(No. 127.)

1892.

PARLIAMENT OF TASMANIA.

METROPOLITAN DRAINAGE BOARD

REPORT OF THE ENGINEER.

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

To the Hon. the Chairman and the Members of the Metropolitan Drainage Board.

GENTLEMEN,

I HAVE the honour to submit for your consideration the following Report on the Sewerage* of the Metropolitan Drainage Area. To enable you to better understand it, it is accompanied by a small scale plan based on the surveys you have had made, so far as they have been mapped and reduced, and, where this has not yet been done, upon the best information otherwise obtainable. I propose to report to you on a later occasion upon the very important matter of house-drainage, and so have entered into no details respecting it in this Report. Report. Plan.

PRELIMINARY CONSIDERATIONS.

2. In the preparation of this Report it has been taken for granted— General scope of work.

(*a.*) That it is desirable to collect by underground drains, and dispose in a harmless manner of the sewage of all such parts of the area as are occupied by people in sufficient numbers to reasonably pay for the cost of such collection and disposal:

(*b.*) That with respect to such sewerage-works as cannot be easily superadded to any system that may be now adopted, provision should be made not only for present needs, but also for those, as far as they can be foreseen, of the next forty or fifty years; but that, with respect to work that can be at any time added without interfering with the action of the system, it is better to leave to the future the care of making provision as the needs arise.

3. The area of the district under your jurisdiction, as nearly as can be estimated until the boundaries are surveyed, is about 14,300 acres. Of this area about 2428 acres are now, or may be expected to be in the near future, occupied more or less thickly by buildings, and they form the districts with which this Report particularly deals. There are five or six hundred acres more that may be also built upon, but they are in situations that can at any time be drained independently of the system herein described. I am indebted to Mr. Johnston, the Registrar-General, for much detailed information as to the occupation of the Metropolitan Area, information upon which have been based the calculations hereinafter given as to the provision to be made for present necessities and probable future requirements. The occupation varies in density from over 57 to the acre in one of the census districts in Hobart to about 6 to the acre in the occupied parts of New Town and Queenborough. The mean density of population in the City of Hobart is about 19 to the acre, and of the 2428 acres of occupied area, 13 to the acre. The total population of the area is under 32,000; thirty years ago it was probably about 25,000. If this estimate is accurate it shows that the population increased about 27 per cent. in that period. But as most of the increase took place in the last ten years, it will be safer, if provision be made now for the population of 40 years hence, to estimate that it will be 67 per cent. greater than at present. This is the estimate that, generally speaking, has been taken. It is certain that this or any other increase will not be uniformly spread over the occupied area referred to. The more thickly peopled parts of Hobart will probably remain without any great augmentation of population. The nature of the land and its configuration will affect other districts. It will therefore be seen that in the calculations hereinafter given each portion of the occupied area has been, in the matter of provision to be made for future occupation, dealt with by itself and in accordance with its circumstances. In taking the above estimate of increase it has not not been forgotten that it is only an estimate, and consequently, as will be seen, a large margin has always been left beyond actually calculated requirements—in fact, double the existing population is virtually provided for. But if it be thought desirable to make at Area. Population, and probable increase.

* In this Report the word *sewerage* means the plan or system of sewers by which the sewage is to be collected; *sewage* means the liquid matter that flows through the sewers; *sewer* means a public conduit for sewage, and *drain* a private one.

the outset provision for a much larger increase of population than that suggested, such provision can be made without altering the principles upon which this Report is based, and calculations of the consequentially augmented cost can be readily made.

Provision to be made.

4. With regard to the nature of the works in respect of which provision should be made for this increase of population as distinguished from those for which present needs should only be regarded, it may be generally said that the works intended for the collection of sewage should be designed on a scale sufficiently large to serve at least for the above-mentioned period of years with its estimated increase of population, as great inconvenience and outlay must accompany the replacement of smaller sewers by larger. On the other hand, most of the works connected with the storage, pumping, and ultimate disposal of the sewage, may be limited in scale to present needs if liberally estimated, as further provision of tanks, engines, and machinery may at any time be added without obstruction to works that have been designed to admit of extension. The provision of land is the principal exception to this general rule, as all that may probably be required for future extension of disposal works should be at once secured, or probably greatly enhanced prices may have to be paid.

Work of collection considered apart.

5. The consideration of the whole matter will be simplified by separating the details of the collection of the sewage from those of its disposal. The two matters are naturally inter-connected, and the adoption of one method of disposal instead of another may modify some of the details of the method of collection. But in this Report the method of collection described has been designed as far as possible to meet the requirements of any one of the practicable modes of disposal that are set forth, so that it may be taken as equally applicable to all.

SEWAGE COLLECTION.

Sewage to be collected.

6. The sewage to be collected consists, in the first place, of the water constituting the domestic and manufacturing supply after it has been used, and consequently the quantity of the water supply gives a gauge of the quantity of sewage of this sort that has to be collected. The Hobart water supply is reputed to be equal to a distribution of 65 gallons a day to each head of population. If this be so it is not probable that more than 40 gallons a head would constitute the daily domestic and sanitary supply, as the rest would be accounted for by street and garden watering, steam production, gutter flushing, waste, and purposes which would not require sewers to carry it off after use. It has therefore been assumed that 40 gallons of sewage a day has to be taken away for each head of the population of the districts sewered, and this quantity is called the dry-weather flow; it is a quantity that is largely sufficient to insure the proper working of the sewers.

Rain-water.

7. In the next place there is rain-water. However desirable it may be, both in order to diminish the size and cost of the sewers and to prevent the impoverishment of the sewage in case it should be intended to utilize it, to separate the rainfall from the house slops, it is impracticable to do so altogether, as there are paved yards that have to be swilled into grated catchpits that communicate with the sewers, which also must receive the rain that falls on such yards. It is therefore assumed that in connexion with each house there are 100 square yards of roofed and paved areas from which the rainfall in ordinary quantities may pass into the sewers. It is a question as to what shall be considered ordinary quantities. The mean yearly rainfall at Hobart is just under 23 inches, but more than a third of this quantity has been known to fall in a month, and a twelfth of it might fall in an hour. It would be manifestly absurd to build sewers twenty times larger than otherwise necessary in order to meet emergencies that may rarely occur. It has therefore been assumed that provision for a rainfall of two inches a day on the area named is amply sufficient, and that all excess over this quantity should be allowed to pass off as storm overflow. The quantity named would give 180 gallons a day for each head of the population, making, with the above-mentioned 40 gallons, 220 gallons a day, which is called the wet-weather flow. In recommending to you the adoption of this quantity as the maximum provision that should be made for rain, the arguments of those who maintain that as much rain as possible should be admitted into the sewers for flushing purposes have not been overlooked. But rain is virtually useless for the purpose, as it cannot be depended on; for, as flushing is most needed in dry weather when there is no rain, the same arrangements have to be made for flushing sewers that require it in cases where rainfall is all admitted as in cases where it is not. The admission of all the rainfall has therefore for effect to needlessly increase the size and cost of sewers, and worse than uselessly augment the quantity of sewage to be dealt with.

Road drainage.

8. With respect to street and road drainage, the admission of it into your sewers is very undesirable. The sand and small gravel washed in from roads are very injurious to the sewers—especially the glazed pipes with rapid falls—and very greatly increase the difficulty of sewage treatment or discharge without treatment. If the sewage is to be treated, this sand and gravel form a heavy and valueless addition to the material to be pumped or otherwise lifted and removed—adding greatly to the cost, without adding to the fertilizing powers of the resulting manure. If the sewage be discharged without treatment, the sand and gravel, charged in their passage along the sewers with fæcal and other noxious matter, carry them down and at discharge form shoals and mud-banks of most objectionable nature. At cab-stands special arrangements would be made to admit the

street washings into the sewers, but at all other places the scavenging should be so done as to effectually prevent the pollution of the various rivulets of the District by storm-waters flowing from the roads.

9. There are no maps to be relied upon as shewing the existing sewers of the City of Hobart and most other parts of the Metropolitan Area, therefore for the present it has been assumed that, with the exception of Glebe Town, all the rest of the thickly-occupied area will have to be sewered. If it be found that there are existing sewers properly constructed for receiving house drainage, of course they will be utilized; if not so constructed they will be left for road drainage, if suitable for that purpose—otherwise they should be effectually cleansed and filled or taken up. With respect to the Glebe Town and other properly-constructed sewers that receive road drainage as well as house sewage, means will be taken at their junction with the new system of sewers to keep out, by means of catch-pits with storm-water overflows, both the road detritus and superabundance of storm-water, unless it be found that such work has already been done.

Water-closets.

10. So far no special mention has been made of water-closet sewage, because, without trenching on your province to decide as to whether such sewage shall be admitted to the sewers or not, it has been assumed that it will be so admitted in common with all other house refuse, for the fact of it being received or not received will not alter the size or character of the sewers that have to be constructed, nor will it affect the question of sewage disposal, though it will greatly affect the question of the sanitation of the houses in which people dwell. All this will naturally have to be treated in the Report on house drainage. It will be sufficient to say here that the question of water supply need not impede the adoption of closets, as they are universally used in England in towns, including London and Liverpool, with less than half the 65 gallons a head of the Hobart daily supply; and, as will be explained, there are ready and efficient means of checking waste in their use. And their adoption will save a great quantity of the water now required to flush gutters into which house slops of all sorts are permitted to run—a service, the efficient performance of which would require at the season when water is most scarce at least double the quantity required for flushing closets.

Inequality of flow.

11. The flow of sewage through the sewers varies greatly at different times during the day. In English towns the hour of greatest flow is usually between 9 and 10 o'clock in the morning, when about one-seventh of the daily quantity passes. It may consequently be anticipated that here the dry weather quantity of sewage for the hour of greatest flow will be $\frac{1}{7}^{0}$, = say, six gallons a head of the population. In wet weather the hourly provision of maximum rainfall admissible into sewers ($\frac{1}{24}^{0}$), $7\frac{1}{2}$ gallons a head, has to be added, making $13\frac{1}{2}$ gallons a head as the wet weather quantity in the hour of greatest flow. The sewers must be made of capacity sufficient to carry this quantity in the time, as otherwise they will get gorged, and some of the sewage may become stagnant and begin to form deposits in the sewers. It follows that whereas a sewer with a carrying capacity of $1\frac{2}{3}$ gallons an hour for each head of the population would suffice to take away a twenty-fourth part of the daily dry-weather quantity of sewage, it needs, on account of hourly variation of flow, and possible addition of rain-water, a sewer of eight times that capacity to properly drain the district. It will be seen that such capacity is largely provided for.

Sizes of sewers.

12. A great deal of the prejudice that still exists in some quarters against the use of underground drains is due to the recollection of what used to occur in connexion with the sewerage systems of 50 years ago. It was taken for granted that all sewers would become filled with deposit, and that they should therefore be made large enough to be cleansed by manual labour. The truth is that the very size of the sewers produced the tendency to deposit. They were of a size so out of proportion to the real requirements, that only a comparatively little driblet of water ran sluggishly down their flat bottoms, and deposition was certain to take place. The deposit soon fermented, and the useless space in the sewers became filled with sewer-gas which escaped in all directions into the houses and streets. No available quantity of water could flush the enormous sewers, and the rush of water in heavy thunderstorms only drove more sewer-gas into the houses. What occurred at the Westminster Palace is a good illustration of the old system. When the Houses of Parliament were built the architect provided for their drainage by a sewer running under part of them, and having a cross-sectional area of about ten square feet. In the busiest part of the Parliamentary Session not more than about one-eightieth part of this cross-sectional area was occupied by sewage; the other 79/80ths became chiefly a holder of the sewer-gas evolved from the fermenting deposits in the enormous drain. The condition of things became unbearable, and they have been remedied by the adoption of a system that has replaced the old sewer by one with about one-twentieth of its cross-sectional area, but which can be easily flushed and ventilated. It is therefore not only because sewers made of a size bearing some proportion to that really needed to easily discharge their duty are very much cheaper to construct than the great tunnels of the old system, that they are here recommended, but also because the smaller sewers act much more efficiently from every point of view, both hydraulic and sanitary. They require but little flushing, and a small quantity of water is sufficient to perform that flushing when required. They can be thoroughly ventilated, and ventilation is of the highest importance, not only for the prevention of the evolution of sewer-gas and its removal if produced, but also to prevent the growth of sewage fungus—a growth that greatly adds to the necessity and difficulty of efficient flushing.

Natural divisions of area.

13. The Metropolitan Area is naturally drained by a number of rivulets flowing into the estuary of the Derwent, and the mouths of these rivulets point out in an obvious manner the places towards which the sewage may be most naturally and most economically directed for treatment or discharge. Generally speaking, the sewers have been designed to convey the sewage to these places and deliver it there at a level that will admit of the adoption of any method or methods for its ultimate disposal that you may judge best after consideration of both the sanitary and financial aspects of the question. The basins of these rivulets form natural drainage districts or systems that can be either independently or conjointly treated. The most important of these basins is that of the Hobart Rivulet, containing 1346 of the before-described 2428 acres of occupied building land, with a population at the recent census of 22,317, and with an outlet about Macquarie Point. Adjoining this system is that of the two valleys lying on each side of Mulgrave Point, with an outlet at Battery Point, and containing about 200 acres with a population of 3760 at the census. Further to the south is the joint system of the Wellington and Ashfield Rivulets, occupying about 300 acres, with a population of 1950. On the north there is the system comprising the valleys draining into New Town Bay, with an area of 510 acres and a population of 2950. And there are various smaller systems draining into Sandy Bay. The following is a description of the sewerage works proposed for each of these systems.

The Hobart Rivulet Basin, Macquarie Point Outlet.

Upper part of basin.

14. The Main Hobart Rivulet Sewer begins as a nine-inch pipe at the cottages in Patrick's Rivulet Valley, above the Cascade Brewery. The gradient of this part of the sewer will be about one in forty. At the Brewery it will receive a branch sewer from the south, providing for the drainage of the houses belonging to the Company in the Hobart Rivulet valley. It is estimated that in the two valleys named there may be sixty acres of building land, and provision is made for the drainage of a population of 900 people; to this point there will be about 600 yards of 9-inch drain, and 100 yards of 6-inch.

From the Brewery the sewer, still 9 inches in diameter, will run along the south bank of the Hobart Rivulet. At the bridge on the road leading to M'Robie's Gully there will be junctions left on each side for receiving the sewerage from that gully and a portion of the Cascade Road not yet built upon. Further on it will receive the drainage from the Cascade Asylum and from part of the Cascade Road, and yet further on from the back street between the road and the rivulet and from part of the road. The sewer then will cross the rivulet to the northern bank, and there receive part of the drainage of the back street. At Glen-street it will receive the drainage of another part of the Cascade road and of D'Arcy, Washington, Upper and Lower Wentworth streets, and other streets in the Wellesley and Leslie Road Districts. The main sewer will in this Section have a fall of about 1 in 50, and will have to carry the drainage from about 120 acres of building land, with an existing population of about 700, and a prospective one calculated at 1800. The branch sewers will all have a considerable fall. In this Section there will be about 4500 yards of 9-inch sewers and 1500 yards of 6-inch.

Within City. From Glen-street.

15. Below Glen-street the main sewer, having a diameter of 12 inches, will recross the rivulet to the south bank, and at Anglesea-street receive a branch sewer with ramifications bringing in the drainage of Anglesea, Denison, John, Anne, and New streets, and part of Macquarie-street, Holbrook Place, and Adelaide-street. At Elphinstone-street it will receive another branch bringing the drainage of that street and part of Holbrook Place and Adelaide-street. At Lord-street there will be another junction for the sewer of that street. Near All Saints Church a sewer with its branches will bring in the drainage of parts of Macquarie, Davey, and Adelaide streets, and Elboden and Holbrook Places. At Gore-street a branch drain will bring the drainage from houses in Milton-street and the south side of Upper Liverpool-street. At Denison Lane it will receive the drainage of parts of Macquarie, Antill, and Davey streets. Crossing the rivulet above the mill weir, and it will receive a branch sewer bringing the drainage from other parts of Upper Liverpool and Milton streets, and then run under and along the occupation road to Molle-street. The additional area drained by this Section will be about 140 acres, with a present population of 1592, and a prospective one calculated to be 2800, making the total area drained 260 acres, and the total population provided for, 4600. The main sewer will have a fall of 1 in 50, and the branch sewers will all have good gradients. The additional length of sewers will be about 1330 yards of 12-inch pipes, 3000 yards of 9-inch, and 1900 yards of 6-inch.

From Molle-street.

16. At Molle-street the main sewer will receive branch sewers from the south, bringing the drainage from parts of the Barracks and of Davey, Macquarie, and Molle-streets; and from the north, bringing the drainage from Molle and Upper Molle, Upper Bathurst, Upper Goulburn, Princes, Augustus, William, Frederick, Amelia, and New streets, and parts of Goulburn-street and Forest Road; it will have a diameter of 15 inches and a gradient of 1 in 60, and will run along Collins-street to beyond Chapel Road, where it will turn northwards and pass through yards and gardens to Barrack-street. The area drained in this Section will be 110 acres, with an existing population of 1200 and a prospective one of 2200, and the sewers will consist of 360 yards of 15-inch pipes, 2100 of 9-inch, and 900 of 6-inch. The total area drained to this point being 330 acres and the total population provided for, 6000.

SHEET 1

SULLIVAN'S COVE

Partly surveyed by J. Griffith, W. M. Hardy, C. W. Lennox & A. Stewart.

Scale of Feet

Scale of Links

To accompany Report

A. Mault

SHEET 2

97	96	95	85	24
29	28	21	17	13
30	26	22	18	14
31	27	23	19	15
32	25	24	20	16
45	41	37	33	49	48

City Boundary

ARTHUR ST

BUTTERWORTH ST

ADELAIDE ST

WELLINGTON BUILDINGS

QUARRY ST

HARY ST

VETERANS ROW

UNION ST

DEVONSHIRE SQUARE

Quarry St

KNOCKLOFTY TERRACE

City Boundary

BATH ST

LINWOOD CRES

PETTY ST

WARWICK ST

ALLISON ST

PATRICK ST

CENT

POETS ROAD

BONNINGTON ST

AUGUSTUS ST

PRINCES ST

UPPER BATHURST STO

UPPER COULBURN ST

SALVATOR ROSA GLEN

Knocklofty

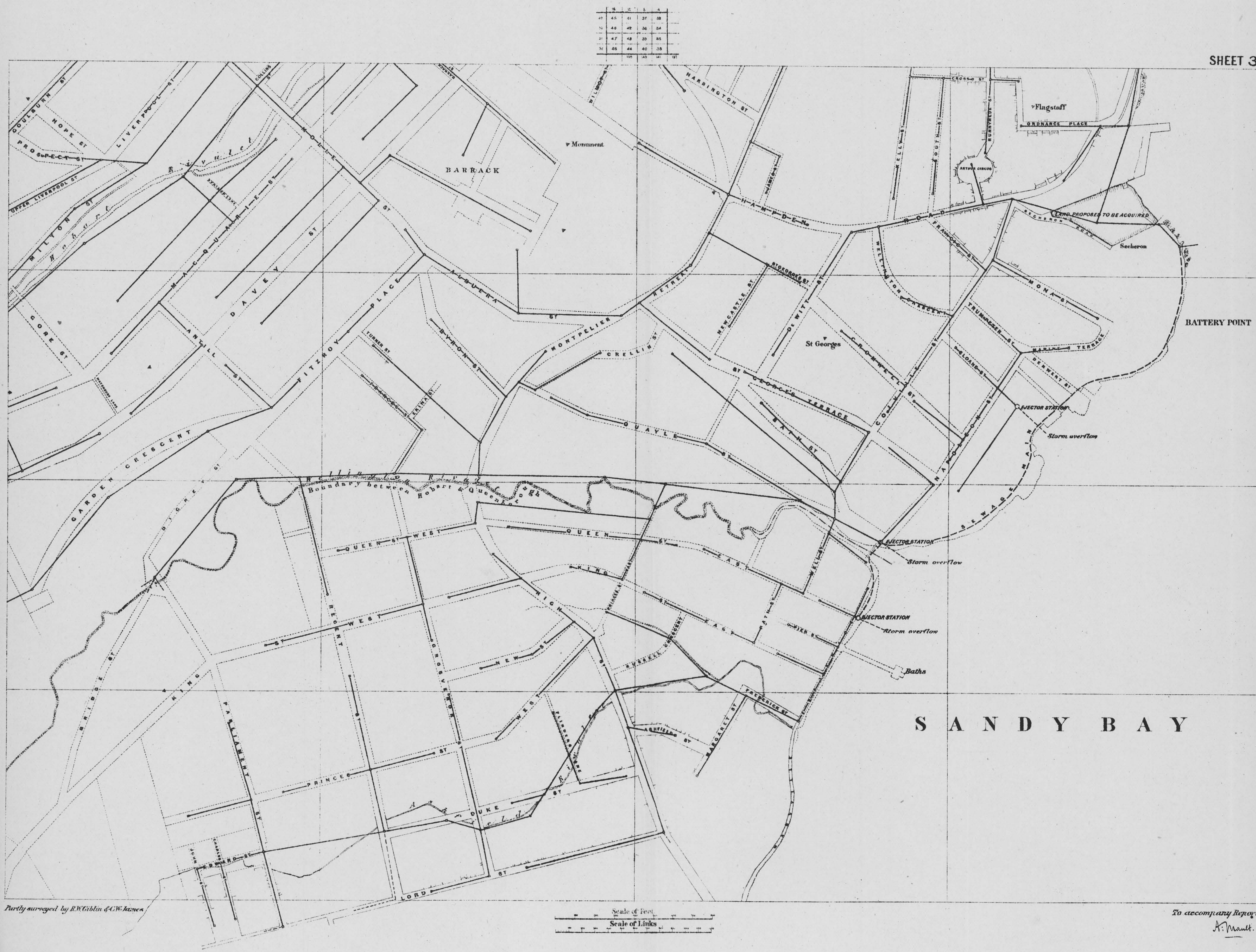
Scale of Feet

Scale of Links

Partly surveyed by A.Stewart & J.Griffith.

To accompany Report

A. Mault


SHEET 3
Hobart Rivulet
Wellington Rivulet
Boundary between Hobart & Queenborough
BARRACK
Monument
Flagstaff
ORDNANCE PLACE
ARTHUR CIRCUS
HAMPDEN ROAD
LAND PROPOSED TO BE ACQUIRED
SECHERON ROAD
Secheron
BATTERY POINT
St Georges
ST GEORGE'S TERRACE
QUAYLE ST
CRELLIN ST
MONTPELIER RETREAT
ALBUERA ST
BYRON ST
FITZROY PLACE
GARDEN CRESCENT
DAVEY ST
MACQUARIE ST
COLLINS ST
GOULBURN ST
HOPE ST
PROSPECT ST
UPPER LIVERPOOL ST
LIVERPOOL ST
MILTON ST
GORE ST
ANTILL ST
HARRINGTON ST
KELLY ST
SOUTH ST
CROSS ST
NEWCASTLE ST
DE WITT ST
CROMWELL ST
COLVILLE ST
WELLINGTON CRESCENT
FRANKLIN ST
MONA ST
TRUMPETER ST
SLOANE ST
MARINE TERRACE
DERWENT ST
NAPOLEON ST
BATH ST
EJECTOR STATION
Storm overflow
SEWAGE MAIN
EJECTOR STATION
Storm overflow
EJECTOR STATION
Storm overflow
Baths
QUEEN ST WEST
QUEEN ST EAST
KING ST WEST
KING ST EAST
HIGH ST
NEW ST
REGENT ST
GROSVENOR ST
PRINCES ST
DUKE ST
LORD ST
EDWARD ST
PARLIAMENT ST
BRIDGE ST
KING ST
RUSSELL CRESCENT
FREDERICK ST
MARGARET ST
ASHFIELD ST
Ashfield Rivulet
SANDY BAY
Partly surveyed by R.W. Giblin & G.W. James
Scale of Feet
Scale of Links
To accompany Report
A. Mault.

SHEET 4

61	57	53	49	45
62	58	54	50	46
63	59	55	51	47
64	60	56	52	48

Forest Road

Macrobie's Gully

Cascades Establishment

Hobart Rivulet

CASCADE ROAD

Cascade Brewery

UPPER WENTWORTH ST

UPPER D'ARCY ST

LOWER D'ARCY ST

LOWER WENTWORTH ST

CONGRESS ST

HUON ROAD

From Franklin

CLEN ST

City Boundary

D'ARCY ST

MARINE TERRACE

HILL TERRACE

MILTON ST

UPPER LIVERPOOL ST

GOULBURN ST

AMELIA LANE

NEW ST

MACQUARIE ST

ELIZABETH ST

MACQUARIE PLACE

HOLEBROOK PLACE

St Luke's

Wellington Rivulet

Partly surveyed by R.W.Giblin & A.Stewart

Scale of Feet

Scale of Links

To accompany Report

A. Mault.

SHEET 5

96	92	88	84	80	76
95	91	87	83	79	75
94	90	86	82	78	74
93	89	85	81	77	73
25	21	17	13	9	5

Lord's Hill

Swan's Hill

N.W.end of Base

Partly surveyed by J.Griffith & A.Stewart

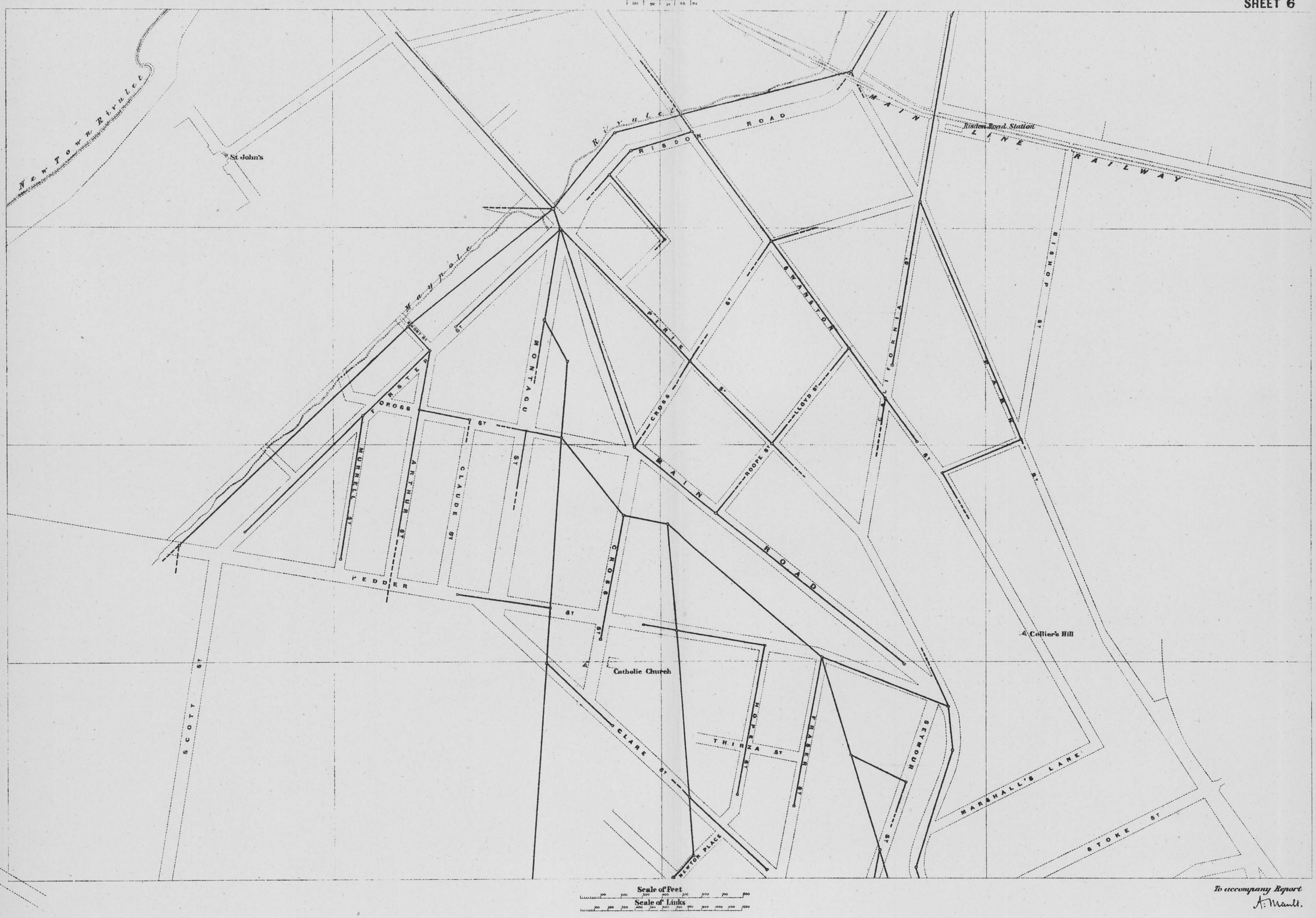
Scale of Feet

Scale of Links

To accompany Report

A. Mault.

SHEET 6



To accompany Report
A. Mault.

SHEET 7

132	128	124	120
131	127	123	119
130	126	122	118
129	125	121	117
116	112	108	104

BOUNDARY OF METROPOLITAN DRAINAGE AREA

From Intersection

South Glenorchy Railway Station.

FLETCHER'S LANE

REDWOOD LANE

MAIN ROAD

Wadsley's Hill

MAIN LINE RAILWAY

To Hobart

Boundary between Newtown and Glenorchy

Rivulet

NEW TOWN BAY

Storm overflow

ELECTOR STATION

SEWER MAIN

CORNELIAN BAY CEMETERY

Maypole Rivulet

RISDON ROAD

Partly surveyed by G.C. Bernard

Scale of Feet

Scale of Links

To accompany Report

A. Mault.

44	40	36	
149	145	141	137 133
150	146	142	138 134
151	147	143	139 135
152	148	144	140 136

SHEET 8

DUNKLEY'S POINT

PROPOSED FUTURE DISCHARGE

Proposed Ejector

Proposed Ejector

Derwent Water

S A N D Y B A Y

Maring's Rivulet

Red Chapel

Public School

BOUNDARY OF METROPOLITAN AREA

Road to Kingston

MH

Surveyed by R.W. Giblin

Scale of Feet

Scale of Link

To accompany Report

A. Mault

17. At Barrack-street the main sewer, increased to 18 inches in diameter, will receive a branch sewer from the south bringing the drainage from the rest of the Barracks and from parts of Davey, Macquarie, and Barrack streets; and another branch from the north bringing in the drainage from parts of Barrack, Brisbane, Melville, Bathurst, Goulburn, and Liverpool streets. The main sewer will then turn down Liverpool-street and at Harrington-street receive branch sewers from the south, bringing in the drainage from parts of Harrington, Macquarie, and Collins street and from Victoria and Melbourne streets; and from the north carrying the drainage from parts of Harrington, Bathurst, and Goulburn streets. From Harrington-street the main sewer, with the same dimensions and fall, will continue down Liverpool-street, receiving branch sewers from Watchorn, Murray, and Market streets, till it reaches Elizabeth-street. This further length from Barrack-street will drain about 70 acres more, with a present population of 2950, estimated to increase to 3500, and with 660 yards of 18-inch sewer, 5900 of 9-inch, and 1650 yards of 6-inch. The total area drained to this point being 440 acres, with an existing population of 6442, but with provision made for 10,300.

Elizabeth-street basin.

18. At the junction of Liverpool and Elizabeth streets the main sewer will receive the drainage from what may be called the Elizabeth and Warwick street valleys. The sewerage system of these valleys will begin in Elizabeth-street to the eastward of Little Arthur-street. At Burnett-street it will receive branch sewers draining parts of that street, Arthur, Mary, Quarry, Lochner-street, and Veterans' Row. At High-street there will be a branch from that street. At Melville-street it will receive the drainage of the Warwick-street valley, comprising more or less of that from Lansdowne Crescent, Adelaide, Petty, Allison, Bonnington, Hill, Brown, Union, Warwick, Patrick, Brisbane, Harrington, and Upper Murray-streets. Between Melville and Liverpool-streets the main sewer will receive branches from Bathurst-street. This system drains 334 acres with an existing population of 6680, estimated to increase to 9060, and the drainage will be effected by means of 300 yards of 15-inch pipes, 500 yards of 12-inch, 9900 yards of 9-inch, and 1800 yards of 6-inch.

Argyll-street.

19. The main sewer, increased to the capacity of a barrel sewer 30 inches in diameter, will continue along Liverpool-street to Argyll-street, receiving branches from behind James's Place, and from parts of Argyll, Melville, Bathurst, and Liverpool streets. It will then turn down Argyll-street to the Hobart Rivulet, along the northern bank of which it will run, receiving branch sewers from Campbell, Sackville, and Cross streets, and will cross the Park Rivulet. The gradient of the greater part of this section will be 1 in 433. The additional area drained will be 42 acres, with a present population of 1365, and with provision made for its increase to 1680. The length of the sewers will be 760 yards of 30-inch, 1000 yards of 9-inch, and 400 yards of 6-inch. Up to this point the total area drained is 816 acres, occupied by 14,487 people, with provision made for 21,040.

Park Rivulet basin.

20. At this point will be received the drainage of the houses in the Park Rivulet basin, the sewers for collecting which will begin in Letitia-street beyond the Recreation Ground, and between Clara and Colville streets receive a branch bringing in the sewage from parts of New Town Road, Commercial Road, Lord's Road, and Argyll, Yardley, and Thomas streets. Between this point and the Quadrant branch sewers will bring in the drainage from Audley, Colville, Ware, Wellington and George streets. At the Quadrant the sewage will be received from the Mount Stuart District and Providence Valley, and from Queen, King, Little Arthur, Strahan, Lefroy, and parts of Elizabeth and Argyll streets, and, by another branch sewer, that from Williamson-street. From the Quadrant the sewer will run alongside the Park Rivulet to Bathurst-street, a branch sewer along Park-street receiving and bringing on the sewage from the Glebe Town Sewerage System; and the sewage from parts of Warwick, Patrick, Brisbane, Bathurst, Argyll, and Campbell streets will be brought in by other branch sewers. The works in this basin comprise 500 yards of 15-inch pipes, 900 yards of 12-inch, 12,500 yards of 9-inch, and 2800 yards of 6-inch. It contains an area of 460 acres, with a present population of 5750, but provision is made for 9200.

Outfall.

21. From the Park Rivulet crossing and junction the main sewer, with a cross sectional area equal to a barrel culvert of 36 inches in diameter, will run on the north-eastern side of the Hobart Rivulet to opposite the Kerosene Store, receiving two branches with the drainage of part of Park-street and the Railway Offices, and also so much of that of the Gas Works as you may decide to admit. Near the Kerosene Store it will receive from across the rivulet, by means the nature of which will depend on the system of sewage disposal you may decide upon adopting, the sewage from the southern side of that part of the rivulet basin that lies eastward from Harrington-street and Hampden Road. This district has an area of about 70 acres, with a present population of 2080, and with provision made for 2450. The lower portion of the branch sewers draining it will have a fall of only 1 in 600; the other portion will have good falls. Parts of Hampden Road, Davey, Macquarie, Collins, Murray, Argyll and Campbell streets are in this district, and the whole of Wilmot, Dunn, and Hunter streets, and the courts and lanes opening into them. From the Kerosene Store junction the main sewer will turn northwards toward the outlet at Macquarie Point. The sewers in this section will consist of 900 yards of 36-inch, 300 yards of 15-inch, 400 yards of 12-inch, 3600 yards of 9-inch, and 400 yards of 6-inch.

Area of Hobart Rivulet Basin.

22. The entire area of building land occupied in the Hobart Rivulet basin is, as before stated, 1346 acres, of which about 993 are within the City of Hobart, 36 in Glebe Town, 82 in New Town,

105 in Mount Stuart, 120 in the Wellesley Road District, and 10 in the Leslie Road District. The existing population is 22,317, being about 17 to the acre, and provision is made for 32,690, or about 24 to the acre.

Battery Point Outfall.

Battery Point.

23. Two systems of sewers have their outfall at Battery Point. One, beginning as a nine-inch sewer, will bring the drainage from the houses on the south-east side of Holebrook Place, and, running down Garden Crescent and Fitzroy Place, will receive the drainage of those places and of part of Davey-street; and also in its course down Albuera-street and Montpelier Retreat, that of the houses in parts of St. George's Terrace, Hampden Road, and James-street. This part of the sewer would drain about 90 acres, with a present population of 1100, and an estimated one of 1800. At Salamanca Place it will receive branches from that place, and from Gladstone, Morrison, and Brook streets, draining about 30 acres more, with a population of 750. Thence it would run as a 12-inch sewer along the New Wharf, receiving opposite Kelly Steps a branch bringing the drainage from Kelly and South streets. Thence, as a 15-inch sewer, it would continue round the Esplanade, receiving branches from Runnymede-street and Ordnance Place. The additional area thus drained would be about 40 acres, with a present population of 1010 and an estimated one of 1400. Opposite Secheron Road it would receive the other system of sewers, bringing drainage from an area of 40 acres, occupied at present by a population of 900 persons, with provision made for 1400. This area includes De Witt, Cromwell, Colville, Francis, and Mona streets, Wellington Crescent, and part of Hampden Road. The sewers along the New Wharf and Esplanade will have a fall of 1 in 600, but all the rest will have good gradients. There will be 150 yards of 18-inch sewers, 700 yards of 15-inch, 200 yards of 12-inch, 6600 yards of 9-inch, and 2500 yards of 6-inch. The total area draining to the Battery Point outfall is thus about 200 acres, of which 195 are in the City of Hobart and 5 in the Road District of Leslie. The present population is 3760, being at the rate of 19 to the acre, and provision is made for 5350, being 27 to the acre.

Napoleon-street Basin.

Napoleon-street.

24. There is a small basin adjoining that last described, and occupying about 12 acres on each side of Napoleon-street. The drainage from this, unless artificially lifted, will have to be discharged into Sandy Bay, near the patent slip. There is at present a population of 160, and provision is made for 240. There will be 450 yards of 9-inch sewers and 350 of 6-inch laid down for its sewerage, and the gradients will be good.

Wellington Rivulet Basin.

Wellington Rivulet.

25. The Wellington Rivulet Sewer will begin with 12-inch pipes at the bridge over the rivulet at Parliament-street, junctions being left to receive sewers, when required, from further up the valley, and from parts of Parliament and Bridge streets. It will run down the north bank of the rivulet, receiving branch sewers from the south at Regent, High, East Princes, and Wells streets, and from the north from Francis-street, Montpelier Road, and Quayle, Bath, and Napoleon streets. These branches will bring in the drainage from parts of the streets named, and from King, Queen, Turner and Byron streets, and St. George's Terrace. The area drained is about 170 acres, of which about 60 are in the City of Hobart and the rest in Queenborough. The existing population is about 1000 being about six to the acre, and provision is made for 3400, or 20 to the acre. The gradient of the main sewer will be 1 in 70, and those of the branch sewers still better. There will be 1400 yards of 12-inch sewer, 4600 yards of 9-inch, and 1200 yards of 6-inch.

Ashfield Rivulet Basin.

Queen-borough.

26. The Ashfield Rivulet sewer will begin as a 9-inch pipe sewer in Edward-street, with branches from John and Charles streets. At Parliament-street it will receive a branch bringing in the drainage of parts of that street and Princes-street, and at Regent-street another from that street. Following generally the line of the rivulet, it will cross and receive branch sewers from Grosvenor, Flinders, and Margaret streets, together with one draining the side valley that crosses Douglas Crescent and Princes-street, East. From Margaret-street it will be taken along the Esplanade to the Wellington Rivulet outfall so as to avoid duplication of the outfalls. In this basin there will be 650 yards of 12-inch pipe, 4000 yards of 9-inch pipe, and 1000 yards of 6-inch pipe sewer; and the area drained, all of which is in Queenborough, will be about 130 acres, with an existing population of 950, being at the rate of seven to the acre, and provision is made for 2000, being 15 to the acre.

Lower Sandy Bay.

Rural. Queen-borough.

27. Beyond Lord-street the Lower Sandy Bay District is divided into a number of valleys which can at any time be very easily drained. There are, probably—in addition to the land now occupied—about 200 acres more that may eventually be built upon. The population is now about 400. The first of these valleys is that drained by the Rifle Range Rivulet, and in it no work is at present proposed. At the Cemetery Rivulet Valley about 300 yards of 9-inch pipes would supply present needs, and at the Derwentwater Valley about 500 yards of a similar-sized sewer.

Eventually the drainage from both these valleys ought to be discharged from the end of Dunkley's Point after receiving such treatment as may be determined. At Maning's Rivulet Valley about 400 yards of 9-inch pipes would suffice for the present, with a discharge from the little rocky point at the mouth of the rivulet. At the valley of the rivulet discharging behind the Red Chapel about 600 yards of 9-inch pipes and 100 yards of 6-inch pipes would suffice for the present, and their outfall would be at the rocky point behind the Chapel.

New Town Basin.

New Town. 28. The New Town Main sewer will begin on the Main Road at the saddle above the Commercial Road, where it will receive a short branch from Wilson-street. A little further on another branch will bring in the drainage from Archer and Lord streets. Continuing along the Main Road it will next receive a branch from Argyll, George, and Stoke-streets. Turning down Pedder-street, at the end of Fraser-street it will receive a branch drain from that street, and another that will bring in the drainage of the houses on the west side of the Main Road, and from Seymour-street, part of Clare-street, and of the Augusta Road. Leaving the street it will follow the bottom of the valley to Cross-street, where it will receive a branch from a lateral valley bringing in drainage from parts of Pedder, Hope, Clare, Newton, Bedford, and Alfred-streets. A little further on another lateral valley sewer will bring the drainage from other parts of Pedder and Clare-streets, and the Augusta Road. The main sewer, now 12 inches in diameter, still following the valley, will gain Montagu-street, and at the meeting of the roads opposite the *Maypole Inn* will receive a branch bringing in the drainage of Forster, Ross, Claude, Arthur, and Murrell-streets, and another branch bringing in that of the Charitable Institution, and two others from Pirie-street and the Main Road. From the Maypole Cross Roads the main sewer will run down the right or south-eastern bank of the Maypole Rivulet. At Swanston-street it will receive a branch sewer from that street, thence running as a 15 inch sewer it will gain the Risdon Road, along which it will run to the shore of New Town Bay, where it will receive a branch drain bringing in the drainage of parts of California, Park, and Swanston-streets. The area drained is about 390 acres, all in New Town, with an existing population of 2200, or about 6 to the acre; and provision is made for 6000, or 15 to the acre. The collecting sewers will be 750 yards of 15-inch pipes, 900 yards of 12-inch, 10,350 yards of 9-inch, and 5300 yards of 6-inch. The gradients will be good.

New Town Rivulet Basin.

South Glenorchy. 29. The New Town Rivulet Valley sewer will, for the present, commence a little to the west of the Main Road, and follow generally the course of the stream on its left or northern bank to Pitt Farm, where it will cross to the other bank, gain the Risdon Road, and have a common outfall with the New Town system of sewers. Branch sewers will serve the houses on both banks, and there will be 2000 yards of 9-inch pipes and 700 yards of 6-inch. The area drained will be about 120 acres, of which about 40 acres will be in New Town and 80 in South Glenorchy. The present population is about 750, being about 6 to the acre, and provision is made for 1800, or about 15 to the acre.

The Queen's Domain.

The Domain. 30. The system for collecting the drainage of Government House and other buildings on the Queen's Domain would so much depend upon the system adopted for sewage disposal, that its consideration may be postponed for the present.

Cornelian Bay Basin.

Cornelian Bay. 31. Between the Domain and the New Town basin there is a small valley nearly unoccupied by houses, and which naturally drains into Cornelian Bay. When this valley comes to be built upon arrangements will have to be made to lift the sewage so as to be disposed of with that of the New Town system. This will not be difficult nor costly.

New Town Bay.

Risdon Road. 32. There are beyond the outfall of the New Town Rivulet three small valleys draining into the bay. When these are built upon they will be easily drained, and the sewage from them treated with that of New Town.

Abstract and Summary.

Table. 33. The accompanying table gives an abstract and summary of the above described systems, showing the lengths of the various sized sewers, the extent of each sub-district, its present population and density of occupation, the quantity of sewage to be taken from it during the hour of greatest flow and during the whole day, distinguishing between dry and wet weather flow, the population at its estimated increase in forty years, and the quantity of sewage to be taken from such increased population differentiated as in the case of the existing population, and the hourly and daily carrying capacity of the sewers. With regard to present and prospective requirements and provision made for meeting them, the table may be thus read :—The Hobart Rivulet main sewer at Glen-street (the city boundary) will drain an area of 120 acres, with an existing population of 700, requiring provision for carrying off during the hour of greatest flow 4200 gallons of sewage in dry weather and 9450 gallons

in wet. In forty years it is anticipated that the population will have increased to 1800, requiring provision during the hour named for carrying off 10,800 gallons in dry weather and 24,300 in wet, and provision is made for carrying away 48,000 gallons in the time. By the time the sewer has reached Molle-street the area drained will have increased to 260 acres, with a present population of 2292, producing, in the hour named, in dry weather 13,752 gallons of sewage, and 30,942 gallons in wet, and it is anticipated that the population will have augmented in forty years to 4600, producing in dry weather 27,600 gallons, and in wet 62,100, and provision is made for carrying off 98,000 gallons; and so on all through the table. In connection with the apparent excess of provision made it is to be explained that it arises from the fact that it is customary to make sewer pipes of certain stock dimensions, and that it is not worth while to have them made of special sizes. The effect of this is that when a pipe a little more than six, nine, or any other number of inches in diameter would be amply sufficient, it is better to go up to the next stock size, though that size may perhaps give very much more carrying capacity than is required.

Subsidiary Works.

Materials.

34. The materials recommended to be used in the construction of the sewers are,—for all sewers under 18 inches in diameter and probably also for those of that diameter, salt-glazed stoneware socket pipes jointed with cement; and for all of larger diameters, brickwork in cement. The sewers should as far as possible be laid in perfectly straight lines, with manholes for inspection at every change of direction. In no place will they need to be laid at a great depth, nine feet being probably the maximum depth, except in short lengths when crossing road embankments. The average depth will be under five feet.

Manholes.

35. For the purpose of inspecting the sewers and observing their working, especially in places where they are likely to be obstructed, manholes should be constructed at every bend and every junction of one sewer with another. As a general rule there should be a manhole for each 200 yards of sewer, and the estimates are based upon this rule. If the manholes be used in connection with the ventilation of the sewers, special means should be taken to prevent the egress of offensive smells by making the openings air inlets only.

Sewer ventilation.

36. The importance of sewer ventilation has been already mentioned. The system of sewerage that has been described has been designed to prevent the sewers ever becoming sewers of deposit. As there is almost everywhere ample fall, comparatively small sewers will suffice to carry off the sewage, and the sewers will have the double advantage of having a rapidly flowing current through them, and of having but small capacity as gas-holders. They will thus require but comparatively little ventilation, and that ventilation will be easily accomplished. Of sewer gases properly so called, that is such gases as sulphuretted hydrogen and other products of the putrefaction of animal and vegetable matter, there need be no fear, as such putrefaction takes time, and that time will not be afforded. In the longest line of sewer, that from the valley of the Patrick Rivulet behind the Cascade Brewery to Macquarie Point, some 6000 yards in length, the sewage entering at the upper end will reach the outfall in little less than an hour, and being in rapid motion all the time, no fermentative or putrefactive process can take place. But, though there be no sewer gas, there will be foul smelling air that must not be allowed to escape into dwelling-houses or the public streets. The most effective plan to deal with it is to dilute it with as much fresh air as possible while still in the sewers, and to keep up a good current of air in them by drawing in as much from the atmosphere as possible and discharging it at such heights and in such positions as will prevent offence. Provision for effecting this is made in the estimates for such part of the work as will be effected independently of house drainage. As regards the ventilation of sewers by special appliances such as gas furnaces and other apparatus for causing draughts and destroying odours by heat, all experience shows their futility. Even connecting a sewer with large boiler fires only ventilates the portion of it in the immediate neighbourhood of the furnace. The best system is to have rather more outlet space than inlet, and to have both furnished with appliances to take advantage of the wind from whatever quarter it may be blowing. But care must be taken not to have a too energetic ventilation, as it may blow out all water from the traps and syphons. In connection with this matter powers should be taken in the proposed Act to affix ventilating appliances in and upon private property.

Sewer flushing.

37. In connection with the manhole at the head of every sewer, means of flushing can readily be provided. It is not recommended that automatic tanks should be fixed in such positions, as their cost is great, and periodical flushing by other means is found to be as efficient and much more economical, even if water carts have to be used. At various places along the lines of the main sewers provision can be made for utilising the water of various rivulets crossed for flushing purposes, and such provision is calculated for. In many other places the sewage itself can be, without danger, temporarily impounded for flushing purposes. With these flushing facilities it will not be necessary to pay a large sum for water for the purpose.

Storm overflows.

38. In many places, especially along the lower parts of the sewers where they are most liable to be overcharged during heavy rainfalls, storm overflows should, and can easily be provided in connection with the manholes. During such rainfalls the sewage is so largely diluted as to be rendered comparatively innocuous, and its admission into streams that are not used for domestic water supply is found to be unattended with danger or inconvenience. The large provision made

METROPOLITAN DRAINAGE AREA—ABSTRACT OF SEWERAGE SYSTEM.

Localities.	Lengths of Sewers in yards.							Area Drained, Acres.	Present Population.		Quantity of Sewage in Gallons—Present Population.				Population provided for.		Quantity of Sewage in Gallons of Population provided for.				Carrying capacity of Sewer at lower end in Gallons.	
	6 in.	9 in.	12 in.	15 in.	18 in.	30 in.	36 in.		Number.	Rate to Acre.	In Hour of greatest flow.		In a Day.		Number.	Rate to Acre.	In Hour of greatest flow.		In a Day.		In an Hour.	In a Day.
											Dry weather.	Wet weather.	Dry weather.	Wet weather.			Dry weather.	Wet weather.	Dry weather.	Wet weat er.		
HOBART RIVULET BASIN, MACQUARIE POINT OUTFALL.																						
From above Brewery to Glen-street	1500	4500	...	...	...	...	...	120	700	6	4200	9450	28,000	154,000	1800	15	10,800	24,300	72,000	396,000	48,000	1,127,000
From Glen-street to Molle-street	1900	3000	1330	...	...	...	...	140	1592	11	9552	21,492	63,680	350,240	2800	20	16,800	37,800	112,000	616,000		
Totals to Molle-street	3400	7500	1330	...	...	...	...	260	2292	9	13,752	30,942	91,680	504,240	4600	17	27,600	62,100	184,000	1,012,000	98,000	2,352,000
From Molle-street to Barrack-street	900	2100	...	360	...	...	...	110	1200	11	7200	16,200	48,000	264,000	2200	20	13,200	29,700	88,000	484,000		
Totals to Barrack-street	4300	9600	1330	360	...	...	...	370	3492	9	20,952	47,142	137,680	768,240	6800	18	40,800	91,800	272,000	1,496,000	146,000	3,504,000
From Barrack-street to Elizabeth-street	1650	5900	...	...	660	...	...	70	2950	42	17,700	39,845	118,000	649,000	3500	50	21,000	47,250	140,000	770,000		
Totals to Elizabeth-street	5950	15,500	1330	360	660	...	...	440	6442	14	38,652	86,987	255,680	1,417,240	10,300	24	61,800	139,050	412,000	2,266,000	216,000	5,184,000
From the Elizabeth-street Basin	1800	9900	500	300	...	...	...	334	6680	20	40,080	90,180	267,200	1,469,600	9060	28	54,360	122,310	362,400	1,993,200		
From Elizabeth-street to Park-street	400	1000	...	...	...	760	...	42	1365	32	8190	18,427	54,600	300,300	1680	40	10,080	22,680	67,200	369,600		
Totals to Park-street	8150	26,400	1830	660	660	760	...	816	14,487	17	86,922	195,594	577,480	3,187,140	21,040	26	126,240	284,040	841,600	4,628,800	382,000	9,168,000
From the Park Rivulet Basin	2800	12,500	900	500	...	...	...	460	5750	12	34,500	77,625	230,000	1,265,000	9200	20	54,200	121,950	368,000	2,024,000		
From Lower Macquarie-street Basin	500	3600	400	300	...	...	900	70	2080	30	12,480	28,000	83,200	457,600	2450	35	14,700	33,075	98,000	539,000		
Totals to Outfall, Macquarie Point	11,450	42,500	3130	1460	660	760	900	1346	2,317	17	133,902	301,219	890,680	4,909,740	32,690	24	195,140	439,065	1,307,600	7,191,800	585,000	14,040,000
BASINS DRAINING TO BATTERY POINT OUTFALL.																						
From Holbrook Place to Salamanca Place	1000	3500	...	...	...	...	...	90	1100	12	6600	14,850	44,000	242,000	1800	20	10,800	24,300	72,000	396,000	48,000	1,127,000
From Morrison-street, &c., to New Wharf	400	1000	200	...	...	...	...	30	750	25	4500	10,125	30,000	165,000	750	25	4500	10,125	30,000	165,000		
From New Wharf, &c., to Secheron Road	500	900	...	700	...	...	...	40	1010	25	6060	13,635	40,400	222,200	1400	35	8400	18,900	56.000	308,000		
Totals to Secheron Road	1900	5400	200	700	...	...	...	160	2860	18	17,160	38,610	114,400	629,200	3950	25	23,700	53,325	158,000	869,000	58,000	1,392,000
From De Witt-street, &c., to Secheron Road and Outfall	600	1200	...	...	150	...	...	40	900	22	5400	12,150	36,000	198,000	1400	35	8400	18,900	56,000	308,000		
Totals to Outfall, Battery Point	2500	6600	200	700	150	...	...	200	3760	19	22,560	50,760	150,400	827,200	5350	27	32,100	72,225	214,000	1,177,000	90,000	2,160,000
NAPOLEON-STREET BASIN. *Totals*	350	450	...	...	...	...	...	12	160	13	960	2160	6400	35,200	240	20	1440	3240	9600	26,400	40,000	960,000
BASINS DRAINING TO WELLINGTON RIVULET OUTFALL.																						
Wellington Rivulet Basin from Parliament-street to Outfall	1200	4600	1400	...	...	...	...	170	1000	6	6000	13,500	40,000	220,000	3400	20	20,400	45,900	136,000	748,000	87,000	2,090,000
Ashfield Rivulet Basin from Edward-street to Outfall	1000	4000	650	...	...	...	...	130	950	7	5700	12,825	38,000	209,000	2000	15	12,000	27,000	80,000	440,000	36,000	864,000
Totals to Outfall Wellington Rivulet	2200	8600	2050	...	...	...	...	300	1950	6	11,700	26,325	78,000	429,000	5400	18	32,400	72,900	216,000	1,188,000	123,000	2,954,000
BASINS DRAINING INTO NEW TOWN BAY OUTFALL.																						
Maypole Rivulet Basin	5300	10,350	900	750	...	...	...	390	2200	6	13,200	29,700	88,000	484,000	6000	15	36,000	81,000	240,000	1,320,000	118,000	2,832,000
New Town Rivulet Basin	700	2000	...	...	...	...	...	120	750	6	4500	10,125	30,000	165,000	1800	15	10,800	24,300	72,000	396,000	40,000	960,000
Totals to Outfall, New Town Bay	6000	12,350	900	750	...	...	...	510	2950	6	17,700	39,825	118,000	649,000	7800	15	46,800	105,300	312,000	1,716,000	158,000	3,792,000
LOWER SANDY BAY VALLEYS. *Totals*	100	1800	...	...	...	...	...	60	420	7	...	...	...	...	900	15	Four Valleys discharging separately.					
SUMMARY.																						
Hobart Rivulet Basin, Macquarie Point Outfall	11,450	42,500	3130	1460	660	760	900	1346	22,317	17	133,902	301,219	890,680	4,909,740	32,690	24	195,140	439,065	1,307,600	7,191,800	585,000	14,040,000
Basin Draining to Battery Point Outfall	2500	6600	200	700	150	...	...	200	3760	19	22,560	50,760	150,400	827,200	5350	27	32,100	72,225	214,000	1,177,000	90,000	2,160,000
Napoleon-street Basin	350	450	...	...	...	...	...	12	160	13	960	2160	6400	35,200	240	20	1440	3240	9600	26,400	40,000	960,000
Wellington and Ashfield Rivulet Basins	2200	8600	2050	...	...	...	...	300	1950	6	11,700	26,325	78,000	429,000	5400	18	32,400	72,900	216,000	1,188,000	123,000	2,954,000
Maypole and New Town Rivulet Basins	6000	12,350	900	750	...	...	...	510	2950	6	17,700	39,825	118,000	649,000	7800	15	46,800	105,300	312,000	1,716,000	158,000	3,792,000
Lower Sandy Bay Valleys	100	1800	...	...	...	...	...	60	420	7	...	...	...	...	900	15	...	...	...	...	...	...
TOTALS	22,600	72,300	6280	2910	810	760	900	2428	31,557	13	186,822	420,289	1,243,480	6,850,140	52,380	22	307,880	692,730	2,059,200	11,299,200	996,000	23,906,000

in regard to the carrying off of rain-water will shew that the storm overflows will come into use only during violent and sudden storms.

Land drainage.

39. In some parts of the area, especially in the older parts of the City, it will probably be found necessary to effect some land drainage and relieve the subsoil of water more or less polluted by percolation through ground that for generations has been made the receptacle of household slops, nightsoil, and filth of all sorts. As the pipes for conveying sewage must be made impervious so as to prevent the pollution of the ground through which they are laid, this land drainage must be effected by means of ordinary open-jointed pipes laid independently, though usually in the same trench, and communicating, where the water they collect is foul, with the sewer at a manhole, or, where the water is not foul, it may be sent into the nearest watercourse. A provision is made for this purpose. This land drainage is often found to have a very marked effect on the public health, especially in connection with consumption and diphtheria.

Work at outfalls.

40. Whatever system of sewage disposal you may adopt it will be necessary to provide at the outfalls the means of discharging the sewage collected there, either continuously or occasionally in case of accidents to machinery and in other emergencies. The discharge should be made at low-water level, between the line of which and of high water the sewers should be constructed in iron. At the Macquarie Point and Battery Point outfalls these works will be rather expensive, as the pipe channels will have to be cut through greenstone. At all the outfalls, if you adopt a system requiring pumping, means should be provided to prevent the influx of water at the exceptionally high tides that occur occasionally in the Derwent.

Special works. Rivulet crossings.

41. The special works connected with the various crossings of the Hobart and other Rivulets will not be heavy. In connection with the collection sewers no other unusual or costly work will be necessary. In a few places, such as at the junctions of the more important branch sewers, manholes with chambers larger than those of other places will be required. But, except where solid greenstone is met with in the excavations, the work may be altogether characterised as ordinary and easy.

Estimates of cost of works.

42. In the preparation of the following estimates I have to acknowledge the assistance I have received from two Members of your Board—the Worshipful the Mayor of Hobart and Mr. Gregory—and from Mr. James, formerly City Surveyor, and Mr. M. Kennedy. The local knowledge of prices possessed by all these gentlemen has been of very great use. In a country like that of the Metropolitan Area, where volcanic action has in so many places disturbed, and replaced with intruded greenstone, the sedimentary rocks and deposits that once occupied the surface, it would be difficult to arrive with any reasonable number of trial holes at a real knowledge of the nature of the material that will be met with in the drain trenches; and without any trial holes at all the knowledge cannot be exact. But from such superficial examination as has been possible, it results that probably 73 per cent. of the material to be excavated will be earthy matter or made ground, 12 per cent. sandstone or argillaceous rock, and 15 per cent. greenstone more or less solid, one-third being probably solid "ironstone." In considering these proportions it must be borne in mind that the sewer trenches are all comparatively shallow, and some of them positively so, and that consequently rock, when met with, may only be a little at the bottom of the excavation. With regard to pipe sewers the estimates are based on special prices quoted to me by Mr. Campbell and Messrs. M'Hugh and Jackson, of Launceston, for their pipes delivered in Hobart. It should be explained that the price mentioned for the numbered items is the aggregate price of a number of works that will greatly vary in cost—for instance, the cost of the additional work connected with crossings of the various rivulets will vary from over fifty pounds in some cases to under fifty shillings in others.

ESTIMATE.

Estimates.

43. The following is an estimate of the quantity and cost of the works connected with the collection of the sewage of the Area:—

		£	s.	d.
900	yards Sewers 36 inches in diameter, at 55*s.*	2475	0	0
760	„ 30 „ „ 25*s.*	950	0	0
810	„ 18 „ „ 18*s.* 6*d.*	749	5	0
2910	„ 15 „ „ 13*s.* 6*d.*	1964	5	0
6280	„ 12 „ „ 11*s.*	3454	0	0
72,300	„ 9 „ „ 8*s.*	28,920	0	0
22,600	„ 6 „ „ 5*s.* 6*d.*	6215	0	0
10,000	House junctions (additional price) at 4*s.*	2000	0	0
9	Additional work at Outfalls	1216	0	0
533	Manholes	2028	0	0
	Provision for special ventilating work	1000	0	0
	Provision for Land drainage	350	0	0
240	Flushing Sluices in Manholes	401	5	0
24	Storm Overflows in Manholes	240	0	0
51	Additional Work at Rivulet Crossings	720	0	0
	Add 15% for contingencies, compensation, &c	7902	5	0
		£60,585	0	0

Their nature and use.

44. This estimate is as near an approximation as can be made until detailed plans are prepared. It can be relied upon as showing you the cost of collecting works for such parts of the district as require immediate attention, and as enabling you to compare the work to be done with the means of doing it.

SEWAGE DISPOSAL.

Preliminary considerations.

45. In connection with the subject of sewage disposal there are one or two general preliminary considerations that have to be stated and discussed. In the first place it is to be borne in mind that though it is necessary to provide means for carrying off the sewage from the houses in the varying quantities hour by hour in which it is produced, and with the sewage a quantity of rainwater that sometimes greatly exceeds it in volume, it is by no means as necessary to provide for the storage, pumping, and treatment of largely diluted sewage, as it is for that of undiluted or dry-weather sewage. This is a consideration of great importance, for if the sewage is to be treated in any manner before discharge it follows as a necessary condition that at least some considerable part of it must be both stored and pumped, when, as in the Metropolitan Area, the collecting sewers deliver it at about the sea level. The storage is necessary, if for nothing else, for the necessity that practically and economically exists of equalising as far as possible the pumping work of each part of the day. If this be not done power must be provided to lift, within the hour, the quantity brought in the sewers in the hour of greatest flow; that is, about four times more power must be provided than would be necessary if the pumping were equalised; and that some pumping is necessary if the sewage is to be treated is self-evident. The answer to the question as to what degree dilution of the sewage is necessary before allowing its discharge, depends partly on the character of the sewage itself, and partly on that of the place where it is discharged. In the Metropolitan Area at present the sewage may be taken to be ordinary house sewage, but slightly affected by that from manufacturing processes; and if some process of purification be adopted, the place where some of it might have to be occasionally discharged without such treatment would be the tidal estuary of the Derwent. Under these circumstances, if pumping power and storage space be provided on calculations based upon double the ordinary dry-weather flow, the sewage that would occasionally pass would be diluted with at least its own volume of rainwater.

If this basis with respect to provision for pumping and storage be taken in connection with the existing population of the area, it is probable that the machinery and tanks to be constructed at the outset will suffice for the requirements of the next fifteen or twenty years. And, as has been already mentioned, machinery and tanks can be added to at that or any other time without interfering with the daily working of the system.

Methods of sewage disposal.

46. The practicable methods of sewage disposal may be described under three heads—I. Utilization on land and purification of the sewage by irrigation over or filtration through the soil: II. Purification by chemical treatment, with or without filtration, and with or without further treatment of the residues in preparation of manure: III. Discharging the sewage without treatment into the tideway, either continuously or only at certain states of the tides.

It will be quite practicable to combine two or more of these methods in the general or partial treatment of the sewage, or to adopt one method at one outfall and another method at another.

The various methods will be considered in the order in which they have been mentioned.

Sewage Treatment on Land: Irrigation.

Methods of Irrigation.

47. There are two methods of irrigation with sewage: first, broad irrigation, in which the sewage is kept on the surface, and its purification is effected by keeping it in contact for a time with the chemical and vital influences of the surface of the soil and of the root fibrils of the grasses, which are usually the only plants grown under broad irrigation; and secondly, filtration-irrigation, in which the sewage is purified not only by surface influences, but also by filtration through a greater or less thickness of porous soil. Both systems require about an equal area of land to deal with a given quantity of sewage. At Croydon, where broad irrigation is practised, the quantity of sewage applied is from twelve to fourteen thousand tons to the acre every year; but in this case profitable farming is the secondary consideration, and dealing with all the sewage the first, so it is applied whatever the condition of the crops may be, and without regard to their being spoiled or not. At Gennevilliers, near Paris, where filtration-irrigation is practised, 16,000 tons are yearly applied to each acre. At Adelaide, where the Gennevilliers plan is adopted, only 5000 tons an acre are applied in a year; and there are special filter-beds constructed, 15 acres in extent, for purifying the sewage when it cannot profitably be applied to the land. As already mentioned, it is desirable, if irrigation be adopted, that all the land required within the time for which provision is made by forecast should be at once secured. The quantity of land required to receive all the sewage at the rate of 16,000 tons to the acre, and on the basis above named (§ 44), would be 410 acres. This quantity should, to avoid the expense of having several establishments, be obtained in one holding.

Broad irrigation.

48. It follows from what has been said that, for a broad-irrigation farm, the land should be of a stiff retentive nature. There would probably be great difficulty in obtaining a sufficient quantity of such land in a suitable locality, and within practicable distance. And as, furthermore, broad-irrigation has the great drawback of producing almost exclusively Italian rye-grass to be cut and consumed green—a crop the continual sale of which would be attended with difficulty—no specific estimate of the cost of adopting it as the method of disposing of the sewage of the

Metropolitan Area has been made. But, generally speaking, its adoption would cost about the same as that of the system of filtration-irrigation about to be considered. The suface work would cost more, but it is probable that its additional cost would be balanced by saving on the subsoil drainage work ; and, of course, the cost of conveying the sewage to the farm would be the same for each system for equal distances and heights of delivery.

The land and its preparation.

49. Land that, as far as can be judged by superficial examination, would be suitable for a sewage-irrigation and filtration farm, can be found in the neighbourhood of South Glenorchy. As it would all have to be thoroughly cleared arable land, its cost would probably be £25 an acre. It is very likely that it could be had on lease, but as the cost of its thorough drainage, surface preparation, and carrier-drain making would come to about sixty per cent. of the cost of the land, it would not be worth while to spend so much on leasehold property. The sewage would have to be delivered on the highest point of the farm, so that it could be sent to any part along the carrier-drains by gravitation. As it would be all screened before being pumped, there would be no necessity for screening it on the farm. But there would have to be one or more dividing-tanks and sluices to command the system of irrigation, or to divert the sewage from the land on to the filter-beds. These filter-beds are a necessary provision to meet the case of having to purify the sewage at a time when, on account of the condition of the crops or otherwise, no portion of the land requires irrigation. At Adelaide 15 acres of such filters are used. Here it is proposed to make only 5 acres of a similar construction. The farm would have to be through-drained. The depth and distance apart of the drains would naturally depend on the depth, porosity, and configuration of the ground. The same conditions will regulate the length and size of the carriers required, and the best material to employ in their construction. The main carriers will be permanent, and provision will have to be made of movable troughs as subsidiary carriers. The whole surface of the farm, where not naturally lying with suitable falls for irrigation purposes, will have to be carefully formed. Proper formation at the outset is absolutely necessary, otherwise not only will the whole surface not be benefited, but parts of it may become sewage-sodden, and consequently unfruitful, and a cause of nuisance. The total cost of the drainage, carriers, and surface formation is estimated at £15 an acre. The filters would cost about £420 an acre. The profitable working of a sewage farm would require some special farm buildings, and a provision of £1000 is made in the estimate for this purpose.

Filter-beds.

Pumping arrangements.

50. No part of the sewage of the area could flow by gravitation to the land at Glenorchy: all will consequently have to be pumped. It will be seen by the table given (§ 32) that of the one and a quarter million gallons of sewage forming the daily dry-weather quantity from the present population of the area, about 900,000 are collected at Macquarie Point, 150,000 at Battery Point, 80,000 at Wellington Rivulet, and 120,000 at New Town Bay. To avoid the expense attendant upon having a number of separate pumping-stations, each of which would require separate machinery, buildings, tanks, and staff of enginemen, firemen, &c., the following scheme is based on an arrangement for concentrating as much of the pumping machinery as it is practicable to do with advantage at the Hobart Rivulet or Macquarie Point Outfall Station. Provision is, therefore, made by means of Shone's ejectors, worked by air compression, established there to bring to that station all the sewage from outfalls lying further off from the sewage farm—that is, from the Battery Point, Wellington and Ashfield Rivulets, and Napoleon-street Outfall Stations. For the present the Lower Sandy Bay outfalls are not dealt with, but compressed air for working their ejectors could be supplied from the main station also. The New Town Station, being nearly on the line of sewage main to the proposed farm, would be worked by pumping machinery independently. The following estimates are based on the suggestion made in § 45 of providing for dealing, as far as storage and pumping are concerned, with twice the present dry-weather flow of sewage.

Hobart Rivulet or Macquarie Point Station.

Collecting works.

51. The works at or connected with the Hobart Rivulet or Macquarie Point Station may be divided into two parts, those necessary for collecting the sewage from the stations south of it, and mentioned in the preceding paragraph, and those required for sending the sewage to the farm. In reference to the collecting works, to avoid the necessity of having storage tanks for equalising the hourly flow at the southern stations—each of which tanks would require a small staff of men to manage them—sufficient ejector power is provided for dealing with the quantity of sewage brought in during the hour of greatest flow. This provision includes two 400-gallon ejectors, two 200 gallons, and one 50 gallons; that is, ejectors capable of raising and discharging the quantities named in a minute. These ejectors and their fittings would cost about £1700, and the construction of brickwork chambers for them is estimated to cost £1540. About 2000 yards of 12-inch and 1000 yards of 10-inch cast-iron sewage mains would be needed, with 2000 yards of 5-inch and 1000 yards of 4-inch air mains, the whole of which would cost £3670. All these works would be outside the pumping station. Within it would be placed the air-compressing machinery, the total power required being about 22 horse-power, and provision is made for this in conjunction with the pumping machinery. But as the whole of this power would for many years to come be but seldom required, it is proposed to have two sets of engines, geared to work independently or collectively. In ordinary times one set would suffice, in emergencies both would be available.

Pumping works.

52. The quantity of sewage thus collected at the Macquarie Point Station, together with that flowing to it by gravitation, would amount, calculated as above described, to two and a quarter

million gallons. To insure that sufficient storage space was always available to equalise the pumping, two sets of tanks or reservoirs would be necessary, each capable of holding six hours' flow, or 90,000 cubic feet: such tanks built of brickwork in cement would cost £8100. A deposit of sediment would always take place in these tanks, and its removal could be effected more safely and cheaply by an ejector than by manual labour. The sewage would have to be screened before being pumped, and the requisite works for effecting the sludge removal and screening would cost £640. The lift from the tanks to the farm is about 55 feet, and with an 18-inch delivery main the head required to overcome the friction in 8000 yards of this main would be nearly as much more. The engines required to send the sewage to the farm would have to be of about 66 horse-power; but, as in the case of the compressing engines, the whole of this power would be seldom needed; the power would be furnished by duplicate engines. These, of a power sufficient for both services, and with all the necessary boilers, pumps, compressors, and other fittings, are estimated to cost £3000.

The 8000 yards of pumping main would cost £16,000. It might be laid parallel to the railway, if not within its fences. And £1000 are provided in the estimate for engine and boiler houses, chimney shaft, and fencing.

Site of works.

53. No provision has been made in the estimate for the purchase of land for these works, as it is taken for granted that a sufficient quantity of the land to be reclaimed near Macquarie Point could be obtained for the purpose.

New Town

54. The works at New Town would be similar, but on a much smaller scale. They would comprise two sewage tanks, each capable of holding 10,000 cubic feet of sewage; two 4 horse-power engines, pumps, and compressor; a 50-gallon ejector for the sludge; 400 yards of 9-inch sewage main; and the necessary buildings and land: the whole estimated to cost £2715.

Total cost of disposal by irrigation.

55. The following table gives the estimated total outlay for establishing the necessary works for disposing of the sewage by irrigation:—

	£	s.	d.	£	s.	d.
The Farm—						
410 acres of land, at £25	10,250	0	0			
Drainage, levelling, and carriers, at £15 each	6150	0	0			
5 acres of filter-beds, at £420	2100	0	0			
Control tanks, sluices, and movable carriers	500	0	0			
Provision for farm buildings	1000	0	0			
Contingencies, 10 per cent.	2000	0	0			
Total outlay on Farm	...			22,000	0	0
The Hobart Pumping Station—						
Tanks or reservoirs	8100	0	0			
Sludge ejector and chamber	640	0	0			
Two sets engines, boilers, pumps, compressors, &c.	3000	0	0			
8000 yards (1600 tons) 18-inch cast-iron pipes (partly used for New Town outfalls)	16,000	0	0			
Engine and boiler-house, chimney, &c.	1000	0	0			
Fencing, roads, &c.	270	0	0			
Contingencies, 10 per cent.	2901	0	0			
Total outlay at Pumping Station	...			31,911	0	0
At Southern Outfalls—						
Five ejectors and fittings	1700	0	0			
Chambers for ditto	1540	0	0			
367 tons of iron mains	3670	0	0			
Contingencies, 10 per cent.	691	0	0			
Total outlay at Battery Point, &c.	...			7601	0	0
At New Town Pumping Station—						
Tanks	910	0	0			
Ejector and chamber	390	0	0			
Engines, pumps, &c.	700	0	0			
Buildings, land, and fencing	440	0	0			
27½ tons iron mains	275	0	0			
Contingencies, 10 per cent.	272	0	0			
Total at New Town Station	...			2987	0	0
Total special outlay for Irrigation	...			64,499	0	0
Add cost of Collecting Works	...			60,585	0	0
Total cost of collection and disposal by Irrigation	...			£125,084	0	0

56. The following is an estimate of the yearly cost of working this irrigation system :— Yearly charge for collection and disposal by irrigation of the sewage.

	£
Interest and sinking fund on capital outlay, at 5 per cent.	6254
Repairs to works, 1 per cent.	1250
Water for sewer-flushing	500
Sewer men and superintendence	700
Pumping stations, labour, coal, water, oil, &c.	2320
Administrative expenses and contingencies	1000
TOTAL	£12,024

By the time the sinking fund will have paid off the capital the above yearly working account will probably stand at about £6500, as the interest will cease on the one hand, but the cost of repairs will increase on the other.

It will be noted that nothing has been said on one side about the costs to be incurred, and on the other the profits to be realized by the farming operations. It is very difficult to know what to say. But experience of all sewage farms points to the conclusion that they should be considered only as a means to purify sewage, and not as a source of profit. At Adelaide, though none of the sewage has to be pumped, a considerable yearly loss occurs. Profits of farm.

SEWAGE TREATMENT BY CHEMICAL PROCESSES.—PRECIPITATION.

57. There are innumerable methods of clarifying and partially purifying sewage by precipitation. But, if methods in which the use of more or less costly chemicals and mixing machinery and other appliances are necessary be excluded from consideration, practically only two processes that have been tried on a large scale would remain to be discussed—namely, precipitation by lime or lime and iron, and precipitation by ferozone. Of the two, the former requires much more machinery, and much more, though cheaper, precipitating material. But the greatest disadvantages connected with its use are that it produces a larger quantity of sludge of very much poorer manurial quality, and neither deodorized nor disinfected, and consequently difficult and disagreeable to deal with. Another disadvantage, that of not effectually purifying the effluent water, is not of much consequence here, as the water would certainly be sufficiently purified for discharge into the estuary of the Derwent. For these reasons, if any precipitation process is to be adopted, the ferozone one is recommended. Various precipitation processes. Lime processes.

58. So full an account of ferozone and of the modes in which it is used have been given in my Report on last year's International Congress of Hygiene, copies of which you have had, that your time need not be taken up by another description. It will be sufficient to say that it purifies the sewage by the best of all processes—the oxidation of the organic matter in it as well as its precipitation, and that the resulting sludge is not greatly augmented in bulk beyond that of the solids in the sewage, is deodorised, and that the addition of the ferozone adds to its manurial value. Besides this, the whole of the constructions needed for carrying on the process will be also needed to carry on any other precipitation process. Consequently if at any time any better precipitant is discovered, the whole of the works that may have been constructed for using ferozone will be available—no part will be useless; there will only have to be superadded the special mixing machinery and other appliances necessary for the new material that may be proposed. Ferozone process.

59. The following scheme is based upon arrangements, similar to those described in connection with the irrigation scheme, having for their object the diminution of working expenses by concentrating as much as practicable the necessary staff and machinery. It may be found that before really starting the work some modifications of the scheme may in this respect be desirable, but it is not probable that any serious divergence from the financial results herein set forth will be made, for any lessening of first outlay on works will probably be counterbalanced by increased yearly cost of working, and *vice versâ*. Concentration of works.

60. At the Hobart Station would be treated not only the sewage flowing to it by gravitation, but also that from the southern stations. The means for bringing in this would be virtually the same as those described in paragraph 51; and the tanks for its treatment would be similar to those mentioned in paragraph 52. The steam power provided would be sufficient to work by compressed air the ejectors at the New Town Station. As the precipitating tanks would have to be built partly below low-water level, some portion of the purified water would have to be discharged by pumping every tide. A considerable quantity of sludge would also have to be raised. All the machinery would be in duplicate as in the preceding scheme. Hobart Station.

At New Town the sewage of New Town and Glenorchy would be treated in tanks similar to those described in paragraph 54, but, as above mentioned, the sewage-lifting would be done by compressed air from the Hobart Station. New Town Station.

61. The following outlay will have to be made to establish the works necessary to carry out the purification of the sewage by this method of precipitation :— Estimated outlay on precipitation works.

	£ s. d.	£ s. d.
Hobart Station—		
Tanks or reservoirs	8100 0 0	
Ejectors and chamber	1700 0 0	
Two sets engines, boilers, compressors, &c	1600 0 0	
Engine and boiler-house, sheds, and floors	700 0 0	
Fencing, roads, &c.	270 0 0	
Contingencies, &c., 10 per cent	1237 0 0	
		13,607 0 0
Southern Outfalls (as in Irrigation Scheme)	...	7601 0 0
New Town Station—		
Tanks	910 0 0	
Ejectors and chambers	1090 0 0	
Land, fencing, sheds, &c.	350 0 0	
137½ tons iron mains	1375 0 0	
Contingencies, 10 per cent.	373 0 0	
		4098 0 0
Total special outlay for precipitation	...	25,306 0 0
Add estimated cost of works for collecting sewage	...	60,585 0 0
Total cost of precipitation system	...	£85,891 0 0

Yearly charge precipitation system.

62. The following is an estimate of the yearly cost of working this precipitation scheme in connection with the sewage system :—

	£ s. d.
Interest and Sinking Fund on Capital outlay, £85,891, at 5 per cent.	4295 0 0
Repairs to works at 1 per cent.	859 0 0
Sewer-men and superintendence	700 0 0
Water for flushing	500 0 0
Pumping and precipitating stations, wages, coal, &c.	1570 0 0
Administration expenses and contingencies	1000 0 0
Ferozone, 274 tons at £4	1096 0 0
Total	£10,020 0 0

Sludge disposal.

63. The above total would have to be increased or diminished contingently upon any loss or profit that might accrue from the treatment and sale of the sludge produced by the precipitation process. At first it is probable that there would be a mean quantity of about 80 tons of this sludge a day, consisting of 8 tons of solid matter diluted with 72 tons of water, a part of which returns to the tanks. There are many ways of more or less profitably treating this sludge. One of the simplest and really most profitable methods is to treat it in connection with the general scavenging work of the district. To do this it would require about 20 tons a day of dry street-sweepings, dust, ashes, and such like house-refuse to mix with so as to form a marketable and transportable manure. Arrangements would have to be made with the Municipal Authorities for the requisite supply of this dry refuse. If these arrangements could include the establishment of destructors in connection with the precipitation and pumping works, not only would the disposal of the whole of the refuse, both liquid and solid, of the Metropolitan Area be carried on together more economically and effectively than if treated apart, but if the destructors were properly constructed and arranged much of the fuel provided in the estimates would be saved. But, as all these arrangements would take time for their adjustment, and futhermore, as the sale of the manure, which might amount to fifteen or twenty thousand tons a year, would also take time for its development, it would be safer to increase the above estimate of the yearly charge, if this system be adopted, to £10,500 to cover the cost of removal by lighterage of such portion of the sludge not otherwise disposed of.

Sewage Disposal by discharge into Tideway without Purification.

Discharge into tideway.

64. There remains to be considered the advisability or otherwise of the discharge of the sewage of the area into the tideway of the estuary without any antecedent purification. By tideway is meant such portions of the estuary as are subject to the main current of the flux and reflux of the tide, and consequently not such places as the mouths of the Wellington and New Town Rivulets, which are situated at the most inland portions of Sandy Bay and New Town Bay, quite out of the main stream. At these places, so far as current is concerned, there is still water for a considerable period every tide, and the conditions are made most favourable for the deposit of sewage mud. Furthermore, at both these places the water is very shallow, and considerable areas of sandy flats are left exposed at low water of every tide. These flats are bad enough now; but they would soon become pestiferous mudbanks if sewage were discharged in their neighbourhood. It will therefore be necessary, if this system of sewage disposal be adopted, to carry the sewage brought down by gravitation in the sewers, whose natural outfall has been described as being at the above-named places, to some point in the tideway for discharge. The nearest points for such

discharge would respectively be Battery Point for the Wellington Rivulet outfall, and Cemetery Point for the New Town outfall. In the following scheme these two points have been accordingly taken as the discharging-places of the sewers of the Sewerage Districts above mentioned.

Question as to tidal or continual discharge.

65. Another question to be answered in connection with this mode of sewage disposal is as to whether its discharge should take place continuously or only at certain states of the tide. The proper answer depends in great part upon two contingencies: first, the relative level at which the sewage can be discharged; and secondly, the nature of the tidal action at the place of discharge. I am indebted to the Marine Board of Hobart for permission to copy the diagrams of the automatic tide register of the year 1891; and I have been thus enabled to fix the mean sea level, and learn much of tidal range, action, and phenomena at Hobart. The tides are irregular, and have a mean range of about four feet, though the greatest range—that is, the difference between the levels of the highest high-water and the lowest low-water of the year—was 6·67 feet. As far as can be judged from the levels already taken, the whole of the sewage of the area can be delivered at the various outfalls at a level of two feet above mean sea level, that is, virtually, at mean high-water level. If this be so, the occasional occurrence of exceptionally high tides may be practically disregarded. During 1891 the tide would have been over the invert of the sewers laid at the above-mentioned level for only 137 hours during the whole year, and during four hours only would the sewage have been backed up to a head of fifteen inches. The practical importance of this relative level of sewer invert and tidal action is that the sewers will never become tide-locked; and, further, that from an engineering point of view there will be no necessity for storage tanks to hold the sewage until the state of the tide permitted its discharge, or for pumping any part of the sewage, with the exception of that arriving at the points named in the preceding paragraph.

Hobart tides.

Tidal action.

66. As for the nature of the tidal action in the estuary of the Derwent off Hobart, it is necessarily as irregular as the tides themselves are in their intervals of occurrence. At the higher high tides there is an upward current of three-quarters of a knot an hour at half-flood, and at the lower low tides a downward current of 1½ knots an hour, as marked on the Admiralty charts. At most times the upward current is not perceptible in the wider reaches and bays, and a comparatively small freshet from above neutralises it in mid-stream. During January observations were recorded during 711 hours, in which the tide was rising 350 hours and falling 361 hours. As the estuary drains some three million acres of land there is a natural downward flow that must counterbalance during a considerable time each tide the tendency of the rising tide to create an upward flow, and that must augment proportionately the tendency of the falling tide to create a downward flow. This natural flow of the land-water not only accounts for the different rate of the current at half-flood and half-ebb tide, but makes it certain that the down-flow lasts longer than the up-flow. So if the mean rates for the whole tide be one-sixth of the maximum rates above given, it is probable that this mean rate would be applicable to at least 16 hours of downward flow against 8 hours of upward flow. This would give an upward flow of a mile a day, and a downward one of four miles, being an effective downward flow of three miles—a rate sufficient for the carrying off of the 15 million tons of land-water that daily comes down the river.

About two years ago, under the auspices of the Central Board of Health, and in prevision of what would be required in connection with the question of sewage disposal, I made a series of observations with floats to determine what course the stream took at all states of the tide and in all conditions of wind and weather. To render the floats visible it was necessary to make them to some extent exposed to the action of the wind. They were released off Macquarie Point, and almost invariably kept a course parallel to the general course of the stream. In high easterly winds they were drawn slightly inwards into Sullivan's Cove and Sandy Bay, but never once were they driven near the shore below the starting point.

All these facts show conclusively that there would be no danger that the sewage discharged at Macquarie Point would continue floating up and down the river for days before it was finally got rid of.

Sedementation of the sewage in the estuary.

67. But it may be supposed that some inconvenience might arise from the mudbanks that often are formed at sewer outlets. These mudbanks are not likely to be formed in a tideway like that off Macquarie Point. But if the sewage were drawn into the comparatively quiet waters of Sullivan Cove sedimentation would probably take place. From what has been observed there is not much danger that any great quantity of the sewage would be so drawn in. But if it be supposed that a quarter of all discharged at the Point were drawn into and immediately in face of the harbour, and that it therein deposited all the solid matters it held in suspension, it would take more than a hundred years to form a layer of mud over the bottom of one inch in thickness. But, as far as the observations made allow of a judgment to be formed, it is absolutely certain that not one-tenth part of the sewage would be so drawn in, and as this part could only be drawn in with the outgoing tide it is not probable that it would deposit much of its solid constituents. The danger of mudbanks being formed is therefore a very slight one.

Works required.

68. The works required for securing the discharge of the sewage of the New Town Rivulet and Wellington Rivulet systems into the tideway at the points before mentioned would consist of two sets of 10 horse-power engines, boilers, air compressors, and receiver, which would be placed in a central position, say, at the Hobart Rivulet outfall; 4-inch air mains running thence to New Town and Queenborough, and 10 and 12-inch sewage mains from ejectors at the outfall stations to the proposed points of discharge. At all the points of discharge there would have to be screens to

prevent the passing out of the larger solid matters in suspension in the sewage—that is, the portions of the sewage that would be likely to float and be carried about as much by the wind as the current—as such floating objects might be blown up on to sandy beaches and create some nuisance.

Cost of works.

69. The following is an estimate of the cost of these works :—

	£	s.	d.	£	s.	d.
Hobart Station—						
Engines, boilers, compressors, &c.	1150	0	0			
Buildings	500	0	0			
Roads, fencing, &c.	200	0	0			
Contingencies, 10 per cent.	185	0	0			
				2035	0	0
Wellington Rivulet Station (and Napoleon-street)—						
Ejectors and chambers	1490	0	0			
155 tons cast iron pipes	1550	0	0			
Contingencies, 10 per cent.	304	0	0			
				3344	0	0
New Town Station—						
Ejectors and chambers	1340	0	0			
280 tons cast iron pipes	2800	0	0			
Contingencies, 10 per cent.	414	0	0			
				4554	0	0
Total special outlay	...			9933	0	0
Add estimated cost of collection	...			60,585	0	0
Total cost of collection and discharge without treatment	...			£70,518	0	0

Yearly charge.

70. The following is the estimate of the yearly cost of working this system :—

	£	s.	d.
Interest and sinking fund on capital outlay	3526	0	0
Repairs, at 1 per cent	706	0	0
Sewer-men, &c.	700	0	0
Water for flushing	500	0	0
Pumping expenses	950	0	0
Administration and contingencies	1000	0	0
Total	£7382	0	0

This total would be reduced to below £7000 if the arrangement was made for providing the necessary heating power by means of destructors, as suggested in paragraph 67. After the repayment of the capital outlay the yearly charge would be about £4000.

Comparison of the Three Systems of Sewage Disposal.

Comparison from a sanitary point of view.

71. The three systems of sewage disposal, of which the above details have been given, may be compared from two points of view—the sanitary, and the financial or economical. From a sanitary point of view probably the disposal of the sewage by chemical purification is theoretically the best. If properly carried out, it is not only safe but the process is unaccompanied by any nuisance. This cannot be said of any irrigation farm I ever inspected. Sewage farming is said to be not unhealthy, but it is certainly accompanied by unpleasant odours. Practically speaking no danger to the public health need be apprehended in connection with the carrying out of any one of the three systems.

Points to be considered in calculating ways and means.

72. To properly consider these systems from an economical point of view it is necessary to have regard to the ways and means of carrying them out. In that connection one or two points must not be lost sight of in the calculations to be made. In the first place, the whole of the burden will not have to be borne until the works are completed. In the following calculations it has been assumed that this completion will take place in 1897. The rate for paying the yearly charge for the whole of the works will therefore not have to be calculated on the rateable value of to-day, but of the time of completion. During the past five years the rateable value has increased within the City of Hobart at the rate of 12½ per cent., and in the Suburbs at various rates, ranging from 8 per cent. in Glebe Town to over 24 per cent. in New Town. It has been assumed that these rates of increase will be maintained during the next five years. In the next place, the portions of the area outside the district actually drained will not be called on to contribute to the payment of the cost of constructing and maintaining the works, but only for special work that may be undertaken for their benefit, together with a small contribution towards administrative expenses. As the whole of Hobart and Glebe Town, nearly all Queenborough, and the occupied parts of New Town, South Glenorchy, and Sandy Bay are included in the drainage system, the excluded portions of the area are of very small rate-producing value,—the estimate being that their yearly rateable value is only £5000 out of the £30,000 yearly value of the whole of the districts in which they occur.

Crown property

On the other hand, there is within the area Crown property of great value, which is altogether unnoted in the Valuation Rolls. From lists of the property kindly furnished me by the officials

of the Lands and Works' Departments I estimate that the capital value of the Crown property within the area is about £645,000. This sum, taken at the rate fixed in the Town Boards Act, would represent a yearly rateable value of £38,700. All this property will be as beneficially affected by your work as private property of similar character, and will, it is presumed, contribute its share towards the cost of that work, either directly or by commutation. Without presuming to trench upon the question of how this contribution will be made, it has been assumed for purposes of calculation that this rateable value forms part of the general rateable value of the district.

The following calculations are accordingly made on the bases that, of the £224,000 of yearly rateable value in the area, £219,000 will be rateable, together with £38,700, the yearly value of the Crown property in the area,—making a total yearly rateable value at present of £257,700; and that this present yearly value will, by 1897, augment to £289,670. To avoid complicating the calculations, the consideration of the special circumstances of Glebe Town is postponed; but it must be understood that that town, having already completed the greater part of its sewerage work, will not have to contribute to the yearly charge on the same conditions as the other districts.

73. The following Table shows comparatively the cost, the yearly charge, and the necessary rate for each of the three systems that have been described:— Table of comparative cost and rating.

System for disposal of sewage.	Total cost of works.	Total yearly charge.	Poundage rate necessary to meet charge.
Irrigation.....	£125,084	£12,024	10*d.*
Precipitation	85,891	10,500	8.7*d.*
Discharge without treatment	70,518	7382	6.1*d.*

For the purpose of further comparison, it may be mentioned that the sum collected in the City of Hobart for carrying out the pail system is equivalent to a rate of over 6½*d.* in Pound; and this sum is collected for doing only a very small part of the duty that will be done by the sewerage system.

74. To the economic advantages to be gained by the adoption of the system of discharge without treatment for the disposal of your sewage are to be added some important considerations. In the first place, the whole of the works necessary for its being carried out are equally necessary to the carrying out of either of the other systems, and leaves your choice untrammelled to ultimately use them or any other improvement in sewage treatment that science may discover. It so happens that even the engine power needed for it forms an integral part of that required for the other systems. On the other hand, if the irrigation system turned out to be too burdensome financially, the money spent on preparation of land, conveyance of sewage, and other special works would be lost on the change of that system for another. Or the disinclination to sacrifice money spent on special work for any precipitation system might militate against the adoption of far superior methods that may be discovered. System recommended.

In the next place, the adoption of the system of discharge without treatment will greatly expedite matters, as no delay will take place caused by the necessity to provide large storage reservoirs and pumping plant, and, in the case of irrigation, purchase and preparation of the farm. With the beginning of the work the beginning of house drainage will take place, and every yard of sewer laid will be at once available for use.

OUTLYING PORTION OF THE METROPOLITAN AREA.

75. From time to time the necessity will arise for extending the sewerage system beyond the limits of the special drainage area to which it has been confined in the preceding part of this Report. Such necessity will arise from the progress of building, and the progress of building is accompanied by increased valuation, and consequently increased paying power. The special drainage area will thus have to be gradually extended after the completion of the urgent work that has been described. Generally speaking, if the present rate of increase of rateable value be maintained, the increment will suffice to find ways and means to construct from about 1½ to 2 miles of additional length of sewers every year. Sewerage of outlying area.

In the meantime general measures will have to be taken in the outlying part of the area to prevent the fouling of the streams. As these measures will have to be taken with isolated houses, they will be described in my Report on house drainage. It may be mentioned here that their scope and object will be the proper disposal of night-soil, manure, and fermentescible refuse, and the prevention of the saturation with slops and sewage of the soil in the neighbourhood of houses.

CONCLUSION.

76. In conclusion, will you allow me to say that though it is inevitable that anyone who has considered this question for so long a time as I have should form a decided opinion as to the best method of dealing with sewage, I have tried to place before you a fair statement of the whole matter, for the decision of it rests with you. Any further details or explanations you may require I will gladly furnish.

I have the honour to be,
Gentlemen,
Your faithful Servant,

Hobart, 6th October, 1892. A. MAULT, *Consulting Engineer.*

WILLIAM THOMAS STRETT,
GOVERNMENT PRINTER, TASMANIA.