tank of house where typhoid fever had occurred. Water originally taken from creek. Colour, brownish yellow, sediment amounting to 63 grains per gallon, about 52 grains being mineral and the rest organic filth, swarming with life, including worms.

Sample 5, from tank or barrel next door to house where sample 4 was taken. Water originally from creek. Colour brownish yellow, slight turbidity, offensive smell, contained portions of insects, much organic matter, sporules, &c.

Sample 6, from tank or barrel in neighbourhood, filled from creek. Colour faintly yellow, slight sediment, and living organisms, including worms.

In the case of Nos. 4 and 5, and to a less marked extent in No. 6, water, originally impure, appears to have been from time to time added to store tanks or barrels which were never cleaned out,—a filthy mixture, dangerous at all times, and specially so with disease in the vicinity, being the result.

Sample 7. It is to be regretted that the water from the Lake River should have been influentially defended in the press in a letter from which the two following extracts are taken. "A friend of mine from Queensland.....laughs at the idea of it being unfit to drink after seeing the stagnant water of that colony;" the river being just previously described as "..... flowing through a large grazing as well as marshy country which carries a large quantity of stock, the excrement of which is washed into the streams."

EVANDALE.

Samples 2 and 3, taken from Nile Creek. The results obtained show a perceptibly greater amount of impurity in No. 2 than in No. 1. The creek was fuller than usual when the samples were taken, and this probably rendered the results more favourable.

Sample 4, from well near graveyard, has probably received both sewage and the drainage from the graveyard. Its immediate closing was strongly recommended.

Very great care is necessary in making deductions from the results obtained, and no single standard for comparison has been or can be adopted, the general characters of the water of the particular district when obtainable being the best guide.

A. This "standard" was proposed some years ago as showing the greatest allowable amounts of the various impurities in drinking water, and it is of course desirable that they should fall as much below this as possible.

B. C. That portion of the London Water Supply which is taken from the Thames is usually considered to be more impure than is desirable, and various proposals have been made to replace it at enormous expense by water brought from places hundreds of miles distant. The river at London Bridge is proverbially impure.

D. Effluent sewage after removal of all solid matters by filtration.

E. This sample of Hobart water was coloured brown with vegetable matter, and was taken from an ordinary house-tap the day after a long continued drought had been succeeded by heavy rain. The loss of residue on ignition amounted to 4·2 grains per gallon, which may in this case be considered to fairly represent the total organic matter, chiefly of vegetable origin, present in the water.

F. This water contained only a small quantity of vegetable matter in suspension, and the analysis was made on the unfiltered water. The total mineral matter amounted to 2·9 grains per gallon.

G. Total solids and chlorine in considerable quantity; two-thirds of the former consisting of chloride of sodium (common salt) and chloride of potassium, the remainder chiefly of lime and magnesia salts; very small amounts of ammonia and nitric acid, not accurately determined.

H. Chloride of magnesium and other salts of lime and magnesia present in sufficient quantity to produce medicinal effects.

I. The water of this well had evidently been polluted by surface drainage.

K. Contained various living organisms and their ova; mineral matter 2·8 grains per gallon.

Comparative experiments made in cultivating the minute forms of life in the Hobart and Evandale waters showed them to be most numerous in the first-named and the South Esk waters, and least so in the well water. No conclusions can, however, be drawn from these or similar results at present, in the absence of knowledge as to what forms are dangerous or harmless.

Connection between impure water supply and spread of disease.

Typhoid fever is spread by the contamination of water or air by a specific poison derived from the discharges of infected persons, and there is little doubt that this poison consists of living germs, although they have not yet been absolutely identified. The disease may be due to—

1. Percolation of liquids containing these germs, sometimes to a considerable distance, through the soil into wells and springs or underground tanks, or discharge of sewage into rivers.
2. Exhalations from ill-trapped closets, defective sewers, and privies, &c., containing germs derived from patients; water stored in the immediate vicinity may in this way be rendered dangerous.
3. Contamination of milk, and possibly also of spirits, by admixture with germ-polluted water; the disease is said to have been spread in one case at least by the use of bad water for washing the milk-cans. The popular belief in the absolute protective action of spirits, even in immoderate proportion, is a dangerous delusion.

When exhalations (2) issue into the air they are stated to be immeasurably more likely to communicate disease than is the atmosphere which immediately surrounds fever patients.

The following cases of the spread of typhoid fever by water are instructive, and can scarcely be too frequently quoted.

1. Three hundred and fifty-two persons suffered from typhoid fever, the cause being conclusively proved to be the accidental addition to the water of a small amount of excrement from a sick man who worked for a time in the deep wells supplying otherwise pure water to a large district. Such admixture would defy detection by chemical or any other means known at present.

2. A case of typhoid fever occurred in a cottage on the banks of a Swiss mountain stream, which below the cottage flowed for some distance underground; the water, &c. taking two to three hours to reach a village some distance lower down, the course and rate of flow being ascertained by throwing in opposite the cottage about a ton of salt. A still larger quantity of flour was afterwards thrown in and well mixed with the water; none of it reached the village, showing that filtration, which entirely stopped the flour, allowed the germs of typhoid to pass in sufficient quantity to communicate the disease to seventeen per cent. of the population.

3. The town of Croydon was supplied with water obtained from deep wells sunk inside the town; these were lined with iron cylinders for a certain distance from the surface to shut out the subsoil water which was known to communicate more or less with the sewers; water from the wells was frequently analysed, but no results pointing to defilement could be obtained until the level was lowered by pumping, and samples of the water trickling through the sides of the wells collected and examined, the movement of the subsoil water being also traced by chemical means. Undoubted sewage contamination was discovered, a sufficient reason for the fact that one person in forty-two living in the Croydon Water District suffered from typhoid fever, as compared with one in eight hundred and nine in the district immediately outside, although in many cases the same sewers were used in common by the two districts. The well yielded 0·04 part, and three samples of the leakage 0·14, 0·26, 0·22 parts of albuminoid ammonia per million.

The cases in which this disease has been spread by wells found to be in communication with cesspools are very numerous.

Unfortunately, neither the Microscopist, the Physiologist, nor the Chemist can give a definite answer as to the freedom from disease germs of any water, or, save outside rather wide limits, pronounce an opinion as to its probable unwholesomeness, the difficulty in the latter case being much greater if no history of the supply and its surroundings, and no knowledge of the general character of the waters of the surrounding district, be available.

The safest plan is to consider no water to be fit for human consumption into which sewage has entered, or can at any time enter; and the best test of safety to carefully trace the supply to its source and ascertain that no objectionable impurity gains access to it.

Water mixed with sewage may be, and has been, used for a long time with apparent impunity; but the greater the pollution the greater is the liability to receive sooner or later the germs of typhoid and other diseases, the nitrogenous matter furnishing material for their multiplication, and possibly also, by lowering the general health, preparing the way for their attack.

The slightest admixture of these germs with the purest water having been conclusively shown to be most dangerous, it is manifestly of the highest importance that the supply of towns should be preserved from risk of contamination by the prohibition as far as possible of all settlement on the gathering grounds, while that precaution, as in this Colony, remains a comparatively easy matter. This matter has received much attention in Victoria with very beneficial results.

An originally pure supply may be fouled in the mains by leakage through defective joints when the water is turned off, or the pressure is insufficient to reach the higher ground, a partial vacuum being produced in the empty pipes by continued drawing in the lower parts of the district, which would greatly facilitate the entrance of surface water.

The necessity for the utmost care in thoroughly disinfecting all discharges, &c. from a typhoid patient cannot be too frequently insisted on, and full directions as to the best means to be employed are given in the "Rules" issued by the Government; this precaution should be continued for two or three months, as it is stated that a patient is capable of communicating the disease during that period of convalescence.

Other zymotic diseases, notably cholera, may be spread through the medium of water; and, even in the absence of specific germs, an undue proportion of organic filth is injurious to health, and consequently predisposing to disease.

The typhoid germ appears to find a most suitable hotbed for its propagation in collections of excreta, and, in the words of Dr. Parkes, "the occurrence of typhoid fever points unequivocally to defective removal (or disinfection) of excreta, and it is a disease altogether and easily preventible."

Four samples of water were examined as to their fitness for use in steam boilers, sewage contamination being incidentally discovered in one of them taken from a well.

Collection of Samples.

Insufficient quantities of water having been frequently received for examination, the following directions were drawn up as a guide:—

The water to be analysed should be collected and forwarded in a "Winchester* Quart" bottle, with well-fitting stopper; great care must be taken that the bottle (and any vessel employed in filling it) is perfectly clean; to ensure this it should be rinsed round with a little strong sulphuric acid (oil of vitriol), water added, and the bottle well shaken (shot must not be used), the acid is then poured away, and the bottle filled and emptied about a dozen times to wash out all the acid; before filling it should be rinsed out with some of the same kind of water as that which is to be analysed; it should be nearly but not quite filled, and the stopper tied over with clean linen or calico. If a stoppered bottle cannot be obtained, a clean new cork must be used. Before taking a sample from a pump or pipe the water should be allowed to run for a minute or two.

A sample from a river, pond, or tank should be taken by immersing the bottle as far from the side as possible, with the mouth well below the surface, taking care to avoid stirring up the mud and to prevent the entrance of scum. The source of supply, the position and depth of well, tank, &c., with distance from drains or cesspools, and any other circumstances likely to affect the quality, such as recent heavy rain or long drought, should also be noted.

The necessity for these precautions is obvious when it is considered that the objectionable impurities, even in very bad water, amount to only very few parts per million.

W. F. WARD, *Government Analyst.*

The Hon. the Chief Secretary.

* Capacity half a gallon; it may be procured from any druggist.

WILLIAM THOMAS STRUTT,
GOVERNMENT PRINTER, TASMANIA.