

## REPORT

ON THE

## DRAINAGE OF THE LOWER WESTERN AND CENTRAL DISTRICT OF VICTORIA.

SIR,

The area the drainage of which, I now propose to discuss, is the zone between the Harbour and Caine Road, bounded to the west by Slaughter-house Point, and to the east by the Cricket Ground. It includes

- District No. 1 Shektongtsui
- „ No. 2 Sei Ying Poon
- „ No. 3 Taipingshan
- „ No. 4 Cheung Wan
- „ No. 5 Choon Wan.

It therefore contains the bulk of the Chinese population.

2. In a previous report, it was recommended that the sewerage-system of the High-level District should be completely distinct from that of the lower districts.

The problem now to be solved is:—

- (a.) The removal of the sewage from the lower zone, with the rain which falls upon it; to the sea.
- (b.) The conveyance of storm-waters from the hill-sides above, through the district, to the sea.

3. The present arrangements for the sewage and storm-water of this district are practically those described in my report of 1882.

Briefly, the practice has been to cover in natural storm-water channels and connect to them branch-drains, conveying both sewage and storm-water. In many cases both main and lateral drains are in very bad condition.

4. In the report on the sewerage of the high level district the objections to the use of storm-water channels for the conveyance of sewage, were fully set forth. These objections apply with even greater force in the case of the low-level district, where, in many places, the storm-water channels are nearly level and accumulate, not only sewer-tainted air, but also sewage deposit.

5. The methods for the improvement of the drainage of this; and other districts, suggested in my report of 1882, have not been tried. This is fortunate, for my subsequent experience leads to the conclusion that they would not have remedied, completely, the evils which existed then; and which exist still.

6. As regards the construction of the branch-sewers no appreciable improvement has taken place. With a few exceptions, any extensions that have been carried out, have been made upon no definite principle. It will now be necessary to re-sewer the whole district with earthenware pipes; and to divert the sewage proper, or dry-weather-flow of the sewers from the storm-water channels, which are not; and cannot be made suitable for its reception. The existing stone-channels therefore, should revert to their legitimate use, the conveyance of storm-water from the surface of the district, and from the hills above it.

7. The first question that must be discussed is the number and position of the sewer out-falls. Now the sea must be the ultimate receptacle for the sewage of Victoria. When the system of self-cleansing sewers is complete, the sewage will be delivered into the harbour fresh, before putrefaction has commenced, assuming always that the house-drains are in order. In this condition, sewage is comparatively inoffensive, and is readily consumed by marine organisms, great and small.

8. The following are the leading considerations, which rule the selection of position for sewer out-falls. The sewage should be delivered into water, not less than six feet deep, at extreme low water, and at point where there is an uninterrupted flow of tide; so that the effluent may be removed and diluted, as quickly as possible. For this reason, salient angles are preferable to re-entering as the position of out-falls.

9. The existing Praya affords a very considerable range of choice, as to the position of out-falls. When the new reclamations are complete and the extraordinary irregularities in alignment, which disfigure the existing Praya, have disappeared; one position will be very nearly as good as another. Therefore there will be no necessity for constructing costly intercepting-sewers, to conduct the sewage to one or two great out-falls. Indeed, unless the sewage is wholly intercepted and carried, say, to an out-fall to Sulphur Channel, opposite Green Island, or to North Point; no appreciable benefit will result from its concentration, to any one out-fall. Such complete interception cannot be effected, unless a considerable portion of the sewage is pumped; for the strip of land, between the Queen's Road and the Praya, is practically level; and no sewer, having a gradient sufficient to establish a self-cleansing velocity, could be constructed so as to convey the whole sewage, by gravity, to such a distant out-fall.

10. The complete interception of the sewage, from the harbour-frontage, would be exceedingly expensive, both as to first cost and maintenance. It would not effect any appreciable improvement in the sanitary condition of the city; nor, considering the mass of vessels which frequent the Praya, and the garbage which they throw overboard, would the amenity of the place be increased. The Praya is not a promenade; nor is Victoria a bathing place. The cost of complete interception cannot, therefore, be justified by any corresponding advantage, and should not, therefore, be incurred; until, at least, experience has demonstrated the inaccuracy of this conclusion.

11. Were the existing Praya the permanent sea-frontage of the city, it would be necessary to carry out the sewage out-falls by means of iron pipes, laid at the bottom of the sea into deep water, and to a distance of from 50 to 100 yards from the shore, so as to be clear of tiers of vessels which throng the wharf; and check the flow of the tide. But it has been decided that the Praya is to be advanced by about 280 feet, and the rubble-bank on which the new wall will stand will be in 15 to 30 feet of water. It is also intended that the wall itself shall be carried down, vertically, to a depth of about three feet below low-water-mark spring-tides. The rubble-bank will always be covered with water. The increased depth, the improved alignment of the new wall, together with the constriction of the waterway, caused by the advance of the Praya, will most probably produce an improvement in the tidal current, along its front. When the new works are complete, it will be sufficient to carry the out-fall, to the edge of the berm of rubble, on which the wall is founded, or so far beyond it as to reach a depth of six feet at low-water spring-tides. By using cast-iron pipes with ball-and-socket joints, a further extension may at any time be made.

12. During the progress of the Reclamation Works, the sewage should be carried out to the new line of sea-wall, by means of temporary wooden shoots, supported on piles. In arranging the levels of the sewers, the position of the out-fall; and the level of the sewers, has been selected, in accordance with the proposed alignment of sea-wall.

13. The Harbour being accepted as the destination of the sewage, the only reasons, for limiting the number of out-falls, are to save cost in their construction; and to make sure that sufficient sewage will flow through each, to keep it clear of deposit.

14. The invert of the main-sewers should be laid not lower than 2.75 feet above Ordnance-Datum, at the point where the sewer passes through the new Praya-wall. Now mean-sea-level is 3.69 feet above Ordnance-Datum; so that the invert of the sewer will be 0.94 below mean-sea-level. As the out-fall sewers will be not less than 1' 6" in diameter; when the water in the harbour stands at mean-sea-level the middle of the sewer-pipe will be only about two inches under water. Now mean-sea-level means the average level of the sea, as obtained by adding together the height thereof recorded, every hour, for a whole year or more, and dividing by the number of observation. By thus fixing the centre-line of the main-sewer, at or near to mean-sea-level, it is certain that the pipe will be free from sea-water, for nearly one-half of every day, month or year, and that the sewage will flow freely through the sewer, and cleanse it from deposit.

15. It has to be remembered that the normal dry-weather flow of sewage, will only fill the sewer to a depth of perhaps one-fourth or one-third of its diameter. At high water, the sea rises above the top of the sewer, and fills it completely. The stream of sewage then occupies the whole area of the sewer, and its velocity is reduced; so that deposit may take place. If the sewer were laid lower, say at low-water spring-tides then it would only be free from sea-water, and thus in a position to establish a proper velocity, for a few hours each month; and thus the probability of deposit would be much greater.

16. A good example of the manner in which in the absence of special flushing arrangement, deposit accumulates in a channel, to which the tide has access, may be seen at the mouth of the Albany Nullah. This nullah, above the tidal action, keeps itself quite free from deposit, the stream, running down its centre, having ample velocity. But in the part to which the tide has access, this velocity is checked, when the tide is high, and deposit takes place, which the stream cannot remove, when the tide falls. Had the invert of this nullah been made higher, as it might have been; this deposit would not have taken place.

17. The centre-line of the main-sewer at the face of the Praya-wall should, therefore, be at or near mean-sea-level. From the wall, the sewage should be carried out, to deep water, by a cast-iron pipe, of smaller size than the sewer; the diameter of this pipe should be so calculated, that the ordinary dry-weather-flow of sewage will establish a sufficient current in it, to keep it clear of deposit. This pipe may be prolonged, to any desired distance, into the harbour. At the Praya-wall, a storm-overflow will be provided, which will allow the sewage to escape direct, in rainy weather, when the sewer brings down more water than the iron outlet-pipe can carry. When this takes place, the sewage will be so diluted with rain-water, that the direct escape will cause no inconvenience.

18. The level of the outlet, thus fixed, determines the distance at which the out-falls must be placed from each other. The main sewers must have a certain fall; and their upper extremities must be at a sufficient depth below the ground, to allow the house-drains to discharge into them.

19. It is further desirable that the sewage out-falls should not be in the immediate vicinity of the main storm-water outlets; especially those that discharge storm-water, from the hills, above the city. The silt which these storm-water channels bring down, will, in time, form deltas at their mouths, which will have to be removed by dredging. The cast-iron outlet-pipes will impede this operation; or be liable to injury in its execution. It is desirable also to keep the delta of silt and sand, free from sewage contamination.

20. In accordance with these principles, six out-falls have been selected, in the following positions:—

1. Opposite Queen Victoria Street,
2. „ Hillier Street,
3. „ Wing Lok Street,
4. „ Eastern Street,
5. „ Western Street,
6. at Slaughter-house Point.

21. In the present condition of the Praya, the position of the out-fall opposite Hillier Street, in a bay, is not all that could be desired. The Praya Reclamation will, however, remedy any defect in this respect; and after careful examination, it has been found impracticable to drain the whole of the flat district, near Bonham Strand, to the Wing Lok Street out-fall, without the use of gradients so flat as to endanger the self-cleansing properties of the main sewer; and thus give rise to evils far greater than any that can be caused by the out-fall, even were it to remain as it is at present.

22. The area draining to the several out-falls is shewn by the coloured lines on the plan. In the arrangement of the tributary-sewers, care has been taken to concentrate the sewage flow of each district, in the upper ends of the intercepting sewers, along the Praya, which have, necessarily, flat gradients; compared with those in the upper parts of the town. This will ensure a sufficient flow through them, whenever the tide is down, to set up a self-cleansing velocity through them; and thus obviate, to a great extent, if not altogether, the necessity for artificial flushing.

23. The sewers, even in the level parts, will have gradients sufficient to establish self-cleansing velocities, with the normal flow of sewage that may fairly be counted upon. The dry-weather flow of the nullahs which traverse the town may be used to augment the volume of the sewage. It may therefore be anticipated that very little artificial flushing will be required, though provision for so doing, if necessary, will be made.

24. The natural gradients of the tributary-sewers are, in almost every case, more than sufficient to establish self-cleansing velocities; with the normal flow of sewage. To ensure proper cleansing, however, it will be well to establish, at the heads of some of the branch-sewers, where the flow of sewage is small, automatic flush-tanks. These consist of a tank, containing from 30 to 100 gallons, according to circumstances; and provided with a specially-constructed syphon, which, when the contents of the tank reaches a certain level, comes into action, and discharges the same, in a sudden rush. These automatic flush-tanks may be conveniently erected, in connection with the public fountains, receiving the waste-water and slops from them. In this way, water, that would otherwise be wasted, will be used to cleanse the branch-sewers, without any additional demand on the water-works.

25. The size of the main sewers is sufficient to discharge about one inch rain in 24 hours, falling on the district, which drains to each.

26. With the exception of a few short branches, the minimum size of street sewer will be nine inches. As regards the conveyance of sewage only, a much smaller diameter would suffice. Experience has shewn, however, that long street-sewers, less than 9" in diameter, are inconveniently liable to casual obstruction. Moreover the rain-water from back-yards, and in some cases from the roofs of houses, must be admitted to house-drains, and thence to the branch-sewers. The excessive capacity which the use of 9" branch-sewers affords, will allow them to carry off the rain-fall, which must be admitted to the house-drains. But, at or near the points where the branch-sewers join the principal collecting sewers, storm-overflows will be provided, by which any water brought down by the branches, over and above the quantity which the collectors can carry, will escape to the storm-water channel. So, when the secondary collectors join the main-sewers, other storm-overflows will be provided. By these means, the main trunk may have a carrying capacity much less than the sum of those of the branches, and the evils attending large sewers may be avoided. In short, the system at its commencement, will be "combined," receiving both rain water and sewage, in the course of the collecting and out-fall sewers, more and more of the rain-water will escape by storm-overflows; till the iron outlet-pipe will carry the dry-weather sewage only.

27. The sewers will be provided with man-holes, at all junctions and changes of direction; so that there will be complete access to the sewer, for the purpose of inspection; and for the removal of casual obstructions.

28. In a report on the sewerage of the High-level District the principles of sewer-ventilation have been fully discussed. The same principles apply to the lower district also. Whenever practicable, it will be well to carry up ventilating pipes, above the roofs of the houses, care being taken that these elevated ventilators are as inconspicuous as possible. It must always be remembered that the real remedy for stench from ventilating openings consists in self-cleansing sewers, good house-drainage, properly used, with a liberal water-supply; and not any elaborate or complicated system of ventilation.

29. The existing storm-water channels should be utilised, to the fullest extent, for carrying off rain-water. It is probable that the greater number of these will require little more than the usual repairs.

30. In the lower parts of the town, however, the storm-water channels will, in many cases, require renewal; on account of the new Praya works. When this is the case, care must be taken to raise the invert of the channel to the highest practicable level, consistent with sufficient discharging capacity. The object of raising the invert is two-fold: firstly to give a good gradient across the new reclamation, and secondly to make the outlet as high as possible, so that the storm-water channel may be free from tide-water, for as long a daily period as possible. This is desirable, for the reasons set forth, when discussing the questions of sewer-outlets. An elevated invert also facilitates construction, at it increases the time that the foundation is uncovered by the tide. To give the necessary sectional area, to the

storm-water channels, they should be made wider and shallower than has, hitherto, been usual. To this end also, the covering of the channel will be most conveniently made flat, of concrete supported on iron girders; or iron or steel trough-plates; the concrete forming the road-way.

31. A storm-water channel, on this principle, is now under construction in Jubilee Street, the covering being carried on old rails, returned from Tytam Works. The reconstruction of this channel was undertaken, because the old one ran under the site of the Central Market.

32. It will be well, in order to save expense, to reduce the number of storm-water channels, which cross the reclamation, to the minimum, consistent with sufficient discharging-capacity. The construction of the proposed sewers will allow of the abandonment of many of the minor outlets, which now exist along the Praya; and which serve as out-falls, for both sewage and rain-water. The sewage will be intercepted by the proposed sewer, which will have sufficient capacity to carry the rain-water, to the nearest storm-overflow, where it will escape to the storm-water channel.

33. It will be well to keep the cost of altering or reconstructing the storm-water drains separate from that of the sewerage-system proper. Minor alterations and repairs may be, legitimately, charged to the usual vote—Main Drainage and Sanitary; whilst alterations, on account of the new Praya Reclamation, will be properly charged to that undertaking.

34. Inasmuch as dirty water is often thrown into the side-channels of the streets; and the rain-water which flows down them, at the commencement of showers, is little better than sewage, trapped gulleys should be provided in them, in connection with the sewers, in addition to the ordinary gulleys, communicating with the storm-water channels.

35. When the proposed works are complete, there will be no objection to the use of water-closets, by those who desire to do so: provided always, that proper appliances for flushing are used in connection with them. The introduction of water-closets will be a great boon to the European community; for, as the prosperity of the community increases, there will be more and more difficulty in having hand-removal properly carried out.

36. I do not contemplate the introduction of the water-carriage system, universally, as I do not consider that the population generally is ready for it; notwithstanding its superiority to any other. In Hongkong, moreover, the facilities for complete and efficient hand-removal, which exist in China, do not exist; as there is no extensive area of agricultural land, in the vicinity of the town. If water-closets are largely introduced in European houses, their use may spread to the Chinese also. If such a tendency does shew itself, it should not be resisted.

37. Were this the case, complete diversion of the sewage might perhaps become desirable. In the preparation of the present project, regard has been had to the possibility of meeting such a demand. The proposed arrangements are such, that this could be effected, without material alteration of the general project.

38. It is unnecessary to go into the details of the arrangements, for complete interception. The most convenient and economical means of doing this will be to lay a cast-iron pipe along Queen's Road and Praya, working under pressure; with branches, carried up the side-streets, to intercept the sewage, at sufficient elevation to carry it, by gravity, to the desired out-fall. The sewage of the district below, this elevation, must be pumped into this main. The pumping could be effected by hydraulic motors, established at the proposed out-falls, worked by water from the water-works, or by water under still higher pressure, supplied from some central pumping station, and which would also be available for working Hydraulic cranes.

39. The estimated cost of the sewerage of the district, now under consideration, is as follows:—

31,454 yards of sewer varying from 21' to 6" diameter principally 9",.....	\$105,094.65
Man-holes, ventilators, street gulleys; and syphons for crossing the storm-water channels, .....	32,012.00
Flushing tanks, &c.,.....	5,000.00
Out-falls, .....	3,000.00
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• Total,.....	\$145,106.65
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40. This sum does not include the cost of making connections to house-drains ; as this is, for the present, done by the house-holders. It is most desirable that the actual connection should be made, and the trap fixed, by the Drainage Department. The discussion of this question, however, involves the consideration of the whole subject of House-drainage, which is so important that it will be dealt with in a separate report.

41. The works described in this report may be completed in three years, from date of order to commence. Pipes, etc. are in stock, to the value of about \$50,000, which will be available for the work.

I have the honour to be,

Sir,

Your obedient Servant,

OSBERT CHADWICK.

To

The Honourable W. M. DEANE, C.M.G.,

*Acting Colonial Secretary.*