(No. 47.)

1886.

PARLIAMENT OF TASMANIA.

DRAINAGE AND SEWERAGE OF THE CITY OF HOBART:

REPORT TO THE CENTRAL BOARD OF HEALTH, BY ALFRED MAULT, ENGINEERING INSPECTOR TO THE BOARD.

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

TASMANIA.

REPORT

TO THE

CENTRAL BOARD OF HEALTH,

BY

ALFRED MAULT,

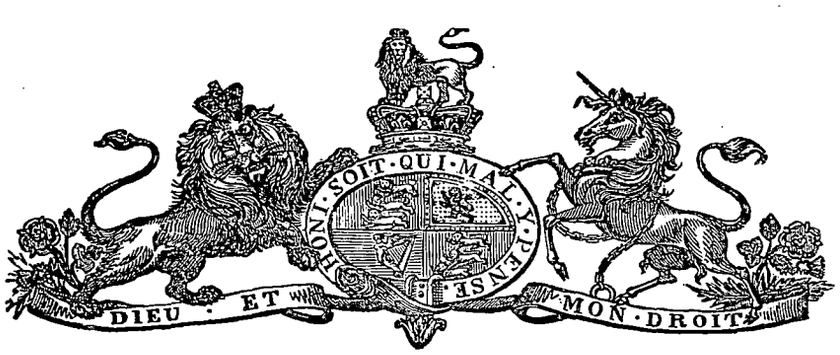
Engineering Inspector to the Board,

ON THE

DRAINAGE AND SEWERAGE

OF THE

CITY OF HOBART.



Tasmania:
WILLIAM THOMAS STRUTT, GOVERNMENT PRINTER, HOBART.

1886.

The Secretary, Central Board of Health, to the Right Worshipful the Mayor of Hobart, Chairman of the Local Board of Health.

Sir, Central Board of Health Office, Hobart, 1st July, 1886.

In accordance with the following Minute, I have the honour to forward you herewith a Report on the Drainage and Sewerage of the City of Hobart, which was laid before the Central Board of Health at a meeting this day :—

"The Board having read and considered the valuable and exhaustive Report furnished by its Inspector, Mr. Mault, regarding the Drainage and Sewerage of the City of Hobart;

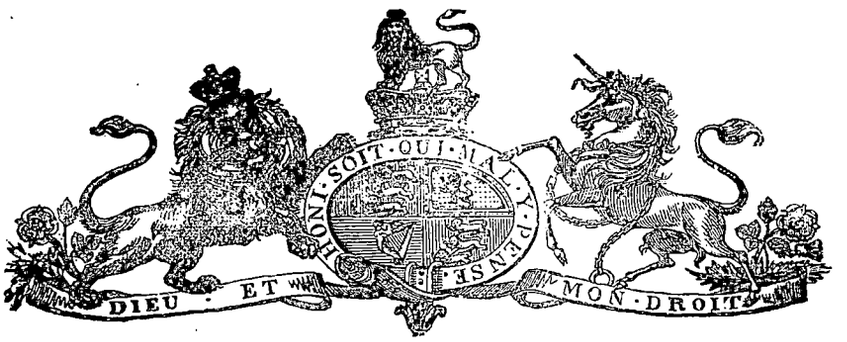
"It was resolved,—

"That copies of the Report should be forwarded to the Chairman and Members of the Local Board of Health of Hobart for their consideration, with the hope that the information contained therein may be of material service to that body when it seeks the assistance of the Government in carrying out a scheme of underground drainage for the City of Hobart,—a course of action which the Central Board strongly recommends it to adopt, as the present insanitary condition of the City is such that prompt and extensive measures should be taken for the preservation of the public health.

"And further,

"That copies of the Report should be forwarded to the Members of the Ministry and the Members of both Houses of Parliament for their information."

I have the honour to be,
Sir,
Your obedient Servant,
W. H. GRAHAM, Secretary.



REPORT on the Sewerage of the City of Hobart, by Mr. A. Mault.

To the President and Members of the Central Board of Health, Tasmania.

Mr. President and Gentlemen :

1. In accordance with the Resolution (No. 83, April 1st, 1886) of the Central Board of Health, I have made an examination of the City of Hobart especially in reference to its drainage, and have now the honour to report to you the result. Resolution of Board.

2. I have received much assistance in the way of information respecting the water supply, the levels of the streets, the methods at present employed in removing offensive matters from the city, and other subjects connected with the sanitation of Hobart, from Mr. James (the City Surveyor) and other officers of the Local Board of Health. The accompanying plan is based upon one lent to me by Mr. Hall, of the Lands Department. The estimates hereinafter given are founded upon the schedule of contract prices furnished to me by the Works Department; and Mr. Rait has shown me a plan of the sewers which had been constructed up to the time of his leaving the service of the Corporation. I thankfully acknowledge all the help thus rendered. Assistance rendered.

3. The City of Hobart occupies an area of 1270 acres, and contains less than 4500 houses and 25,000 inhabitants. The length of the streets is about 37 miles The water supply is in the hands of the Corporation, and is said to be equal to 65 gallons a day to each inhabitant, or an average of 330 gallons a day to each house—an exceptionally large quantity. The water is drawn from sources that for the present are quite safe from contamination by sewage. It is very good, but would be of still better quality if more care were taken to remove from the mountain streams all dead tree-ferns and other decaying vegetable matter. Area, &c. of city and water supply.

4. No proper plan of the existing sewers is in the possession of the Corporation, so that I am not in a position to say how much of the city is already drained, and whether it be so efficiently or not. But it appears that some considerable portion of the existing sewers have been constructed to carry the waters of several small rivulets that run through various parts of the city. These sewers are consequently larger than would be required for the conveyance of house sewage only, and could not be conveniently or economically made part of any general system of sewerage. It would therefore be better that such sewers should be left to fulfil the purpose of carrying the watercourses, together with that of taking off rain-water from the streets, all house sewage being cut off from them. Plan of present sewers wanting; utilisation of present sewers.

5. I would mention parenthetically that in this Report the word "sewer" means a public conduit for sewage; "drain" (used substantively) means a private conduit for such matter; "sewage," the more or less liquid matter that passes in the sewers and drains; and "sewerage," the system or plan of arrangement of the sewers and drains. Interpretation.

6. The number of water-closets in the city is not known; but judging from such information as I could get, and by their number in similar places in England, it is probable that there are less than 400. What proportion of these drain into sewers and into cesspools respectively is not ascertained. There are about 600 houses that have privies with movable pans, that are periodically emptied by nightmen employed by the Corporation. There must, therefore, be about 3500 houses that have ordinary privies. Of these last comparatively few have ashpit middens, so common in England. Nearly all have a Water-closets, privies, cesspools, and ashpits.

cesspit for privy purposes only,—the ashes and dry kitchen and other refuse being disposed of otherwise, and the slops thrown into public or private gutters, or on the ground. As far as examined most of these cesspits are very imperfectly constructed, and allow of the absorption of the liquid portion of their contents by the surrounding earth; and they seem to be emptied at very uncertain intervals.

Street gutters.

7. In direct contravention of Clauses 180 and 241 of "The Police Act" (29 Victoria, No. 10), and of Clause 116 of "The Public Health Act," kitchen and chamber slops are allowed to run into the side gutters of the public streets, where such exist and are available. But it is only in part of the city that there are paved gutters, and in only a very small proportion of that part are they in a good condition. Where they exist these gutters convey the sewage exposed to sun and air either directly into some watercourse, or into a sewer communicating with one, and in either case it flows ultimately into the estuary of the Derwent. In its passage along these open gutters in a shallow, intermittent stream, it is precisely in the condition most favourable to the development and giving-off of unpleasant and noxious emanations. Part of it is partially dried, and remains in the joints and holes of the gutter-beds, or is glued to the borders by the coagulated grease of the kitchen washings, and becomes still more noisome. In some cases these gutters are open sewers of several hundred yards in length, receiving foul water from every house they pass, and consequently becoming more and more offensive as they go, until in the lower part of their course they are a continual source of stench and danger. They are swept out at varying intervals of time by the scavengers employed by the Corporation. From the daily return-sheets, kindly lent to me by His Worship the Mayor, it appears that the present staff of scavengers sweep and cleanse about a mile and a half of streets a day, having two and a half miles of gutter. As the greater part of these gutters are so ill-paved, the long intervals which these returns show to occur between their cleansings necessarily make their condition very unwholesome.

Houses that cannot use the gutters.

8. Moreover, in many parts of the city where streets are made and gutters paved, the conformation of the ground is such that the back parts and yards of the houses are lower than the streets, and consequently the house sewage cannot run into the gutters. In such circumstances, in places where the premises abut upon a natural watercourse, this watercourse is made the common sewer; but in most other parts the sewage has to find its own way into a watercourse, however distant, or lose itself in the sodden ground.

In unmade streets.

9. This condition of things is still more prevalent in the parts where the streets are not made. Their surface and that of the neighbouring land becomes a swamp from the continual discharge of house sewage endeavouring, and usually vainly, to find some outlet. Under such circumstances it is not surprising that considerable areas in various parts of the city have become saturated with sewage. It lodges in every hollow, even on steep hill-sides, forming little stagnant pools, and the whole surface becomes a sort of fermenting-bed for filth.

Dry refuse.

10. In a portion of the central districts of the city the house sweepings and dry refuse are removed by the scavengering department, under special rates and regulations. But the smaller classes of houses are almost entirely unprovided with proper dustbins. In reply to the question, "Where do you put your ashes and dust?" the answer is usually "Wherever we can." And to "What do you do with animal and vegetable refuse from cooking?" the answer is often, "Oh! a woman lives there who keeps a cow," or "who keeps a pig, and we give it to her." Or, in places where there are no such conveniences, the fish offal and cabbage leaves lying in the neighbouring streets, lanes, and yards show that they are thrown with the ashes—"Wherever we can."

Unsatisfactory condition, and proposals for amelioration.

11. From the preceding description of the present arrangements for the removal of sewage and house refuse from Hobart, it is evident that the existing state of things is not satisfactory. In making recommendations for ameliorating it, it will be convenient at first to consider separately the removal of the different kinds of matter that have to be treated, such as—(1) House slops, (2) Fæcal matter, (3) Ashes and dry refuse.

House slops.

12. *House Slops.*—It is impossible to prevent the admixture of chamber slops with those of the kitchen and wash-house; consequently, house slops rapidly become offensive when exposed to sun and air. Therefore, any open channels that may be made for their conveyance ought to be very carefully constructed so as not to retain any of the matter; and ought moreover to be frequently and thoroughly cleansed. These are two absolutely indispensable conditions to any open air system of drainage.

Outlay for gutters, &c.

13. This system cannot be applied to the whole of Hobart, the conformation of the ground (as before remarked) preventing it. But to apply it where possible it would be

necessary to provide proper gutters to all streets that have none. The greater part of the made thoroughfares have only pebble-paved gutters, and many streets are altogether unmade. At present there are not more than 10 miles in length of good gutters, so that at least 50 miles more would have to be made altogether or in part, costing at least, on an average, £176 a mile, = £8800. The sewers necessary to take the sewage from the gutters to existing sewers or watercourses would augment this sum to at least £12,000. The sewers from houses that could not drain into the gutters would cost more than another £8000; making a total outlay of at least £20,000.

Cost of cleansing.

14. These open gutters would have to be cleansed at least once a day, and in some places even that frequency would not prevent all nuisance. The present staff of scavengers cost, including proportion of cost of superintendence and general expenses, about £2000 a year. They sweep (as before mentioned) about a mile and a half of streets a day, and the gutter-cleansing seems the principal part of this work. This gives over £4 a mile as the cost of the work at present. But if the gutter-cleansing part of this scavenging cost only one-eighth part of this for each mile of street, the yearly charge would be over £5500 for a daily cleansing.

Total annual cost.

15. Consequently, the yearly cost of taking away the house slops by means of open gutters, where practicable, supplemented by underground drains where necessary, would be:—

	£
Interest on cost of works as above, £20,000 at 4 per cent. ..	800
Repairs on above at 5 per cent.....	1000
Cost of cleansing (exclusive of water)	5500
Total yearly cost (exclusive of water)	£7300

And the work done at this cost would be by no means satisfactory. In hot weather the gutters would become offensive in spite of frequent cleansing; and the various rivulets passing through the city would remain what they are,—open sewers, constantly needing cleansing, and very costly to cleanse.

Underground drainage.

16. The only other practicable way of taking away the house slops is by underground drainage. The conformation of the ground on which the city stands makes this easy, for it is such that in no part is "deep" drainage necessary. In almost every street the only depth necessary is that which will protect the crown of the culvert from injury,—say two feet. Consequently, no city of its size can be more economically drained than Hobart.

Disposal of the sewage.

17. As to the disposal of the sewage, it is evident, from the position of the city and the levels of the lower and more thickly-peopled streets, comparatively to those of any suitable land in the neighbourhood, that all systems of irrigation are practically excluded from consideration; for, supposing that at the old racecourse at New Town, or some other site as near to Hobart, a sufficient quantity (at least 200 acres) of land suitable for irrigation by sewage could be procured, the cost of the land in purchase-money, deep drainage, levelling, and other works necessary, would amount, at £100 an acre, to £20,000
The cast-iron pumping main, say three miles of 15-in. pipe at £2200 6600
Engines, pumps, buildings, and reservoirs, say..... 3400

TOTAL £30,000

The interest on this outlay at 4 per cent. would be....	£1200
The cost of repairs and maintenance on cost of works, say £20,000 at 5 per cent.....	1000
Pumping expenses, fuel, wages, &c.....	600
TOTAL	£2800 a year.

This would burden the 200 acres of land with an annual charge of £14 an acre, independently of the cost of cultivation, &c., and, consequently, no such outlay could be recommended: for no farmer would take the land at such a rent, hampered with the condition that he must every day receive and pass over it all the sewage sent, whether the land required it or not; and the most sewage would be sent in very wet weather when the land least needed irrigation. The sewage must, therefore, as at present, flow into the estuary of the Derwent. And it can do so harmlessly, provided that the outfalls be constructed subject to the conditions hereinafter laid down.

Plan.

18. In order to properly lay out a system of sewerage, a large scale, detailed plan of the city is absolutely necessary. There is no such plan. The accompanying small scale plan is only intended to give a general idea of the work recommended to be done, and to furnish some practical data upon which an estimate of the cost may be founded. In all probability the information that a detailed plan, showing all the buildings, will give, will necessitate the altering of the course of some of the sewers marked, especially those near the Hobart Rivulet; but this will not greatly affect the cost of the work.

Sewage only provided for.

19. The system of sewerage laid down is based upon the idea that only house-sewage will have to be conveyed, together with such rain-water as cannot conveniently be separated from it,—for instance, such as falls in paved court-yards,—all street water being conveyed away by the existing channels. This separation is very necessary for several reasons: first, if storm-water has all to be provided for, the sizes of the sewers and, consequently, their cost must be enormously increased; and secondly, street gratings allow large quantities of sand and road *detritus* to pass into the sewers, and, where these sewers have a great fall, the rushing down of this *detritus* quickly destroys their efficiency by wearing away the glazed lining of the pipes or smooth surface of the bricks of which they are constructed. To prevent this, where road drainage must be provided for, and where gradients are steep, costly works in the shape of frequent catch-pits and man-holes have to be made. Again, the exclusion, as far as practicable, of rain-water from the sewers will make the quantity of sewage to be dealt with much more manageable and much less costly to treat should it hereafter be found desirable to adopt any system of purification or manurial fabrication. And lastly, it is the heavy road *detritus* that, at the outfalls, settles at once to the bottom and forms shoals that have to be removed.

Advocates of separation.

20. This separation of the rainfall from the sewage is advocated by Rawlinson, Hawkesley, Bazalgette, Bailey-Denton, Dr. B. S. Richardson, and all the leading sanitarians of the day; and the Royal Commissioners (1884) on Metropolitan Sewage Discharge fully adopt this view.

Dr. Taylor's Report.

21. Here in Hobart, where the rain storms are often tropical in their violence, the remarks of Dr. Taylor, of Brisbane, who was employed in 1884-5 by the Queensland Government to enquire and report upon "the best system of sanitation, and particularly as to the disposal of sewage" in England, are quite applicable (*see* his Report, p. 31). This Report, containing the results of a careful examination by a singularly intelligent and capable observer of the systems adopted in the principal towns in England, is a very valuable document, and may be said to contain the last expression of the matured opinions of the most experienced sanitarians of the age.

Rivulets.

22. This separation of the sewage from the rainfall will restore to their natural purity the various rivulets and water-courses running through the city. And steps ought to be taken, by the enactment and enforcement of by-laws and otherwise to preserve this purity, and prevent the fouling of the beds of the streams by the throwing in of house and garden refuse.

Drainage basins of the city.

23. The surface of the city is naturally divided into four larger and two smaller drainage areas, which would require, unless expensive works were undertaken, two principal and two subsidiary outfalls.

(*a*) The district draining into the Domain rivulet, containing about 700 houses, and an area of 200 acres; and its boundaries may be said to be Park-street on one side, and on the other an imaginary line running from the city boundary down between Elizabeth and Argyle streets as far as Brisbane-street, and thence down Campbell-street.

(*b*) The district draining into rivulets from Knocklofty, joining the Hobart Rivulet at Elizabeth-street, contains about 1200 houses, and an area of 350 acres. It extends from the preceding one to an imaginary line running from Poet's-road to a point in Barrack-street half-way between Brisbane and Patrick streets, and thence to the bridge in Murray-street.

(*c*) The district draining into the Hobart Rivulet (including the Upper Goulburn-street watercourse) contains about 1400 houses, and an area of 400 acres. It extends from the preceding one to a line passing from the boundary down Davey-street to Barrack-street, and thence down Macquarie-street.

These three districts would have a common outfall.

(*d*) The surface draining into the St. David's Cemetery watercourse, together with such part of the surface draining into the Wellington or Sandy Bay Rivulet as could be easily diverted into a common outfall at Battery Point, contains about 1000 houses, and an area of 250 acres. This district extends from the

preceding to an imaginary line passing south-east of Davey-street along Garden-crescent, Fitzroy-place, Albuera-street, St. George's-terrace, Colville-street, and Mona-street.

(*e*) The remainder of the city area, draining into the Wellington Rivulet, contains about 170 houses, and a superficies of about 50 acres, and extends from the preceding district to the above-named rivulet, and would require a separate outfall.

(*f*) The small basin draining towards the lower part of Napoleon-street contains about 70 houses, on an area of 20 acres. This district should have a separate outfall.

Outfalls.

24. In arranging the outfalls two important considerations have to be borne in mind. The first and more important is, that the sewage should be carried into the estuary at places where it will cause the least nuisance, and have the least effect upon the harbour; and the other is, that the outfall sewers should offer facilities for carrying out any system of sewage treatment for commercial or agricultural purposes that may hereafter be found desirable. These conditions are well fulfilled by the positions assigned to the principal outfalls on the accompanying plan.

Provision for increase of city.

25. In laying out a system of sewerage provision ought to be made for more than the immediate wants of the present population; therefore the calculations upon which the sizes of the sewers have been determined are based on the assumption that the population to be provided for is double the existing one. This may be thought to be an excessive provision to make, but it is purposely done, partly to provide for the extension of area hereinafter advocated, and partly to overrate rather than underrate the outlay to be made. So it is to be borne in mind that the main sewers from each of the above-described districts are calculated to convey the sewage from about double the number of houses at present standing in each respectively.

Quantity of sewage.

26. The quantity of sewage is always about equal to the water supply. In Hobart there are on an average 5·08 persons in each house. Therefore, if the water supply be 65 gallons a head, the daily quantity of sewage from each house will be 330 gallons, equal to 13·75 gallons an hour. But as the quantity of sewage varies greatly in different parts of the 24 hours,—one-seventh of the whole quantity sometimes passing in one hour,—provision must be made for this maximum flow of, say, 50 gallons an hour from each house.

Quantity of rainfall to be provided for.

27. As previously mentioned, it will be impracticable to separate all rain-water from the sewage. It has therefore been assumed that in connection with each house there is a paved or roofed area of 100 square yards, the rainfall upon which has to be taken away by the sewers, and that this rainfall may amount to two inches a day, or about 1000 gallons on the area mentioned. The flow of this would evidently be irregular also, as in exceptionally violent thunderstorms it might all fall in an hour. It would be manifest folly to provide for such an exceptional hourly flow, as the sewers would have to have twenty times their carrying capacity, and cost ten times more, to meet an emergency that might not happen twenty times in a century. Fifty gallons an hour of rain-water is equal to the highest allowance usually made. Sir J. Bazalgette, in the drainage of London, has only allowed for $\frac{1}{4}$ of an inch in twenty-four hours. Captain Galton provides for $\frac{1}{20}$ of an inch in an hour. Mr. Hawkesley, in his Birmingham sewerage scheme, provides for a maximum flow of 25 gallons of rain-water from each house, and remarks, "beyond this all rainflows may be considered as storm waters, and as such to have become wholly unmanageable by any available system of works and appliances." Besides the provision made for a large regular flow of rain-water, the numerous flushing-pits hereinafter referred to would, by acting as overflows, afford great relief to the sewers in exceptional weather.

Total sewage.

28. With a maximum flow of 50 gallons an hour of sewage, and of another 50 gallons of rain-water, the carrying capacity of the sewers will have to be 100 gallons an hour from each house.

Outfall at Macquarie Point.

29. The common outfall sewer for the above-described districts *a*, *b*, and *c* would have to carry the sewage of more than three-fourths of the houses in the city, or about 3300. As there is still much unoccupied land in these districts, and suburbs behind them, provision is made for 7500 houses, with a maximum outflow of 750,000 gallons an hour. With the fall that could be obtained, this would require a brick sewer 3ft. 6in. × 2ft. 8in. The natural outlet would be that of the Hobart Rivulet, but as this opens into the harbour at a place out of the direct flow of the river and tide, the outfall sewer is turned aside and continued to Macquarie Point, where the sewage would be delivered into the tideway. Along this part of the sewer the vacant ground between the slaughter yards and rifle

butts might be made available, without interfering with the rifle range, for any works that might hereafter be erected for the treatment of sewage. As two such public establishments as the slaughter yards and gas works already exist in this neighbourhood no objection could be taken to the addition of properly-constructed sewage works should they ever be required.

Main sewers districts, *(a)*, *(b)*, and *(c)*.

30. The 3ft. 6in. × 2ft. 8in. outfall sewer would be carried up to the junction of Collins and Park streets, where the main sewer from the Domain Rivulet district (*a*) would enter it. This main sewer would be 2ft. 8in. × 2ft. in its lower part, and a 2ft. barrel-culvert in its upper part. The outfall sewer would be 3ft. × 2ft. 3in. from the above junction to Elizabeth-street, where the two main drains from districts (*b*) and (*c*) would enter it. These main drains would be similar to the one above mentioned. All these, together with the sizes and lines of the subsidiary sewers, are marked on the accompanying plan.

District *(d)*, Battery Point, outfall.

31. The Davey-street and St. George's district (*d*) would be drained by a culvert 2ft. 8in. × 2ft., having an outfall at the extremity of Battery Point so as to be in the tideway. The site of the old smelting works, which it traverses, would furnish room for sewage works if necessary. Provision is made for draining 2000 houses—double the existing number in the district. The subsidiary sewers are shown on the plan.

Districts *(e)* and *(f)*.

32. The plans also show the arrangements for draining the small districts (*e*) and (*f*), and provision has been made for any extension likely to occur. As these drain into Sandy Bay, and out of the direct tideway, they had better for the present be kept separate, as less likely to be offensive. There are existing outlets of sewage where the outfalls are proposed, so that no new nuisance will be created. But as the Wellington Rivulet outfall is so near the new fish-culture establishment and the Sandy Bay baths, an additional reason is given for the incorporation of the suburbs hereinafter advocated, as in connection with the sewerage of Sandy Bay it would be possible to cut off the greater part of the sewage of district (*e*) and deliver it, together with that of all Sandy Bay, into the tideway southwards.

Outfall arrangements: tidal action.

33. At the respective outfalls arrangements would be made for discharging when necessary at all states of the tide. Thus, if desirable, the sewage could be discharged at about half ebb so as to insure its being carried out of Sullivan's Cove and Sandy Bay. This, however, would only be necessary at the Battery Point outfall, and even there, the Harbour Master tells me, it is only at exceptionally high tides that the flood sweeps round into the Cove. According to the Admiralty chart, the half ebb runs down at $1\frac{1}{2}$ knots an hour opposite Macquarie Point, while opposite Battery Point the half flood flows up at $\frac{3}{4}$ of a knot only. The Harbour Master thinks this latter rate overstated, as there is usually only flood enough to counteract the downward flow of the river. However that may be, it is evident that there is opposite Hobart an almost continuous downward current carrying water out to sea, and that this so greatly exceeds any occasional upward flow of tide as to remove any danger that sewage matter would be kept floating up and down opposite Hobart. (In connection with this point see also the subsequent § 47 of this report.) In this respect Hobart differs from many other towns on tidal rivers,—Brisbane, for instance. In dry weather the Brisbane River is not appreciably affected by the downward current of fresh water from a comparatively limited catch-water basin with a small rainfall. The upward flow of the tide is apparently as strong as the downward ebb. Consequently the Brisbane at the city has the character rather of a landlocked arm of the sea than of a river, and sewage flowing into it would float up and down until some strong freshet carried it away, and in the dry season this might not occur for months. The effect of this in a sub-tropical climate may be imagined. At Sydney also, the Admiralty charts show that the upward flow of the tide is equal to the downward ebb, so that in position it resembles Brisbane ; therefore the consequences of the discharge of sewage at both places can never follow at Hobart. There is still less resemblance between the conditions under which this discharge will take place here and in the oft-quoted River Lea. The River Lea is a small sluggish stream draining part of Hertfordshire and Middlesex. The lower part of it is canalized, and from the upper part of it the main supply of the East London Waterworks Company is taken. The Company take all the water except what they are forced to leave for working the navigation. The water thus left is to all intents stagnant, like that of all other navigable canals,—the only current being that caused by the use of the locks. And as the river and canal receive the sewage of all the chief towns of Hertfordshire, and of much of London itself, it may be said that the whole affair at the London end is but a common sewer used as a canal, as the quantity of sewage it receives from a population of more than 20 times that of Hobart is there its main water supply. A population of 200 millions draining into the Derwent would not render it so noisome as the Lea, even supposing the former to be as stagnant as the latter. Consequently the case of the Lea is not one in point.

34. All along the line of sewers provision is made for numerous manholes for inspecting and ventilating the sewers, and for additional special ventilating shafts for carrying off any foul air through charcoal filters. Advantage would be taken of every place at which a rivulet had to be crossed to construct flushing pits, one of which would also be constructed at the head of every principal line of sewer. The requisite junctions for all house drains are also provided. Manholes, ventilators, flushing-pits, &c.

35. The following are the various sizes and descriptions of sewers marked on the plan :— Description of sewers.

No. 1.	Egg-shaped brick culvert	3ft. 6in. by 2ft. 8in.
No. 2.	Ditto ditto	3ft. 0in. by 2ft. 3in.
No. 3.	Ditto ditto	2ft. 8in. by 2ft. 0in.
No. 4.	Brick barrel culvert	2ft. 0in. in diameter.
No. 5.	Ditto, or glazed socket-pipe..	1ft. 6in. ditto.
No. 6.	Ditto ditto	1ft. 3in. ditto.
No. 7.	Glazed socket-pipe.....	1ft. 0in. ditto.
No. 8.	Ditto	0ft. 9in. ditto.

36. In the following estimates of the lengths of the sewers the next highest round number to the quantity actually measured is taken. The prices are based, as before-mentioned, on the current schedules of the Works Department :— Estimated cost.

	£	*s.*	*d*
900 yards of No. 1 sewer, at 42*s*.....	1890	0	0
700 yards of No. 2 sewer, at 36*s*. 6*d*.....	1277	10	0
2600 yards of No. 3 sewer, at 21*s*.....	2730	0	0
5000 yards of No. 4 sewer, at 20*s*.....	5000	0	0
4500 yards of No. 5 sewer, at 16*s*.	3600	0	0
11,000 yards of No 6 sewer, at 14*s*. 6*d*.....	7975	0	0
17,000 yards of No. 7 sewer, at 12*s*. 6*d*.	10,625	0	0
30,000 yards of No. 8 sewer, at 10*s*.....	15,000	0	0
350 manholes (extra) at 200*s*.	3500	0	0
15 crossings of rivulets, at 600*s*.	450	0	0
20 flushing-pits, at 400*s*.	400	0	0
100 ventilating connections, at 200*s*.	1000	0	0
5000 junctions of house-drains, at 5*s*.	1250	0	0
Extra work at outlets	1000	0	0
Contingencies (over 7½ per cent.) ..	4302	10	0
Total.....	£60,000	0	0

In these quantities it is assumed that none of the existing sewers could be utilised for house sewage. If examination showed that they could be used, the above estimate would be diminished. In checking the prices it must be remembered that all the works are at very shallow depths.

37. The yearly cost of carrying out this system of removing house slops would be as follows :— Yearly cost, absolutely and comparatively.

	£
Interest on cost of works, £60,000 at 4 per cent.	2400
Maintenance and repairs, at 5 per cent.	3000
Total	5400

The yearly cost of removing these slops by open gutters was shown (§ 15) to be, at a very low estimate, £7300. The underground drainage system would therefore cost £1900 a year less,—a saving sufficient to pay off the capital amount of £60,000 in 22 years.

38. II.—*Fæcal Matter.*—The removal of this matter has now to be dealt with. As before mentioned (§ 6), about 600 houses in the city are provided with movable pans, which are periodically emptied by the night-soil men employed by the Corporation. A specific charge of 6*s*. 6*d*. a quarter is made for each pan emptied once a week, and 3*s*. 6*d*. a quarter for each one emptied once a fortnight. The house-owners or occupiers provide the pans, which are not in duplicate, and so cannot be removed from the premises to be properly cleansed. At present they are emptied into a soil-cart, scraped out, and replaced. Some time after this emptying the pans are often more offensive even than when full, as the scraping exposes a greater surface to evaporation—to the giving-off of unwholesome Fæcal matter: Pan system of removal.

smells. If this system is to be continued the Corporation will find itself obliged to provide proper pans with airtight lids, in sufficient number to allow them to be removed to the manure depôt to be emptied and properly cleansed, the ones taken away being replaced by clean ones at the time of removal. It is evident that in such a system the receptacles ought to belong to the Corporation. Even then an infinite amount of trouble and expense would have to be incurred in providing duplicate pans for every house, and in keeping them separate and in a proper state of repair. And it is equally evident that this interchange of pans would necessitate the adoption of the most complete and effectual system of cleansing, and disinfection, and separation, as otherwise the pan coming from an infected house might carry disease into a clean one. And it will be found that "complete and effectual system" means "expensive system." As Dr. Trench, the Liverpool Medical Officer of Health, says:—It would be absolutely necessary to have "two receptacles to each house, one to use and one to clean. But it may be said that there is no necessity to return always the same utensil. Then my answer is, that the disgust, the fear, the panic, during epidemics of small-pox, of scarlatina, or of Asiatic cholera, that infection would be brought to one's home by these means, would soon control all municipal authority, and upset the whole scheme."—*(First Report of the Rivers' Pollution Commission.)*

Disposal.

39. The contents of the pans are carted to farms at New Town and Sandy Bay, and used as manure without being disinfected. It need hardly be pointed out that this mode of disposal does not get rid of nor destroy the specific poison—whatever it may be—of any disease that may be prevalent: bacilli having been found as vital as ever in the ground where eleven years before the body containing the germs had been buried.—(See Dr. Taylor's Report above referred to, pp. 12 and 13).

40. The £1 6*s.* a year charged for the weekly emptying of each pan does not, the Inspector says, do more than barely pay wages and horse hire. If to this be added interest on the cost of plant, cost of cleansing and disinfecting, repairs and proportion of cost of general superintendence, &c., the yearly charge will amount to at least £2 a house, being a total charge of £9000 a year for the whole city. If any attempt be made to manufacture manure from the matter thus collected, more or less expensive works will have to be erected, with a very uncertain prospect of remuneration. If in England, with its high and exhaustive system of farming, well-worn soil, and cheap transit, no large town can make manure fabrication profitable, it is hardly likely to be so in a comparatively new and undeveloped country like Tasmania.

Other systems—

41. There are various other well-known systems advocated for the removal of fæcal matter from houses.

Manchester.

The Manchester system consists in the reception of fæcal matter into pails that can be closed with airtight coverings, for removal and manufacture of the contents into manure, &c.

Rochdale.

The Rochdale system is thus described by its patentee:—"Beneath each closet-seat a receptacle containing a small quantity of a chemical disinfecting fluid is placed, in which the fæces and urine are collected, the vessels being removed in a covered cart in the daytime to a manure manufactory, weekly or more frequently if required, an important feature of the process being a retardation of fermentation of the excreta, so as to prevent it from fouling the atmosphere and being depreciated in value as a manure, which is effected by frequent removal of the receptacles prepared as above stated."

Salford.

In the Salford system the receptacles are lined with compressed ashes or other cheap absorbent material. This is called after the patentee, the *Goux* system.

Dry earth system.

In the Dry Earth system the fæcal matter is received into movable pails, and covered with dry earth every time the closet is used. To deodorize the drier part of the excreta 1½ lbs. a day of dry earth is needed for each head of the population, and four times that quantity if all the excreta are to be deodorized. The earth must be quite dry and carefully used, or the above quantities will be exceeded. Damp earth is worse than useless—it adds to the offensiveness. But the earth used may, if properly redried, serve two or three times before its deodorizing power is lost. This system has always proved impracticable in large town communities. The Sewage Committee of Birmingham say in their report—"It is obvious that any system of this kind, though it might be advantageously used in a village, or at particular places under favourable local conditions, would be impracticable in large towns. The quantity of earth required, the difficulty of procuring it, the expense of bringing it to the houses of the inhabitants and of removing it, the sifting and drying required, the care required in keeping the earth dry and throwing it over each stool in sufficient quantity but without excess, with the fact that the system would be chiefly used by the least careful class,—all these difficulties would render its success absolutely hopeless." And Professor Parkes says:—"For workhouses, prisons, barracks in country places, where there is plenty of labour, and no difficulty in obtaining and afterwards disposing of the earth, the plan is most perfect; so also for some villages

if some central authority arranges for the supply of earth and removal of the used soil." The same remarks apply to systems in which the dry earth is replaced by charcoal or specially-prepared chemical deodorizers."

Pail systems only take part of the fæcal matter.

42. A vital objection to all these "conservancy" systems is that they treat only a small part of the excreta, while the greater part—at least three-fourths—is, perforce, allowed to contaminate the ground, poison the watercourses, or pass into the sewers. Miss Nightingale asks:—"Is it not simply a matter of common knowledge that the dry-earth system makes little difference in the amount of dangerous impurity contained in the fluid sewage of a station or town?" (Progress Report, p. 43.) Even at Rochdale, where the best of the systems, as regards adaptability to a town community, is thoroughly carried out under the direction of its patentee, an alderman of the borough, his own reports show this to be the case. Sir R. Rawlinson says, in his evidence before the Royal Commission (1884) on the Metropolitan Sewage Discharge:—"Mr. Alderman Taylor, in a recent return, 1876, set forth that a population of 52,000 in Rochdale is supplied with 5644 pails, from which in the year 1875 was collected 5398 tons of excreta. This gives about 9·2 persons, and 19·1 cwt. of excreta to each tub. The excreta of one person on an average of an entire population is 2½ lbs. per day or 8·1 cwts. per year; which, taking 9·2 persons to each tub, gives 74·52 cwts., or 3 tons 14½ cwts. per pail; 5644 pails, at 3 tons 14½ cwts. per pail, gives 21.624 tons as the weight due, if the pails are used by the population to which the statement apportions them; so that about one-fourth of the excreta of the 52,000 persons is alone accounted for." It is, therefore, not surprising that the Corporations of Rochdale and Birmingham, where the pail system is also in use, have been restrained by injunction from polluting the rivers that respectively flow through the towns; and that Manchester is being similarly pressed by the Local Government Board. And as to the sewage from such towns, the Committee of the British Association say that it is "more difficult to deal with than the sewage from a water-closet town; yet its purification is just as imperatively necessary." And the Rivers Pollution Commission say, in their first report, "not only that it is but a part of the excrementitious matter which is dealt with, but that even as regards that portion of the excrement which they do remove they so entirely depend upon efficient cleanly superintendence and direction that, wherever they have had merely the average man to work them, they have failed. Moreover, this very frequent collection of filth by hand from houses and its removal, sometimes through the cottages themselves, almost necessarily under the eye and nose of the household, whatever may be the importance of the economic object aimed at, is universally condemned by our domestic habits as nasty and offensive. They can never be an entire success, and, in competition with the water-closet, a jury of average householders will certainly condemn them for lack of cleanliness and comfort."

Liernur's system.

43. There are other systems for collecting fæcal matter, of which one of the best known is Captain Liernur's. It is thus worked:—The privies of a number of houses are connected by means of small iron pipes and valves with a central reservoir under the street. The valves are so arranged that the communication with each privy can be opened or closed at will. The central reservoirs are of strong boiler-plate iron and air-tight, so as to resist the atmospheric pressure under which the system is worked. When the privies are to be emptied an engine working an air-pump is brought to the central reservoir, together with an air-tight night-soil cart. The central reservoir is exhausted of air, and then the privy valves are opened and the fæcal matter is sent into the reservoir by the pressure of the atmosphere. The valves are then closed, air sent into the reservoir and exhausted from the cart. Communication between the cart and reservoir is then opened and, consequently, the contents of the latter are discharged into the former.

Paris atmospheric system.

In the atmospheric system partially adopted in Paris, each house has an air-tight cesspool to receive all the water-closet discharge. Large air-tight cisterns, like steam-boilers mounted on wheels, are exhausted of air at the central works by a fixed steam engine, and are taken at night to the cesspools to be emptied. A strong hose-pipe connected with the exhausted cistern is screwed to a stand-pipe that reaches to the bottom of the cesspool. When communication is opened the contents of the cesspool are driven by the atmospheric pressure into the cistern; and this when full is taken to the extra-mural manure works.

A great disadvantage of these systems is that the reservoirs or cesspools cannot be properly cleaned, and so, after emptying, gases are generated that escape into the houses. They are, however, pretty frequently used on the continent of Europe, but not, as far as my knowledge goes, introduced into England. In common with all other separative systems, these atmospheric ones have the great drawback of the employment of the soil-cart, "making night hideous" with its continual visits. As Professor Corfield says:—"We know what air-tight carts filled by "pneumatic pressure" are in continental towns, and have no desire to see their disgusting nocturnal processions in London or

anywhere else." Without entering into calculations, it is evident enough, from the above descriptions of atmospheric apparatus, that such contrivances would be too costly for adoption in Hobart.

Disposal not worth while describing.

44. As none of these systems of collecting fæcal matter by itself are satisfactory, it is not worth while to describe any of the numerous methods of disposing of it after collection, nor to enter into the question of manufacturing it into manure, or into that of its value.

To what the question is thus reduced.

45. Before proceeding further, it will be useful to shortly state the position at which, by all these considerations, we have arrived in respect to the sewage question of Hobart. It is this: First, that at present all the house slops, and three-quarters of the excreta of the population, do, or ought to, flow directly or indirectly into the estuary of the Derwent; secondly, that this will continue to be the case even if the Rochdale or any other "pail" system be adopted; thirdly, that it is cheaper and better to convey this sewage by underground drains than by open gutters; fourthly, that what remains to be settled relates only to the fourth part of the excreta,—the portion usually taken by "pails."

Quantity to be removed.

46. Taking the ordinary average daily quantity of these excreta at $2\frac{1}{2}$ lbs. a head of the population, this remaining fourth part will be 10 ozs. a head daily, of which $2\frac{1}{2}$ ozs. are solid and $7\frac{1}{2}$ ozs. liquid. The daily quantity, therefore, for the present population of the city will be $6\frac{1}{2}$ tons, of which $1\frac{3}{5}$ tons are solid, and the remaining $4\frac{4}{5}$ tons liquid. If this matter be turned into the sewers it will be there mixed with the rest of the sewage, which will amount, in dry weather when no rain-water is passing, to 65 gallons a head of the population, or a daily quantity of 7386 tons; so that the dilution of the solid fæcal matter will be equal to one part of it in 4400 parts of water. The average quantity of solid matter of all sorts left by sewage after evaporation is 100 grains to the gallon. With so large a water supply, Hobart sewage would certainly not exceed this. At this rate the total daily quantity of sewage would contain 10·35 tons of solid matter, or one part in 700 of sewage water. And this would be the rate of dilution before discharge and in dry weather. In wet weather the dilution would of course be much greater.

Conditions of discharge.

47. Another point in connection with this matter has to be considered. The above given rate of dilution of the sewage is that in the sewers before discharge: what will be its condition after discharge? The accompanying plan shows that it is to be sent into the tideway of the estuary. The capacity of the basin of the estuary in front of Hobart and between the outfalls is at least 60,000,000 (sixty million) tons. This quantity of water is in continual motion from the action of wind and tide and the downward current of the river. This downward current is caused by the flow of the drainage from about 3,000,000 acres of land,—a flow equal to a daily average of 15,000,000 (fifteen million) tons of fresh water, being seven times that in the Thames at London. It is evident that the action of this downward current and of the tides must change a great part of the water in this portion of the estuary every day. What would be the effect of turning $1\frac{3}{5}$ tons of solid fæcal matter in the above-described weak solution into this immense body of continually moving and continually renovated water? It would certainly not be appreciable. Water is considered pure and wholesome for drinking purposes when it does not contain more than one part in 4,000,000 (four million) of combined nitrogen. But the estuary water cannot be used for drinking, and even if it could, the sewage would not add to its combined nitrogen one part in 40 millions. I have, therefore, no hesitation in recommending that this part of the sewage should be treated as the rest, and together with it be conveyed by the sewers into the tideway of the estuary.

Liverpool similarly situated to Hobart.

48. The position of Liverpool is very similar to that of Hobart: it is also situated upon a tidal estuary. But the population of Liverpool is more than 26 (twenty-six) times that of Hobart, and the area of land forming the drainage basin of the Mersey is not half that of the drainage basin of the Derwent, so that the mean outflow of the former cannot be more than half that of the latter. Moreover, the Mersey is already polluted above Liverpool with the sewage of more than 2,000,000 (two million) people: the Derwent above Hobart does not receive that of 20,000 (twenty thousand.) Liverpool is now altogether a water-closet town, drained into sewers which discharge into the estuary; and notwithstanding all the above circumstances—so incomparably more adverse than those of Hobart—no inconvenience is felt either in regard to the public health, or to that other matter of vital importance to the second port of the world—its navigation. It is true that Liverpool ranks high in regard to its death-rate, but it is, excepting London, not only the most populous city in the United Kingdom, but the most thickly populated. Seven times more people are crowded upon each acre of its area than is the case in Hobart; and such overcrowding has had its inevitable result. But the sewerage works undertaken, and the compulsory introduction of water-closets,

have greatly reduced and are still reducing the death-rate. And not only so, but the action of the system, by raising the character of the occupiers of the lower class of tenementary property, has satisfied house-owners that the money expended in carrying it out has been profitably spent.

Quantity of water used in closets.

49. The quantity of water that is required for use in water-closets is often urged as an objection to their general adoption. But there are many ways of checking any wasteful use of water in them. If London, with a daily water supply of less than 30 gallons a head, (28·57), and Liverpool, with one of 25 gallons a head, be entirely served by water-closets, Hobart, with 65 gallons a head, ought to have no difficulty.

Other objections.

Liverpool trough closet.

50. But it is urged that as the poorer classes cannot be trusted with the proper use of earth-closets, their use of water-closets will be still more improper. Not only will there be a great waste of water, but a continual expense for clearing soil-pipes and drains into which all manner of filth and rubbish have been thrown. If an open privy be a bad thing, a stopped-up closet is a worse. The truth of all this has so long been known that proper remedies have been provided. One of the best, or the best, is the Liverpool trough closet, of which there is a sketch given on the plan. Its principal arrangements are these :—Under the seat there is a fixed trough with curved bottom always kept filled with water which acts as a stench-trap. In a small compartment adjoining the closet, closed by a door of which the scavenger keeps the key, there is the handle of the plug that shuts off the communication between the trough and the sewer. The scavenger comes once a day and draws the plug. The water in the trough is enough to flush out all the contents of it. The man has a short length of $\frac{3}{4}$-inch hose that he screws to the yard tap, and therewith washes off any filth that may remain. He then closes the plug, locks the little door, and refills the trough with water. Thus the users of the closet can neither empty nor fill it. The man's work is done in less time than it takes to write the description of it. This system has now worked admirably for years, and has stood the test of experience in places where not only the lowest class of the native population live, but where professional beggars, Neapolitan and Greek sailors, Malay Lascars, Chinese, and others not noted for cleanly habits in this respect "most do congregate." Dr. Buchanan and Mr. Radcliffe say : "Nothing could be more admirable than the working of the Liverpool arrangement; and nothing could be more marked than the difference between them and what are called water-closets in the poor neighbourhoods of London and other large towns." (Twelfth Report of the Medical Officers to the Privy Council). And, again, in the same Report : "Where these conditions (*i.e.*, that the management be undertaken by the Corporation scavengers) are observed as thoroughly as they are observed in parts of Liverpool, we believe that water-closets are the best means of removing excremental matters from the poor neighbourhoods of a town." This system works well at the State School in Launceston.

Absolute and comparative cost of working.

51. And this is not only the best, but it is the cheapest system known. In Manchester, with a population of under 400,000, the yearly cost of street sweeping and pail collecting is £87,000 (Dr. Taylor's Report, p. 30). In Liverpool, with a population of 660,000, the cost of scavenging and closet flushing is certainly not a third of this amount. My last return for Liverpool is for 1870, when, with a population of 493,000, the cost was £19,700; the proportional cost for a population of 660,000 would, therefore, be £26,400; whereas, if the cost were rateably as great as in Manchester, it would be £143,550 a year. The Liverpool system may, therefore, be said to save the town £117,000 a year when compared with that of Manchester. Of course, this latter city cannot help this, as it is not situated on a tidal estuary as Liverpool and Hobart are. It may also be mentioned that in Liverpool, before the introduction of the trough and other closets, the scavenging and night-soil department cost £41,866 a year, with a population not above half its present one.

Sewer gas.

52. A general objection against the conveyance of fæcal matter in underground drains may be summed up in two words,—"sewer gas." No doubt the admission of sewer gas into houses has been a source of disease. But its admission is not an inevitable consequence of underground drainage, but of badly constructed drains. So the objection is virtually not against the system, but against the manner in which it has sometimes been carried out. In no good system of drainage ought there to be any possibility of the escape of this gas into a house, for no direct uninterrupted communication between the houses and sewers ought to be allowed. The house-sink, bath, &c. ought not only to be properly trapped, but to drain only into the open side of the trapped grid in the yard through which the other slops are poured, so that if by any accident the trap should cease to act, the sewer emanations would escape into the open air and not into the houses. In like manner the soil-pipe should be interrupted on the sewer side of the D or S trap of the closet by a pipe carried up as high as practicable into the open air. This would not only ventilate the soil-pipe, but add to the flushing power of the water used.

Nuisance at outfall.

53. Another frequent objection is that underground sewers only carry off a nuisance from one place to present it in a greatly aggravated and more unmanageable form in another. It has been shown above that there is no danger that this would happen at Hobart.

Number of trough closets, and cost of emptying.

54. If trough closets be adopted where necessary, it may be anticipated that about 800 would be needed at present, and no alteration would be required in the sewers already described and estimated. The yearly cost of daily emptying in Liverpool is not 20 shillings each; and in Hobart should not exceed twice that sum, or £1600 a year. As the cost of constructing and maintaining the sewers has already been considered, this sum of £1600 a year is the total additional cost of removing the fæcal matter by water-carriage, as compared with £9000 a year for removing it in pails.

Opinion of experts.

55. There need, therefore, be no hesitation in recommending that all the sewage of Hobart be got rid of by water-carriage. This course is supported by an almost unanimous consensus of opinion among the sanitary authorities of the world. This opinion is thus summarised by Dr. Taylor in the Report I have already quoted, and in words that are directly applicable to the circumstances of Hobart:—

"*Removal of Excreta by Water.*—This, when it can be applied, is the cleanest, the readiest, the quickest, and, in many cases, the most inexpensive method. As channels must necessarily be made for the conveyance of the water used for baths and other domestic purposes, such as washing, cooking, &c., they can be used with little alteration for the removal of excreta also. But certain conditions are necessary in order to make this plan a success; for if proper precautions are not taken in the construction of sewers and drains, serious evils will inevitably result. If, on the contrary, proper attention be paid to the trapping, ventilation, and flushing of house-pipes, drains, and sewers, the most perfect immunity from sewer gas or other disagreeable emanations may be guaranteed."

And Dr. Taylor's own conclusions upon the matter, after all the systems that he has seen and examined, are:—"That, where practicable, all towns should be sewered on the separate system, and thoroughly water-closeted; all intercepting plans being more or less objectionable, because (*a*) the excrement is kept for a considerable time about the dwellings, where it is very likely to become a nuisance and injurious to health, instead of being at once removed, as by the water method; (*b*) the interception of the solid excreta does not materially affect the quality or quantity of the sewage to be disposed of from other sources. Birmingham is an example of this. The town is sewered; it contains 400,000 inhabitants, and was in the greatest difficulty how to dispose of its sewage until precipitation and filtration were adopted; yet the solid excreta of only 6 per cent. of the inhabitants passed into the sewers. So also with Manchester. Notwithstanding the costly works at Holt Town for the disposal of solid excreta, the disposal of the sewage still constitutes a difficulty which the local sanitary authority is called upon to meet; (*c*) the water method is more cleanly than any other for the removal of excreta, and is free from that offensiveness which to a certain extent is attached to all intercepting plans, no matter how carefully they may be carried out, and which must exercise an influence on the moral tendencies of the young; (*d*) the relative cost of the two systems is in favour of the water method."

Enlargement of boundaries of Hobart.

56. In connection with this part of the subject there is another recommendation to be made. Hobart is surrounded on three sides by suburbs that naturally drain, altogether or in part, into the same watercourses as drain the city. If the city removed all its own sewage from these channels, the work done would be in part useless, as the rivulets would still be polluted by the sewage of these suburbs. The Domain rivulet, for instance, would be as bad as ever so long as the Glebe Town houses drain into it. These suburbs are not large enough or wealthy enough to act for themselves efficiently in the matter of sewerage; and if they were, they could not (except in the case of Sandy Bay, for which other pressing reasons have been given) get to an outfall except through the city. They are already supplied with water by the Corporation of Hobart. Under the present Public Health Act it is difficult to establish efficient Local Boards of Health in them. For all these reasons it would be better that the boundaries of the City of Hobart should be enlarged so as to include the adjoining suburbs. The city would not then be too large to be well administered as one Municipality. The capital of the Colony would become more important, and many questions of local government would be more easily solved. An illustration of the inconvenience and complication of the existing state of things has just been furnished. A gentleman residing in Park-street writes to the President, under date 10th June, 1886, enclosing a copy of his complaint to the Local Board of Health of Hobart, of the condition of the stagnant open drain opposite Chatsworth Terrace. This nuisance exists on the territory of the Hobart Local Board, but is caused by the houses standing on the territory of the Glebe Town Local Board. Now, if the Hobart Board obtained an injunction under Section

106 of "The Public Health Act" to compel the Glebe Town Board or the owners of the houses to abate this nuisance, the injunction could not be carried out if the houses are to be inhabited, unless the Hobart Board allowed the other to make a drain across part of the city territory into a rivulet that runs altogether on this latter territory,—a course of action that would result in augmenting the nuisance all down the rivulet, to the detriment of the Hobart ratepayers who live along it, for the purpose of aiding the ratepayers of a "foreign" district. The Glebe Town district must drain into this rivulet or the main sewer parallel to it, and consequently it ought to be under the control of the same authority as that to which the rivulet and main sewer belong.

Purification processes.

57. As it has been shown that there is no present necessity for going to the expense of treating the sewage of Hobart for the purpose of purifying it, there is no occasion to refer to any of the numerous processes that have to be adopted when the conditions of discharge are not so exceptionally favourable as they are here.

Ashes and dry refuse.

58. III.—*Ashes and Dry Refuse.*—The question of removing the drier parts of house refuse remains to be considered. Its frequent and proper removal is a matter of great importance from a sanitary point of view. As already mentioned, the city scavengers remove this refuse from certain houses in certain streets for a fixed sum paid in addition to the ordinary rates. The great disadvantage of a purely optional arrangement such as this is that it is sure to be most inoperative in the very places where it is most needed. The owners and occupiers of the poorer classes of houses will not add a voluntary rate to their other burthens, and so the refuse is thrown "where we can," or allowed to accumulate in localities where the confined accommodation and lack of conveniences makes it most necessary to frequently remove it.

Frequent removal should be compulsory.

59. Therefore the periodical removal of all dry refuse should be made part of the regular scavenging of the city; and the providing of proper receptacles by all owners or occupiers of houses made compulsory. The dust-bins should not be too large for two men to lift into the cart for emptying. They should be placed under cover, so as to keep the contents dry; and they should be emptied at least once a week. When this is made a regular part of the scavenger's duty it will cost proportionately less than at present, so that the whole amount paid by each house on the existing scale of charges would not have to be added to the city rates.

Reorganising Scavenging Department.

60. In connection with this subject it would be necessary to reorganise the City Scavenging Department. A daily scheme of work should be prepared in such wise as to insure that all the principal streets be swept at least twice a week, and all the other streets once a week. At present the foreman seems to exercise his own judgment as to the locality he will take his men to, and so proper supervision is impossible.

Disposal of refuse.

61. As to the disposal of street and house refuse it would not be difficult to divide it into certain categories for separate treatment. Mud from road-scraping ought to be kept to be used for "binding" on newly macadamized roads; clean ashes, if the brick-makers, &c. would not take them, might be used for filling up holes; and mixed ashes, garbage, slaughter-house and fish-market refuse, and other special offensive products from manufactories, &c., if they cannot be profitably sold as manure, ought to be burnt, or carried out to deep sea in hopper barges. As it may be indispensable to have means of perfectly consuming infected articles without danger to the public health, it would be better to at once provide such means for the disposal of all noxious refuse, especially as the method of sending it away by hopper barges requires careful supervision under circumstances in which supervision is difficult. The best known apparatus for destroying offensive matter by fire is that called Fryer's Destructor, patented by Manlove, Alliott & Co., which is reported to work well at Leeds and elsewhere. It is difficult to estimate what the cost would be of the machinery and appliances necessary for a city like Hobart, as the circumstances of each locality exercise great influence upon the outlay. But judging from the experience of the Leeds establishments, it is probable that the works here would cost about £3000, and that the yearly expenditure would be about £350. This would effectively get rid of all the offensive part of the refuse of the city.

Summary of recommendations for house sanitation.

62. The following is a summary of the recommendations made. First, in regard to house drainage:—

(*a*) On the completion of the sewerage every house ought to have water-closet accommodation of some description—not necessarily one closet to each house, and every cesspool ought to be emptied, disinfected, and filled up:

(*b*) Every opening from the house to the drain ought to be properly trapped and ventilated:

(*c*) Every communication between the house drains and sewers ought to be interrupted between the trap and the sewer in such wise that any sewer gas generated may escape into the open air and not into the houses:

(*d*) Trough closets ought to be emptied every day :
(*e*) Water-closets ought to have waste-preventing cisterns, with the delivery pipe completely disconnected from the discharge pipe, and with overflow pipe disconnected from the soil pipe or drain :
(*f*) The dustbin ought to be kept dry, and emptied at least once a week :
(*g*) If there be a storage cistern for the water supply, its overflow should be entirely disconnected from any drain or soil pipe :
(*h*) All these requirements ought to be enforced by by-laws :
(*i*) All house drains ought to be constructed under the control of the Corporation.

Summary of recommendations in regard to sewerage.

63. Secondly, in regard to the sewerage of the city :—
(*j*) The suburbs of Sandy Bay, Wellington Hamlets, New Town, and Glebe Town ought to be, at least for sanitary purposes, united to Hobart :
(*k*) A large-scale detailed plan of the city ought to be prepared, showing all the natural features, every building, and the levels of the ground :
(*l*) A system of sewerage should be constructed, with outfalls into the tideway of the estuary of the Derwent :
(*m*) Proper provision should be made for the ventilation, flushing, and examination of the sewers :
(*n*) The existing sewers should be carefully examined to see whether any of them could be made available, and so save the cost of constructing new ones :
(*o*) The rainfall and the sewage should be kept separate as far as possible :
(*p*) The existing rivulets should be cleansed, and used only for carrying off the natural drainage of the ground and rain-water, all sewage and refuse being kept out of them :
(*q*) The scavenging service should be re-organised, so as to regularly and frequently remove the dry refuse from the whole city, and means provided for destroying the infected portions of it.

64. Some time must necessarily elapse before these recommendations can be carried out. In the meantime whatever is done should be so done that it can form part of the general scheme, so that money be not wasted in doing what may have to be done over again in a different way. The strictest oversight ought to be exercised to make the best of the existing arrangements as regards drainage, &c., and the carrying out of clauses 225 to 237 of the Police Act before cited. But proprietors should not be called upon to make costly alterations, either in regard to closets or cesspools, until the Corporation is in a position to know that such alterations will be permanent. This may require the repeal of Clause 5 of the Hobart Health Act, 48 Victoria, No. 37. It will not be necessary to wait for the completion of the whole of the detailed plan of the city before commencing a proper system of general sewerage, as sufficient knowledge of the requirements of the present population and of the provision to make for the future are at once available, so that the sizes of the outfall sewers may be determined when their lines have been laid out and levelled. And when the outfalls are decided, each district of the city may be taken separately. Moreover, there is nothing to prevent the immediate organisation of a proper system of scavenging and removal of dry refuse suited to the wants of the city, and adapted to the method of disposal that may be found the most advantageous.

Summary of estimates of yearly expenditure.

65. The following is a summary recapitulation of the estimates of the yearly expenditure under the two systems of open and closed drainage :—

Open Drainage.

	£	£
Interest on £20,000, cost of necessary works, at 4 per cent. ..	800	
Repairs on above, at 5 per cent	1000	
Cost of gutter-sweeping, exclusive of water	5500	
Cost of collection and cleansing, &c. of pails	9000	
Total yearly cost	..	16,300

Underground Drainage.

	£	£
Interest on £60,000, cost of necessary works, at 4 per cent...	2400	
Repairs on above, at 5 per cent.	3000	
Cost of emptying trough-closets	1600	
Total yearly cost	..	7000
Yearly saving of Underground System	..	£9300

In these estimates no mention is made of the expense to proprietors of changing the present privy accommodation into water-closets, as that would not affect the rates. But seeing that it would affect the ratepayers in their private capacity, it may be mentioned that the total cost of the alterations should not exceed £16,000 ; and that if the Corporation undertook this work as well as the rest, an additional rate producing £1000 a year would pay interest and provide a sinking fund.

66. The diminution of the ratepayers' burden is but one of the advantages of adopting a system of underground drainage by the removal of excreta by water carriage. For this system is the only one that will effectually remove all the nuisances from which Hobart suffers, and make it the healthy and pleasant city it ought to be,—worthy of the incomparable situation that destines it to be the metropolis of the Federation, and the sanatorium of the Eastern world.

Only effectual system, as well as cheapest.

I have the honour to remain,
Mr. President and Gentlemen,
Your faithful Servant,
A. MAULT.

Central Board of Health of Tasmania,
Hobart, 14*th June,* 1886.

WILLIAM THOMAS STRUTT,
GOVERNMENT PRINTER, TASMANIA.

(In continuation of Paper No. 47.)

THE DRAINAGE OF HOBART.

The President of the Central Board of Health.

SIR,

FROM the reports published of the remarks made by His Worship the Mayor and by various Aldermen at the meeting of the Hobart Local Board of Health held on the 17th instant, it appears that the principal objections to my recommendations on the above subject were founded upon allegations that I had not considered the question of water supply, and had under-estimated the probable cost of the works.

In reference to the question of water supply, I have to call your attention to the fact that it has nothing to do with that of the relative merits of surface gutters and underground drains,—which is the principal question to be solved,—except so far as regards cleansing and flushing. Whatever the quantity of water may be, it has to be removed from the houses after it has been fouled by use, and the matter to be considered is how to best remove it. And, whether it be removed by one or the other means, the gutters or drains must remove the quantity such as it is.

As far as the gutters are concerned, it is evident that a large quantity of water will be needed to cleanse them. I have estimated this quantity to be 180,000 gallons a day on the average, and have given the data upon which the quantity is estimated, and they have not been questioned. Of course an "average" quantity implies that it will be sometimes more and sometimes less, but as the larger quantities will always be required in hot dry weather, it will unfortunately happen that the most water will be required when the supply is least.

In regard to underground drains, it is found that they keep themselves clean without any flushing when the sewage therein flows at the rate of 2½ feet a second. This rate of flow is obtained in ordinary drain pipes laid at a gradient of 1 in 250. In no part of the city where waterworks water would otherwise be required for sewer-flushing is there a gradient anything like so flat as this, as a glance at my map will show. In the portions of the sewers where flushing would be required, it would be done with rivulet water or by impounding the sewage water itself.

It is thus shown, that while surface gutters would need for cleansing purposes a great deal of water from the waterworks mains, the underground drains would require none.

It is only when, in connection with underground drains the question of water-closets comes in, that that of the water supply is involved; and thereupon I beg to recall to your attention the 49th clause of my report, wherein it is remarked—"If London with a daily water supply of less than 30 (28·57) gallons a head, and Liverpool with one of 25 gallons a head, be entirely served by water-closets, Hobart with 65 gallons a head ought to have no difficulty." The Corporation of Hobart professes to supply this quantity of 65 gallons a head daily to a population of 25,000, that is, to supply daily more than 1,600,000 gallons. If there be anything like this quantity, it can only be by the grossest carelessness on the one side, and the most culpable waste on the other, that there can ever be any lack of water. Take the high rate of 5 gallons a day for drinking, cooking, and washing purposes (at Croydon 2 gallons a head were found enough in houses without baths) there will be consumed daily ..... 125,000 gallons.

If street watering takes twice the average of the consumption of towns of such a size at home, the daily quantity needed will be	300,000	„
The scavengers certainly do not now take more than	25,000	„
If there be in the city 1000 houses with baths, and each bath be used twice every day, the water taken would be	70,000	„
In Launceston, with two railway stations, large breweries, etc., the meter customers take 60,000 gallons a day: if Hobart required four times as much, it would be	240,000	„
The public fountains certainly do not take daily....	30,000	„
The total of all these requirements when largely provided for is	790,000	„

not half the supply—leaving over 800,000 gallons a day for garden watering and waste. In the face of all these figures it is absurd to gravely reason against adopting water-closets that would need 90,000 gallons a day, on the ground of the heavy claim they

make on the waterworks. The reasoning is still more palpably absurd when the outcome of it is that, in considering a gutter system requiring 180,000 gallons a day, nothing is said about water supply, while it is alleged to be an insuperable obstacle against another system asking for only half the quantity.

As regards the estimates given in my Report, they are based, as stated in clause 36, upon the Schedules of the current contract of the Public Works Department. With your permission I will give you the details, premising that none of the prices are mine except those specially noted. I should also explain that the absence of the cost of junctions in the estimate is only apparent. They are amply provided for by a double measurement of the sewers that are joined together by them. In the measurement of manholes, one upon a No. 3 sewer was taken as typical.

		£	s.	d.
Excavation for No. 1 sewer, 2925 cubic yards.				
„ No. 2 „ 1897 „				
„ No. 3 „ 4290 „				
„ No. 4 „ 7350 „				
„ No. 5 „ 4815 „				
„ No. 6 „ 9900 „				
„ No. 7 „ 8500 „				
„ No. 8 „ 9000 „				
Total	48,677 cubic yards at 1*s.* 10*d.*	4462	1	2
Additional cost of 13,888 cubic yards in rock, at 3*s.* 7½*d.*		2517	4	0
Carting away 21,600 cubic yards at 8½*d.*		765	0	0
Restoring 17,850 square yards of surface at 1*s.* (price added) ..		892	10	0
Brickwork in cement in No. 1 sewer, 76·3 rods				
„ No. 2 „ 52·3 „				
„ No. 3 „ 93·5 „				
„ No. 4 „ 120·9 „				
„ No. 5 „ 94·1 „				
„ No. 6 „ 197.7 „				
„ in manholes 51·5 „				
„ in flushing-pits 6·1 „				
Total	692·4 rods, at £17 8*s.*	12,047	15	6
12 in. glazed socket pipes, 17,000 yards at 6*s.* 9*d.* (priced by department)		5737	10	0
Laying and jointing 17,000 yards at 9*d.* (not in Schedule)		637	10	0
9 in. glazed socket pipes, 30,000 yards at 3*s.* 8*d.* (department price)		5500	0	0
Laying and jointing 30,000 yards at 8*d.* (not in Schedule)		1000	0	0
9 in. pipes for flushing, including laying, 200 yards at 5*s.* 8*d.* ..		56	13	4
Compensation for damage passing through yards, gardens, and paddocks, 9000 yards at 5*s.* (additional price)		2250	0	0
Cast-iron covers and frames to manholes, &c., 74 tons at £13 2*s.*		969	8	0
Foot-irons, handles, &c., 3800 lbs. at 5½*d.*		87	1	8
Wooden blocks for covers, 700 cubic feet, 4*s.*		140	0	0
Huon pine sluice-frames, 40 cubic feet, 8*s.*		16	0	0
Huon pine 1¼ in. sluices, 120 square feet, 1*s.*		6	0	0
4 in. socket pipes for ventilators, 5000 feet at 1*s.* 6*d.*		375	0	0
3 in. galvanised pipes for ventilators, 5000 feet at 7*d.*		145	16	8
Charcoal trays and frames, 200 sets at 37*s.* 6*d.*		375	0	0
6 in. glazed pipes built in for house junctions, 2500 at 3*s.*		375	0	0
12 in. glazed pipes junctions, 900 at 6*s.* (extra price beyond straight)		270	0	0
9 in. glazed pipes, 1600 at 3*s.* 6*d.*, ditto		280	0	0
Crossings of rivulets: only three will involve any great expense; the other 12 will only require about 10 yards of 9in. paving, say £5, or for 12	£60			
leaving for the 3 others £130 each	390			
Sum provided		450	0	0
The extra work at outlets can only be approximately estimated until plans are prepared, but the sum provided allows for 4½ rods brickwork, 10 tons cast iron, and £120 worth of miscellaneous work at each main outfall, and half these quantities at each of the others		1000	0	0
TOTAL		£40,355	10	4

Now the significance of these figures is this :—If the work were one to be undertaken by Government, and if the plans for it were now ready *there is a contract in existence under which it could be done*, as far as the work is concerned, for £40,355, or if cost of plans and superintendence be taken at £5000 and added thereto, could be altogether completed for £45,355. I am, perhaps, not quite correct in saying that the contract in existence would include the 12-inch and 9-inch pipe drains; but to show that my prices for these are more than liberal, I may say that of the above-mentioned sum of £40,355, £16,362 were for these two sizes of drains. At Launceston the Local Board of Health employ their own men to do these works by day-work, and the cost to them of these works would be £9975; so that if I had taken the price Launceston experience shows to be a sufficient one, the above £40,355 would have been reduced to under £34,000.

But as underground work is notoriously uncertain, and as unforeseen difficulties in way of rock-cutting, pumping, watching, &c. might be met with, I added 25 per cent., amounting to over £10,000, to the prices of the existing contract, bringing, with the £5000 provided for surveys and superintendence, the total up to £55,456 18*s*. In pricing out each description of work and sewer separately, the avoiding of fractions made this total into £55,697 10*s*.; and a further provision for contingencies gave the round sum of £60,000. So you will see that I have taken every precaution to frame an estimate that should prove sufficient.

As regards the quantities as distinguished from prices, I do not hear that objection is taken to them. They can only be approximative until a proper plan of the City is made. But as it is very probable that some existing sewers will be found available for use, and thus save some of the quantity taken, in all likelihood there is a sufficient margin to allow for any changes more perfect plans may show to be desirable, especially as such plans are quite as likely to shorten as to lengthen the sewers.

As I have now justified my estimate of £60,000 by giving these full details, it would be interesting to see the details upon which the estimate of £300,000 for the same work is founded.

In conclusion, I should like to make one suggestion. Whatever system be adopted for the solution of the sewage question at Hobart, one preliminary is essential, and that is a proper plan of the City. Could not the necessary steps for beginning such a plan be taken during this Session of Parliament? This, as I have explained in my Report, need not prevent the carrying out of other sanitary work. Such a plan would be found to be of great advantage to all the administrative departments of the general and municipal governments. For the former it would fulfil the uses of a cadastral survey for land registration and taxation, and would afford means of properly laying out and recording all matters connected with the Telegraph and other Public Works Departments. And for the latter it would be a basis for checking the completeness of the incidence of rating, and is indispensably necessary for laying out and recording all work connected with the water supply, drainage, and lighting of the city and the improvement of its streets and thoroughfares.

I have the honour to remain,
Sir,
Your faithful Servant,
A. MAULT.

Central Board of Health, Hobart,
23rd September, 1886.

WILLIAM THOMAS STRUTT,
GOVERNMENT PRINTER, TASMANIA


THE DOMAIN.
GLEBE TOWN.
NEW TOWN.
WELLINGTON
SANDY BAY.
Macquarie Point.
Railway Station
Slaughter Yards
Fishermen's Dock
New Wharf
Franklin Square
The Barracks.
Note: the Black figures on Plan refer to the above Sections.
The Red figures give approximately the height in feet of the Contour lines above mean High water level.
A. Mault. 14 June, 1886.
Sketch of Trough Closet.
Section on AB
on CD.
CITY OF HOBART. Sketch Plan showing proposed Sewerage. Scale of Chains
Lithographed at the Crown Lands Department Hobart. July 1886.