

POONA
SEWERAGE
AND
WATER-SUPPLY
SCHEMES.

SECOND ADDRESS
TO
THE MUNICIPALITY OF POONA
ON THEIR
SANITARY WORKS.

BY
J. C. POTTINGER, M.I.C.E., M. SAN. INST.,
SUPERINTENDING ENGINEER, SANITARY ENGINEER AND MEMBER OF THE SANITARY BOARD,
and
MEMBER OF THE POONA MUNICIPALITY.

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SECOND ADDRESS
TO
THE MUNICIPALITY OF POONA
ON THEIR
SANITARY WORKS.

GENTLEMEN,

Last October my proposals for the Drainage Scheme were placed *Introducer* before you. My instructions from Government were to prepare two alternative schemes, one for discharging the sewage into the river, and the other for utilising it on a sewage farm. The latter turned out to be the more expensive of the two ; and, as the financial results of sewage farms have not been very promising, you were advised by the late Secretary to Government, Public Works Department, and by myself, to reject it.

2. The cost of the other scheme, when drawn out on a scientific basis, was also very considerable ; and, in order to lighten the incidence of the cost on the population, I thought of employing the purified effluent on a farm, instead of turning it into the river. With this view, you sanctioned the construction of a small experimental septic tank and bacteria beds ; and Mr. Mollison kindly undertook to experiment on various fodder crops, and on sugarcane ; with the effluent, and with heavy dressings of *poudrette*, and of farmyard manure, on comparative plots of the same area. These experiments were started last May, and the results obtained during the monsoon were so satisfactory that I finally made an *additional* proposal for an effluent farm, as an *alternative* to running the effluent into the river, *vide* para. 96 of my previous Address. The cost of this addition to the project was, however, considerable ; as, with pumping machinery, rising main, and cost of land, I estimated it at 12 lakhs of rupees.

3. Many of you were somewhat sceptical as to Mr. Mollison's calculation of profits from the farm. I can only assure you that these were strictly correct as regards expenditure : and the only question is as to the rates for selling the produce wholesale, which I will go into later. We have now had one complete year of crops on this land ; which land, as Mr. Mollison stated, was only in poor condition, and had had no manure for two years, although crops had been grown on it during that time. We are, therefore, now able to make a more accurate judgment of results.

4. I would again impress upon you that the only alternative to the utilisation of the effluent on land, is to turn it into the river ; and for this latter purpose, my original scheme (with the septic tanks and

bacteria beds at the Plague Camp site) is the only possible one ; as the sewage must be *highly* purified before it can be turned into the river. It is now universally recognised that a Municipality should not be allowed to pollute a river, to the injury of others, merely to save themselves from expenditure.

Results to be aimed at in treating sewage.

5. Your President, in his Note on the Project, seems to consider that *crude* sewage might be applied to the land ; but you must clearly understand that the *first* object of a true sewage (not effluent) farm, or of any other proposal to deal with sewage, is to *purify* that sewage, as I formerly explained to you ; and the treatment, to be effectual, must accomplish three things :—

- (1) The removal of all large suspended matters, and inorganic solids, such as sand, &c., by means of grit and screening chambers.
- (2) The removal, or liquefaction, of all solid organic matter in suspension ; which can be done by the anaërobic bacteria.
- (3) The conversion of the organic matter in solution, into non-putrefactive and stable substances ; which is done by the aërobic bacteria.

The second point will probably be carried out to some extent in the sewers and rising main, and completed in the macerating tank ; and the third will *then* be done by the land. The obtaining of a profitable return is entirely a *secondary* matter ; and (as I have already explained in my former Address, para. 43) black soil is quite unsuitable for such purification as (2) ; and there is not enough light soil under command of the canal to do the necessary work. There *is* plenty of such soil *above* the canal ; but it has been decided that some water is essential for intermediate waterings, if only for the economical use of the effluent ; and Mr. Mollison's experiments bear this out.

Proposals of former years are now obsolete.

6. It is useless to point to Colonel Ducat's proposals of 20 years ago, or the suggestions of the Government Committee of 8 years ago. The former was condemned by Mr. B. Latham as not being in accordance with the requirements of sanitary science as known then ; and still less would it be so now, when these principles have been thoroughly settled with the knowledge gained by the experience of many towns in the succeeding years. Our knowledge of the action of bacteria on sewage is of recent growth ; and even as late as 1892, very little was known about it. Thanks to the continuous experiments of the Massachusetts State Board of Health, the London County Council, the Manchester Corporation, and various eminent Chemists and Sanitary Engineers in England, during the last 8 or 10 years, we *now* know practically all about it ; and it is therefore no use now bringing up what is ancient history, founded on more or less ignorance of the subject. One might just as well say that

because certain diseases, or injuries to one's body, were treated in a certain way 10 or 20 years ago, we should ignore the results of recent years, which have brought us more definite and scientific knowledge of such matters, and of the best mode of treatment.

7. The results we arrive at are, therefore :—

Alternatives.

- (1) A true sewage farm, worked primarily with a view to purifying the whole of the sewage day by day, is very unlikely to produce any large amount of net revenue ; especially when one considers the heavy cost of machinery and rising main, and the recurring cost of pumping; which will be necessary here, as the farm *must* be beyond the four-mile limit.
- (2) If an effluent farm is objected to on the score of expense, and doubtful profit, the *only* alternative is that of the original scheme for septic tanks and bacteria beds, to allow of a *pure* effluent being turned into the river.
- (3) If an effluent farm is adopted, the best site is that selected beyond Hadapsar, (on the Sholapore Road), under the advice of Mr. Mollison; and you could not have a safer, or more practical, adviser regarding land likely to be profitable, or the reverse. Mr. Santo Crimp also approved of this site.

8. If the effluent is utilised on land, Mr. Santo Crimp has told you that the sewage need not be purified so highly as if it was to be turned into a river; as, *after* the preliminary organic changes are brought about, the land itself will do the rest. He has, therefore, proposed passing the sewage through a macerating tank. The resultant effluent is similar to that of the septic tank alone, and the land acts the part of the bacteria beds. In the sewers themselves, and in the rising main, there will also be a certain amount of bacterial action, similar to that in the septic tank. This macerating tank is to be placed at the end of the rising main, about 6 miles east of Poona ; and as there are no houses anywhere near it, there can be no objection to the proposal; which will effect a large saving.

Macerating Tank.

9. Some of you are startled at the distance of the proposed farm from Poona. Now, in the first place, you *must* go beyond the limit fixed by Government for sugarcane, at the request of the Military authorities ; and there is not the slightest chance of any modification of this order, as it was made for the health of the troops, and after mature consideration ; so we must accept it as a fundamental basis. This limit extends beyond the S. M. Railway crossing on the Sholapore Road, and the sewage must be pumped to this point; from which it will flow by gravitation, without any extra pumping. You have decided, and I think rightly, that the farm must be under the command of the canal ; so we should

The Farm Site.

in any case have to go as far as Hadapsar, where land is expensive. The proposed site for the macerating tank is only about a mile beyond this, on high ground, from which the whole area to the east and north-east of the adjoining portion of the canal can be commanded. Moreover, we can there get one compact block of land, adjoining the canal and a made road, and with a good slope, *moorum* subsoil, and drained by a nullah running through the centre. Further, we can get both black soil, and a proportion of light soil; and the land will be cheaper than if it was nearer to Poona. Mr. Mollison and Dr. Leather both say that a depth of $1\frac{1}{2}$ to 2 feet of black soil is necessary to produce a good crop, with a large percentage of sugar; because, in shallower soil the roots do not get a firm enough hold; and the crop is apt to be "laid" by high winds, or other causes; resulting in an undue increase of glucose, and a reduction in the sugar. If, as has been suggested, the farm was put at Mundwa, we should have to go very nearly as far; to pump the whole way, instead of only 4 miles; and finally to build a raised storage reservoir to command the whole site, entailing extra pumping. Other disadvantages are that the land is more expensive; it is at a distance from the canal; has no made road running alongside it; a compact block of sufficient area would be difficult to get, unless we went some distance beyond Mundwa, as the country near the river is much broken up by nullahs; and there is a deficiency of light soil. So that the balance is considerably in favour of the Manjri site. On Sheet No. 14 of the original book of plans, the inner circle shows the limit of the prohibited area for sugarcane to the east of Cantonments; and the area selected for the farm, by Mr. Mollison, is part of Site No. 2; to the east of the canal, and north of the Sholapore Road, between it and the Railway, and drained by a nullah through the centre of it. This was the site selected by the Government Committee 8 years ago; and, as the Military Department was represented on that Committee, there will be no objection to the site from them. The macerating tank site is just west of this portion of the canal, and a little north of the road, on the highest point. During the monsoon, the effluent could be utilised on some of this high land near the tank, for kharif crops, with the ordinary rainfall, when it could not be applied to heavy land. The value of this high land will be trifling, as it is poor thin soil, and not commanded by the canal.

*Cost of land
for the Farm.*

10. Doubts have been thrown on my estimate of the cost of the land for the farm, which was based on the advice and actual experience of Mr. Mollison; and also of his Manjri Farm Manager, who has been there for years, and who knows how land has sold there. These doubts are based on the statement of the Village Panch, who said that the black soil land there was sold at Rs. 500 to 600 per acre. Now, I have got from the Collector's office a record of all the sales of all descriptions of land in the Manjri village for the last 5 years; and in only two cases has even Rs. 300 per acre been exceeded, viz. 3 acres of S. N. 125, sold for Rs. 1,000 in 1896; and 2 acres $27\frac{1}{2}$ *goontas* of S. N. 148, also sold for Rs. 1,000 in 1897. There was also a very small piece of $11\frac{1}{2}$ *goontas*

of S. N. 104, sold for Rs. 200. Out of the 966 acres selected by Mr. Mollison, from which we can choose the required area, 180 are of shallow light land ; and 121 acres are damaged by percolation water, and are now practically worthless, and only grow rushes and *babul* bushes. Similar light land has been frequently sold there during the last 5 years for Rs. 50 to 100 per acre, at most. The damaged land can never be reclaimed by the owners ; but this *can* be done if the whole area is acquired, and properly treated ; and a drainage outlet provided, for which a survey has been made. This damage is caused by the owners of the land above, letting their surplus water drain on to this lower land ; which would, of course, be prevented when the whole area was managed as a complete unit ; but cannot be prevented by the owners of the damaged land.

11. Even taking Rs. 100 per acre as an outside price for the light land and damaged area, and allowing Rs. 20,000 for draining the latter (which Mr. Mollison considers an excessive allowance), the cost of these 300 acres will only be half a lakh at the outside. Allowing another half lakh for laying out the farm (which is very liberal), we have three lakhs left for the remaining 550 acres, the soil of which varies from good, to only medium, black. So that, even taking the Panch's view, the estimate is a good one ; but I think there will be a considerable saving really, quite enough to pay for the 600 acres of poor soil (for use during the monsoon) at the macerating tank site and for the drainage channel, of the swamped area. On this subject, Mr. Mollison writes to me as follows :—“ I think I may state with authority that the *best* of the sugar-
 “ cane land at Manjri will not cost more than Rs. 400 per acre. About
 “ 4 years ago we bought exceptionally good land for our experiments, and
 “ very favourably situated as regards irrigation channels, roads, &c., for
 “ Rs. 5,000, for an area of between 13 and 14 acres. Considering the
 “ average value of the crops grown on the *light* land there, I cannot think
 “ that the capital value of such land can exceed Rs. 60 per acre ; and for
 “ the *poor* light soil, which forms a part of this area, the owners would be
 “ lucky to get 25, or at most 30, times the assessment. As regards
 “ the water-logged area, there is no doubt that a good deal of it
 “ has been excellent soil, which formerly grew sugarcane. There is
 “ also no doubt that it can be successfully drained, if the nullah
 “ outlet beyond the railway is kept clear, and no surplus water
 “ from the higher land is allowed to overflow on to the low land.
 “ By drainage, and thorough cultivation for a year or two, it can cer-
 “ tainly be made into good arable land ; and the probable increase in
 “ value would, in my opinion, more than compensate for the probable
 “ cost of the improvements, as the land is now practically worthless.”
 It will be necessary to acquire about 600 acres around the macerating tank site, solely for utilising and purifying the three million gallons of effluent per day, during the monsoon ; when one full crop, and a second growth, of fodder jowar can easily be grown on the ordinary rainfall. As this land is very poor soil, and above the canal, its cost will certainly not be more than Rs. 15,000.

*President's
Memo. on
the original
Scheme.*

12. Your President has gone to great pains in criticising the original scheme ; and as his Memorandum probably contains all the doubts and suggestions that can be raised, it will be convenient if I go through it before proceeding with an explanation of the amended scheme. I have discussed the Memorandum exhaustively with him, and I believe he is now satisfied as regards the principal points.

*President's
criticism on
Mr. Santo
Crimp's
proposals.*

13. First, as regards his remarks on Mr. Santo Crimp's proposals. A saving of 5 lakhs, or anything like it, is out of the question by any possible reduction of the Shone System area. The Shone System enables us to keep our pipes small and trenches shallow, as each Ejector treats a comparatively small area. In a Gravitation System, the sewers must become progressively larger, and the trenches deeper, to get a self-cleansing velocity ; and the increased expense of these items is very considerable, especially as the stoneware pipes must be surrounded with cement concrete where the depth is over 15 feet. Moreover, these deep trenches usually have to be shored up ; and therefore cost much more, proportionately, than shallower trenches.

14. Although an impervious floor to each house is practically impossible, on the score of expense, yet a proper system of sewers, connected with a properly constructed W. C. and bathing place in each house, *will* prevent the water-logging of the houses by the large amount of water now spilt in those places.

15. The President's calculation of engine power is based on a misconception. From the level crossing on the Sholapore road, to the macerating tank site, the fall will nearly suffice for the friction in the pipe due to the future maximum flow ; and will suffice for the quantity at first. We have, therefore, only to pump up to a few feet above this ground level near the level crossing ; and this extra height can be got by putting a suitable standpipe there. The future maximum flow during the day, in 1931, will be 3,898 gallons per minute ; and half of this will be the night flow, as laid down by Mr. Santo Crimp. The distance to this point is 19,200 feet from the pumping station ; and the loss by friction in a 25-inch main will be 41 feet ; and the actual total lift (including friction) will be 190 feet, allowing 8 feet for the standpipe. The most economical way of dividing the H. P. is to have two engines capable of doing this maximum day work, one of which will then suffice for the night work ; and one extra engine as a reserve for accidents. Two boilers will be provided, either of which can drive two engines ; and a third similar boiler will be provided for the air-compressors, which will then be available for the pumping engines also in case of accidents. Thus, two boilers will be working during the day ; but one will suffice at night, for one engine and the air-compressor ; and one will always be resting, as in the case of the engines. There is ample proof, even in this country, that Triple Expansion Worthington Engines work regularly at 90 per cent. "efficiency," or more ; which means that only about 10 per cent. has to be added to the *Pump* H. P. As

regards coal consumption, Mr. Santo Crimp is quite right for *compound pumping* Engines ; and he has informed me that he meant what he said ; but the Triple Expansion Worthingtons, *with* superheated steam and Economiser, *will* now work at 2 lbs. per I. H. P. ; and at the Tallah Pumping Station in Calcutta, where a 500 H. P. Worthington was substituted in 1895 for the former engine, it works at 2 lbs. of coal per I. H. P. *without* superheated steam, and with only 75 lbs. pressure in the *old* boilers. Moreover, since the date of starting, it has never been stopped for repairs ; and it has worked, on an average, about 20 hours a day ; as, until lately, the whole of the water-supply depended on it. The higher the " head " pumped against, the better is the " duty " of an engine, and *vice versa*. Large compound engines of 600 or 700 H. P., or more, may work at this rate of coal consumption ; and mill engines, with a piston speed of 300 feet, or more, per minute, can also do so ; but the piston speed of a pumping engine *must* be limited to about 120 feet per minute, as the water cannot follow the plunger at a higher speed ; and this makes all the difference. Again, the *true* test of economy in an engine is the *total* coal consumption for the total *useful* work done ; which in our case is the *Pump*, and not the Indicated, H. P. ; because, in an inferior engine the losses by friction, &c., are larger ; *i.e.* the " efficiency ", or the ratio of the Pump H. P. to the Indicated H. P., is less ; so that an engine burning less per I. H. P. may be burning more per P. H. P., and therefore be really the *least* economical ! This may be more clearly explained by an exaggerated illustration. Suppose we want 100 P. H. P., *i.e.* actual useful work done in lifting water ; and one engine does this work with an expenditure of 200 I. H. P., at a coal consumption of 2 lbs. per I. H. P. per hour ; whilst another does this work with only 110 I. H. P., at a coal consumption of 3 lbs. per I. H. P. per hour. The former will then actually burn 400 lbs. of coal, whilst the latter is burning 300 lbs., for doing the *same* work in the *same* time. The relative coal consumption per *Pump* H. P. would be 4 lbs., and 3 lbs., respectively ; and the second engine, although burning 50 per cent. more coal per *Indicated* H. P., would save you one-fourth of your coal bill for doing the required work !

16. I agree in thinking that more profitable results will be got with the aid of the canal water ; but the experience of the Matoonga Farm (which is not a small experiment, carried on for a limited period) shows that 5,000 gallons per acre of strong sewage (*after* being treated biologically) *can* be profitably utilised, and purified, day after day, without any additional water, on various crops, and without any other labour than that of the lepers ; and that the various fodder crops *can* assimilate this amount *in that form*, *i.e.* not as *crude* sewage. You must not, however, confuse the quantity that such land *can* take up, and finally purify, with the *least economical* amount of effluent that will produce as good a crop as the above maximum application. The former is for purification, and the latter for profitable results. The former is laid down by Mr. Santo Crimp at 5,000 gallons per acre per day for our soil ; the latter

can only be ascertained after 2 or 3 years of trial. The farm must be started on the former basis; and can be either extended, or the surplus effluent sold, after we have found out how much less than 5,000 gallons per acre per day will produce an equally good crop. The Kirkee experiments have already given us this information for Lucerne; which will purify at the rate of 5,000 gallons, but will produce equally good crops with a rate of 3,700 gallons per acre per day. I have already referred in paras. 10 and 11 to the valuation of the farm area; and Mr. Pudumjee, Mr. Nagurkar, and Mr. Moodliar are satisfied that the estimate will not be exceeded.

*Reduction of
the Shone
System area.
(Para. 1.)*

17. And now as to the memorandum on the original drainage scheme. The Shone System area has been reduced to the utmost; and the present scheme is practically that of the original alternative scheme in connection with the sewage farm on the Ahmednagar Road, except that the pumping station has been placed at the site suggested by Mr. Pudumjee, and approved of by Mr. Santo Crimp. I think, however, it is necessary to again point out that the original detailed scheme was for turning the effluent into the river. The idea of an effluent farm was only a proposed addition to the scheme proper, made subsequently on the strength of the Kirkee experiments, and solely with a view to lessening the final cost to the Municipality, as is obvious from the Comparative Statement No. 4, attached to Mr. Doig's Minute, page 55 of my first Address.

*Relative Cost
of the Shone
System.
(Para. 5).*

18. It is useless comparing the cost *per head* of the Shone System here, and elsewhere. In Colaba, Mr. Snow has told Mr. Pudumjee and myself that various reasons made the cost excessive; and, as the population is small and scattered, the rate per head must be high; but the Shone area here is densely populated, so the cost *per head* cannot possibly be compared in the two areas. In Rangoon, all the sewers were of cast iron, and therefore very expensive; whereas here, only the short sewage mains from the Ejectors, and the small air mains to them, need be of iron, the rest being of ordinary stoneware, as in the Gravitation System. The only safe way of proceeding is to properly estimate for each case according to the local circumstances. No one ever proposes to use Shone's ejectors where gravitation is practically able to ensure a self-cleansing velocity in the sewers at a smaller cost. It is not disputed that, although ejectors and high class compressors only use a third of the coal that small direct-acting steam pumping engines would do, they use perhaps double the coal that large high class pumping engines require; but, even so, they are often in reality as economical as the latter, for such conditions as obtain here, for the following reasons:—

- (1) Pumping at various points enables us to reduce the size and cost of sewers materially; and this is of special importance in this country, as the loss from breakages, in transit of large pipes, is a serious item. Also, in course

of time, there is probably some leakage into all sewers, and the smaller they are the less extra water has to be subsequently raised.

- (2) A terminal pumping engine must have the *whole* of the sewage delivered at the lowest level; so that, to lift the sewage from a comparatively small area, the whole sewage from the rest of the town must be lowered to the level suitable for this lowest area. In Poona, at such lower levels, you would be certainly troubled with a large amount of subsoil water in the trenches, which would increase the cost very much; and you would also have to lift eight-ninths of the sewage several extra feet unnecessarily; which means not only larger and more expensive engines, but more coal consumption daily, amounting to a considerable addition to the yearly working expenses. The engines are not 400 to 500 I.H.P., or anything like it, as will be explained hereafter: see para. 73.
- (3) Ejectors enable us to lay all the sewers at such steep gradients that they become self-cleansing; and the cost of cleansing and maintaining them is reduced to a minimum; so that more money may be saved in wages than is spent in extra coal.

The maintenance charges for Colaba include nearly Rs. 8,000 for a special Engine Room Staff; and there are also a variety of other special charges, none of which we shall require. As a matter of fact, there is no *special* staff (except for the engines) maintained for the Colaba sewers.

19. English sewage is much weaker than ours will be (as their water-supply per head is greater); but it has been abundantly proved that even their weak sewage cannot be successfully applied to a *clay* soil, because such soil is not permeable by air; and the aërobic bacteria must have oxygen to enable them to flourish, and do their purifying work. As I said before, our *first* object must be to *purify* the sewage; and in paras. 40 and 43 of my previous Address I have explained why a clay soil is an imperfect purifier, necessitating a very large area. Moreover, it is now known, as an indisputable fact, that *any* manure must be converted into nitrites and nitrates before *any* plant can assimilate such manure. By applying crude sewage to land, you throw this *extra* work of conversion on it; which work black soil is not fitted for; but, by employing the bacteria first, the ammonia salts are previously converted, so that such land *can* utilise them as plant-food; and the resultant growth is sweeter, cleaner, and of increased quantity. Moreover, it has now been universally recognised for the last 20 years that, even with suitable land, the crude sewage must only be used for irrigation after precipitation,

*Application of
crude sewage.
(Para. 14.)*

either by chemicals, or in settling tanks capable of holding three days' supply; both of which are expensive, and still leave the sludge to be dealt with. Also, the use of chemicals often leaves products in solution which are injurious to vegetation, and removes some materials which are useful for plants.

Ryot's profit on sugarcane. (Para. 13.) 20. To the profit of Rs. 150 per acre, given in the President's para. 13, must be added the cost of manure and water for a ryot's crop, which varies from Rs. 250 to even 400, as stated in Appendix B of the President's memorandum.

Disposal of the surplus effluent. (Para. 30.) 21. The present Manjri experiments will tell us, next January, the most economical *minimum* amount of effluent which will produce a heavy crop of cane, with a good percentage of sugar; and the Municipality can decide hereafter whether they will utilise the surplus effluent themselves, or sell it to others. Once the ryots are practically convinced of the value of the effluent, there will be a ready sale for it in the vicinity of the farm, as *poudrette* will not then be available; and, by laying a pipe line, the area commanded can be much extended, as the macerating tank site is high. The ryots are, however, naturally slow to adopt anything new; and, judging from Manjri and Ahmedabad, you must not expect them to take it up generally for some 5 or 6 years. As regards "humus", both Dr. Leather and Mr. Mollison say that its quantity, in any ordinary Indian soil in the plains, is so small that its effect is practically nothing.

Sewage Farm proposed in 1892. (Para 25.) 22. Para. 25 of the President's memorandum I have already dealt with in para. 6, ante. Our knowledge on this subject goes far beyond what it did 8 years ago.

23. As regards his para. 26, a reference to Mr. Mollison's Note, para. 8, will show that in his calculations he *had* allowed for the resting of the land in rotation every third year.

Profit from Lucerne. (Para 27.) 24. As regards the return from the fodder crops, the only doubtful point is the rate taken for Lucerne, as the rates taken for the fodder jowars are acknowledged to allow an ample margin. We have now finished one complete year, with 12 cuttings, of this crop; and the gross dry weight is a little over one lakh of pounds per acre. In the course of the experiment it has been found that three applications in the month produced the best crop, or at the rate of about 3,700 gallons per acre per day. Four, or even five, applications per month *can* be taken up, as at Matoonga, and purified; but three will give as good a crop. For the first six months, however, only one application of effluent and two of canal water were given per month; otherwise, we now find that we should have got about 20,000 lbs. per acre more from these early cuttings. The retail rates mentioned by the President are the weights of Lucerne as wetted by the sellers; and we find that this wetting increases the dry weight (as cut) by 30 per cent! The crop weight of the experiment was

taken dry, just as it was cut; and if we take a wholesale rate for it of 250 lbs. per rupee, (equal to more than 300 lbs. of the Lucerne as wetted for sale), we find that the gross value of the year's cutting is Rs. 409. The total expenses, including ploughing, &c., sowing seed, watering, &c., were Rs. 174, of which the first two items cost Rs. 45; so that the *net* return, even at this liberal rate, is Rs. 235 per acre per annum, and this allows for a fresh sowing *every* year, instead of every third or fourth year, as suggested. If this sowing is only done every third year, and the effluent applied three times per month, the crop will have an average *net* value of Rs. 327 per acre per annum. For the first six months, with one application of effluent and two of canal water per month, the total weight cut was 42,140 lbs. per acre; and for the last six months, with three applications of effluent per month, and no canal water, the amount was 59,948 lbs. The total weights on the other Lucerne plots, manured at the rate of 20 tons per acre (value Rs. 140) of *poudrette*, and of farmyard manure, respectively, and irrigated with canal water every eighth day, were 96,180 and 74,620 lbs. respectively; and the weights in the last six months were 42,616 and 35,252 lbs. respectively. The monthly cuttings of the last two plots have shown a rapid decrease towards the end of the year, the *poudrette* falling from 10,248 lbs. per acre for the eighth cutting to 5,180 lbs. for the eleventh cutting, and 2,800 lbs. for the twelfth; and those of the farmyard manure plots were 8,680, more 4,172 and 2,240 lbs. respectively; whilst the effluent plot cuttings on these occasions were 12,992, 8,652, and 7,952 lbs. respectively. This shows that even such an expensive dressing of *poudrette* was not enough to last the whole year for *heavy* crops, and that 3,700 gallons of effluent per acre per day is worth so much more than Rs. 140 worth of *poudrette*.

The Executive Engineer for Irrigation informs me that the present area under Lucerne, near Poona, is 250 acres; so that we may fairly calculate on making a profitable use of at least 100 acres of this crop, as the demand here, and in Bombay, is much in excess of the supply, and a lower rate will increase the demand.

With scientific cultivation and proper rotation of crops, both Mr. Mollison and Dr. Leather agree that the effluent *can* be applied to the land as frequently as stated by the former in his Note attached to my former Address; and they are corroborated by the Agricultural Department of the United States of America, than whom there can be no higher authority on such matters.

25. Our experiments have proved that the effluent does *not* want *dilution*. When the sugarcane is young, two or three applications of water have to be given, as stated in para. 5 of Mr. Mollison's original Note. Otherwise, on the Kirkee Farm, the effluent has been applied to the crop as it was delivered from the carts. The Matoonga experiments also show that no dilution is *necessary*, nor even any extra waterings for ordinary crops. The formula of the Irrigation Department regarding the amount of canal water (412,000 c. ft.), calculated per

Dilution of the effluent unnecessary (Para. 30).

acre for sugarcane, refers to the discharge of the canal *at the headworks*; and includes all losses by leakage, wastage, &c., before the water reaches the crop, which will not affect us; and Mr. Mollison has proved by actual experiment that the *best* crop is obtained by an *actual application* of about *half* (200,000 c. ft.) of the gross amount allowed for by the Irrigation Department in their calculations for the supply at the head of the canal. It is obvious that when a cultivator can take as much water as he pleases each time, without stint or measurement, from an open channel passing through his fields, he will naturally become more indifferent to waste than if he had to lift the water from a well at his own expense, or to pay for it by measure. The canal authorities have to allow for this as regards *their* water; but, for *our* purpose, Mr. Mollison's figure is the correct one. The amount to be paid for canal water for our sugarcane will probably be Rs. 20 per acre, or less, including the waterings when cane is ripening, and the effluent has to be stopped. The length of the period for these final waterings has yet to be decided, and it may be 3 or 4 months; but it will be during the Rabi season, when the water is cheap. The preliminary waterings of the young shoots will also be during this season; so that the expensive hot weather rate for canal water will not have to be paid; and there will be no trouble about regular waterings, as the supply is then always plentiful.

Cost and method of converting Privies into W.C's. (Para. 33.)

26. The original estimate for the conversion of privies into W. C's. was based on the use of English materials. Since then, I have inspected several W. C's. in Ahmedabad, made by local labour; and the cost is under Rs. 60 each, including the water connection; and I consider that this design answers all requirements. The pan is moulded in cement concrete, over brickwork; and it is then cement-plastered. It is of the "wash down" pattern, with a flushing pipe around, and just below, the rim, which scours the sides and cleans out the "trap"; the latter should be of the "P" pattern. A 2-gallon *syphon* flushing tank would probably suffice here, although 3 gallons is better. The syphon tank is the only way of getting an efficient flush, and it is also an economical preventative of waste. The type of tank known as the "Column" is very simple and efficient. The "Acme" is also a good one. Whatever type is finally adopted, it should be of galvanised iron; as the formation of rust is very objectionable, both because it destroys the tank, and the scales of rust interfere with the working parts. The cistern should be covered, to exclude dirt; and the supply should be controlled by a properly-constructed "Ball valve," which will shut off the water before it reaches the overflow level. The overflow pipe must be large enough to take the full inflow, and it must discharge into the open air. The flushing pipe must be at least $1\frac{1}{2}$ inches in diameter, and $1\frac{1}{2}$ inches would be better; it should be soldered to the tank; and connected to the rim flushing pipe of the seat by a watertight, and if possible a detachable, joint, so arranged that the water will pass equally on both sides of the rim of the basin, to ensure that the two streams will meet in front of the basin and there form a cascade to wash out the contents; the rim flushing pipe

should have perforations along its lower side, to allow of jets of water cleaning the sides of the basin. There should be no sharp bends in the flushing pipe. The flushing tank should be fixed at least 6 feet above the basin; and a small tap should be provided in the lower part of the supply pipe, from which the user can fill a lotah. There are 6,188 houses in Poona having 7,843 privies; and of these, 1,763 (with 2,420 privies) have water connections already; so that the *total* sum required for the conversion will be about $4\frac{1}{2}$ lakhs. I understand that the revision of your establishment and procedure will probably result in a large reduction in the legal processes for recovering outstandings of taxes; but, as regards the poorer population, I believe that Government favour the idea of a *moderate* increase of the Octroi charges as being the best way of making *them* contribute towards sanitary works.

27. There are 13,000 houses in the city, and the cost of connecting them with the sewers will be added to the estimate, as desired. In Ahmedabad it costs Rs. 10 to 12; but I have taken an average of about Rs. 15. *Cost of house connections. (Para. 34.)*

23. The amount originally provided in the estimate for Establishment could *only* have been for "Supervision of Works," as no other establishment will be required until the work is done. The details, as now settled in consultation with some members of the Sub-Committee, are:— *Works Establishment (Para. 35.)*

	<i>Cost per month.</i>
1 Engineer at Rs. 600 per month	Rs. 600
1 Supervisor at Rs. 220 ,,	,, 220
2 Overseers at Rs. 120 each ,,	,, 240
2 Sub-Overseers at Rs. 60 each per month	,, 120
1 Clerk and Accountant at Rs. 80 ,,	,, 80
1 ,, and Draftsman at Rs. 70 ,,	,, 70
1 Peon at Rs. 10 per month	,, 10
Office Rent & Contingencies	,, 60
Total per month ...	Rs. 1,400

Or, say, half a lakh for the three years of construction. As the work will be all done by contract, the expenditure on tools and plant will be small; and the amount provided for these two items is ample.

29. Urinals are objectionable, as they are liable to be used as latrines; and I understand that most of those formerly in the city have been abolished for this reason. I propose to provide 50 new "Trough Latrines," of 10 seats each, in selected places; and this, with the conversion of the existing public latrines (of 409 seats), will provide accommodation at the rate of about one seat for every 50 of those who have no privies in their houses. These latrines will be of the type design of the Sanitary Board: consisting of a double row of compartments, back to back, with a trough between; and a tank at one end to automatically flush, at stated intervals, both basins and trough. Ten seats is the economical minimum, as the trough and the tank must be provided for any smaller number also. *Public Latrines. (Para. 37.)*

Contingencies.
(Para. 38.) 30. The usual 5 per cent. for Contingencies *was* added to each of the *detailed* estimates, as might have been seen by reference to pages 67 & 68 of my former Address. It has now been added in a lump sum on the total. The estimate on page 65, referred to, is only an abstract of the *totals* of the *detailed* estimates, as might have been seen by comparing the figures of its items with the totals on pages 67 and 68. It was surely unnecessary to even imagine that such an invariable item of *every* estimate could possibly have been omitted.

Interest on loans during construction.
(Para. 39.) 31. Similarly, a reference to the "Financial Statement—Loans required," on page 73 of my former Address, would have shown that the "Interest on Loans during construction" *had* already been added; and this was also *especially* referred to in para. 94 of my Address. Moreover, the total for this item, *vide* the "Financial Statement," was only Rs. 2,13,000, not three lakhs. If Government makes the Municipality a present of this, well and good; but that will be a reduction of, and *not* an addition to, the total.

Storage for use during Canal Closures.
(Para. 40.) 32. As Mr. Doig's proposals for the Water-works provides for six days' storage of the full supply, no water tanks in the houses will be necessary to cover the periods of canal closure.

Working Capital for the Farm.
(Para. 41.) 33. From paras. 13 and 14 of Mr. Mollison's original Note, and the former Statements of the previous crop experiments, it is obvious that the working expenses for sugarcane *were* deducted from the gross return. Of these expenses, Rs. 95 are only to be incurred at the time the goor is being made, and this can be recovered immediately by sales, in the usual way; so that the actual *preliminary* working expenses will only be Rs. 125 per acre, at most. For Lucern, the preliminary expenses, up to the first cutting inclusive, will be Rs. 45; and for one of the other fodder crops it will be about Rs. 20 per acre; including seed, ploughing, &c. : *after* the first cutting, the small expenses can be taken from the sale receipts of the first cutting. During the first year we shall only have 275 acres of cane; which will become a ratoon crop in the second year, with a further 275 acres of new cane in that year, as stated by Mr. Mollison in his former Note. The working expenses of a ratoon crop are trifling; so, if we allow Rs. 35,000 for preliminary expenses for the sugarcane, Rs. 4,500 for 100 acres of Lucern, and Rs. 20,000 for say 1,000 acres of fodder crops, including a monsoon area of 600 acres, or a total of say Rs. 60,000 as Working Capital for the farm, instead of the two lakhs suggested, it will be ample. As regards the statement that Mr. Mollison's estimate of the cost of sugarcane cultivation is Rs. 448 per acre, the most cursory glance at the reference will show that this includes Rs. 230 for manure and water, of which we shall only have to pay a part of the water charge; so that the *proper* cost, *as applicable to the scheme*, should have been given as about Rs. 235, instead of Rs. 448.

Sufficiency of the sewers provided.
(Para. 42.) 34. All necessary roads have been provided with sewers, as may be seen from the General Map of the City; and you may safely leave the P. W. D., and Mr. Santo Crimp to see to this. Moreover, as explained

in the latter part of para. 70 of my former Address, there is an ample margin for any future extensions that may become necessary hereafter.

35. It is to be regretted that such a statement as that in paras. 43 and 44 of the President's Memo. should have been made. I have shown that there are practically no grounds for it, or for saying that it is likely that the cost of the scheme will be nearly double the estimate; and it only serves to alarm those who do not care to go into details. There is also no object in making up your minds beforehand that so many thousands of people will not pay the lawful taxes for Drainage and Water supply, as such a public anticipation would only encourage a much larger number to try and escape this payment. The only proper way is to say that *all must* pay; and then, if, after a proper trial, you find that any *must* be exempted on account of poverty, you can go to Government to get the Octroi increased so as to meet this deficit. In any case, the loss will come under the head of "Recurring Charges," and *not* under that of *Capital Expenditure*; and will be extinguished with the loan, as the work is to be done for the houseowners by the Municipality out of borrowed money.

Supposed additions to the estimates. (Para. 43.)

36. I have already explained that the figure given as the cost of the maintenance of the Colaba Section is entirely misleading as regards Poona; and the other figures in para. 45 of the President's Memo. are incorrect. The population is *now* larger than that stated; the pumping head is only 190 feet, including friction, not 225; and only one engine is to work during the night, not two. Here, again, an *actual* estimate is the only safe guide; and the following has been drawn out in consultation with the President and others.

Working expenses. (Para. 45.)

ENGINE ROOM EXPENSES.

Coal Consumption

To start with :—

150 I. H. P. for 12 hours during the day, and	...	...	...
80 I. H. P. do. do. night	...	...	...
at 2 lbs. of best Welsh coal per I. H. P. per hour, as guaranteed.			
Welsh coal per day	...	...	5,520 lbs.
Add $\frac{1}{4}$ more for Singareni coal	...	...	1,880 „
			7,400 lbs.

or 3.3 tons. Say 1,200 tons per annum.

Air compressors, 7 cwt. per day, or 128 tons per annum	...	...	...
Add $\frac{1}{4}$ for Singareni coal 32 tons do.	...	...	...
Total ... 160 tons do.			...

Grand total—1260 tons per annum at Rs. 14 per ton; or say Rs. 19,000 per annum.

Engine Room Establishment.

1 Engineer Superintendent (English, with 1st class Certificate)	Cost per month.
at Rs. 250 per month	Rs. 250
2 Drivers at Rs. 60 each per month	„ 120
4 Oilers at Rs. 15 do. do.	„ 60
2 Firemen at Rs. 15 do. do.	„ 30
2 do. at Rs. 12 do. do.	„ 24
6 Coalers at Rs. 10 do. do.	„ 60
1 Fitter at Rs. 40 do.	„ 40
	<u>Total ... Rs. 584 per month</u>
or say Rs. 7,000 per annum.	
Engine Room Stores, and repairs, say...	... 4,000 per annum.
Grand total for Engine Room ... ..	... 30,000 do.

In making out the above estimate, I have referred to the Municipal Engineers of nine large towns in India, of which three have the Shone System, four have Worthington Engines, and two have other engines; and I have got full details from them. The expenditure on the "Stores" is estimated at :—

1 gallon of heavy oil per day...	... ..	Rs. 75 per month.
1 pint Spindle do. do. ... ..	... ..	„ 5 do.
Cotton Waste ... ..	... ..	„ 10 do.
Soap, Emery cloth, Bath brick, &c. ... ..	... ..	„ 6 do.
Contingencies, say ... ..	... ..	„ 24 do.
	<u>Total ...</u>	<u>Rs. 120 per month,</u>

or, say, Rs. 1,500 per annum; and the Makers' Agent is satisfied with this. The repairs for the first 2 or 3 years will be practically nothing; and, after that, Rs. 1,000 per annum will be a liberal allowance; so you see that I have allowed a very liberal margin in taking a total of Rs. 4,000 in my estimate.

Construction Engineer. 37. The Engineer I would propose for executing the work is Mr. Fern, who has had 17 years' practical experience in supervising the carrying out of the Bombay Drainage Works; and is very highly recommended by both Mr. Smith and Mr. James, the two Bombay Municipal Drainage Engineers.

Maintenance Establishment (Para. 46.) 38. The following estimate has been drawn out, and approved of by the same Members, for the maintenance of the Drainage Scheme after construction :—

1 Engineer at Rs. 300 per month	Rs. 300 per month.
1 Overseer at Rs. 120 per month	„ 120 „
3 Maistrees at Rs. 30 per month each	„ 90 „
1 Clerk and Draftsman at Rs. 60 per month	„ 60 „
2 Peons at Rs. 10 per month, each	„ 20 „
4 Fitters at Rs. 30 per month, each	„ 120 „
4 Turncocks at Rs. 10 per month, each	„ 40 „
20 Sweepers, &c., say	„ 200 „
Contingencies and Repairs, say	„ 150 „
	<u>Total ...</u>
	<u>Rs. 1,100 per month.</u>

or, say, Rs. 13,000 per annum.

Karachi only calculates for:—1 Fitter, 1 cooly, 2 sweepers, and 2 carts with sweeper drivers, for 6,000 house connections. In the borough of East Ham, one of the suburbs of London, the Sanitary Authority undertakes the clearing of stopped drains in the district ; and the work has not entailed any large expenditure, and saves the owners and occupiers of houses much trouble. At the present time, when there are nearly 13,000 houses connected with the sewers, only two men are constantly employed on this work.

39. The Engineer I would propose for this Maintenance, (and the proposal has the approval of your President and others), is Captain Lyon, now Assistant Engineer, Public Works Department, in charge of Poona Headquarters at present. He will have taken his pension three years hence ; and is willing to take up this appointment, for which he is admirably qualified by his long experience in this country. The other details are based on the actual expenditure of other towns.

40. The Water-Supply Scheme, to which I will refer subsequently, provides for 20 gallons per head per day, which will suffice for all purposes ; as the present loss, by leakage from the old aqueducts, &c., will not then occur. Government will probably give the whole of this water-at a cheap rate; but the cost comes properly under the head of Water-Supply ; as, whether the Drainage Scheme was done or not, your water-supply would have *had* to be improved, both as regards quantity, quality, and pressure. *Water-supply
(Para. 47.)*

41. The sewers are intended to carry the whole of the water-supply to the town, and this is the way that all scientific drainage schemes are invariably worked out.

42. The water required for the intermediate irrigation (not for dilution of the effluent) will be charged for under the head of Working Expenses of the farm, and has been allowed for under that head.

43. Provision has been made for the extra Sinking Fund and Interest charges required to extinguish in 20 years, that portion of the loan required to cover the cost of the machinery. The combined rate of Sinking Fund and Interest has been laid down by Government for different periods, and for different rates of interest ; and no further provision is required under this head. *Renewal of
the Machinery.
(Para. 49.)*

44. The machinery (by which an ordinary person would, from the context, understand that the *whole* of the machinery was meant) does *not* "work day and night without intermission." There are to be three engines, of which only two work during the day ; and of these two, only one works at night. One is, therefore, always at rest, whilst two are at rest every night; and similarly for the boilers; so that *each* engine and boiler gets considerably *more* rest than the single engine of a mill, even allowing for all its stoppages for holidays, &c. At the end of the 20 years, if the plant is nearly worn out, a

fresh loan can be raised for another 20 years, and new machinery bought; and, as the debt for the old machinery will then have been paid off, the people *then* will be no worse off in this respect than the *present* generation is *now*.

The carrying out of the scheme (Para. 50).

45. It is worse than useless to talk about the Drainage Scheme costing 40 lakhs, or 50 lakhs, or any other such sum. A careful estimate has been made to include everything; and you may leave Government to see that this estimate is a correct one. The rates have been taken from works actually done, and have been adopted to local circumstances under the advice of your own Engineer; the cost of the machinery has been got from the Makers, and includes delivery and erection; and an ample margin has been allowed for Contingencies, Establishment, Tools and Plant, &c. Out of the total of about 18 lakhs for Works only, the machinery, and the pipes of steel, iron, and stoneware, as well as the other fittings, will have to be got from England, and will cost about 12 lakhs, besides $2\frac{1}{2}$ lakhs for W. C. fittings; and there is also the cost of the farm, and the provision for working, and land compensation, which comes to Rs. 4,60,000; leaving about 6 lakhs for local works, exclusive of Establishment and Contingencies; and there is no reason why this should not be properly spent in three years. For the greater part of the Water Works Estimate of $7\frac{1}{2}$ lakhs for Works, is for the purchase of pipes, machinery, and the high level tanks, *viz.*, Rs. $4\frac{1}{2}$ lakhs; and the local work can probably be easily done in *two* years. The quicker the work is carried out, consistently with due care, the cheaper it will be; as you will be saved the heavy charges for the supervising establishment, and for interest on loans during construction; and the sooner your scheme is working, the sooner will you be getting a return for your expenditure from the farm. Moreover, as it will practically be all contract work, you will get better rates by avoiding delay, once the work is started.

46. It is quite impossible to carry out such a work piecemeal, and it is *now* quite unnecessary to do so tentatively; and, finally, any delay in improving the health of the city is inadvisable. Mr. Santo Crimp, in his para. 12, distinctly says that you can expect no amelioration of the present conditions until you have an efficient drainage scheme. The above points are strongly put in para. 34 of Mr. Santo Crimp's Report. It is useless to expect Government to allow sugarcane cultivation within the limit which has been fixed after careful consideration, and for well-known reasons as regards the effects of continual irrigation near Barracks, irrespective of any consideration of a sewage farm there; and Mr. Santo Crimp, in his para. 29, also emphasises the fact that *crude* sewage should *not* be applied to the class of land in question.

Shone System necessary for a portion of the city (Para. 51).

47. It is impossible to do away with the Shone System altogether. Its extent has been minimised to the greatest possible extent, but still we have a future population of 23,000 to consider; these will live along the river, and would continue to pollute it; and this portion of the city would remain as a dangerous area, and just where it would do most

harm. Mr. Santo Crimp personally told me that this area should be sewerred concurrently with the rest ; and he would have mentioned this in his Report if he had supposed it possible that there could be any question about such an obvious matter.

48. The septic tanks have been abandoned; but the macerating tank is a necessity, as explained before, and as stated in Mr. Santo Crimp's para. 29.

49. The results of the Kirkee experiments with sugarcane have proved that there is no truth in the extracts from ancient books, attached to the President's Memo. ; and these experiments bear out what Dr. Leather and Mr. Mollison have said, their opinions being based on recent research and knowledge of plant food. Not only has the juice of the effluent sugarcane crystallised, but also that of the cane grown partly on night-soil ; and the goor was in each case as hard, (though of a darker colour in the case of the effluent), as that grown on poudrette, or farm-yard manure. As the land had had no manure for two years (although monsoon crops had been grown on it), and was light soil, and as no other manure was applied to the effluent plot, there can now be no dispute that the effluent will produce good goor.

*Suitability
of the effluent
for sugarcane.
(Para. 18.)*

50. There never was any question, at least as far as I was concerned, of " the fodder grasses and cereals " giving us " a clear profit of 2½ lakhs a year," or anything like it. A reference to page 73 of my former Address will show that the anticipated amount was half a lakh for 375 acres ; and, if sugarcane was not grown, this area and amount might have been probably trebled.

*Profit from
FodderCrops.
(Para. 52.)*

51. Even if the farm revenue falls short of my estimate, why should it be necessary to consider how the whole 2½ lakhs could be raised by extra taxation. Such a suggestion is only calculated to mislead, and cause alarm ; as even the fodder crops would bring in more than half the amount, and there would also be a considerable amount due to the saving on the present system. At the same time, when Government assisted the Municipality last year with their plague expenditure, to a far greater proportionate extent than other Municipalities, it was specially done with a view to leave you a taxable margin for your Drainage and Water Works ; and this taxable margin was, I believe, held to be about Rs. 1,30,000 giving an incidence of taxation per head of Rs. 3-5-2 per annum, as settled, I understand, after consultation with your President. If the Municipality do not now utilise this taxable margin, to the necessary extent, on sanitary works, they cannot expect to be favoured exceptionally in the future as regards plague expenditure ; and this taxable margin will then have to be utilised for that purpose. Extra taxation is always unpopular, and the cry of poverty is that of every Municipality.

*Extra
taxation.
(Para. 52.)*

52. As stated in my previous Address, I am entirely of opinion that a better water-supply should be ensured ; but it is very far from the facts to say that " the canal water in the monsoon is full of mud to

*The condition
of the Canal
Water.
(Para. 52.)*

“almost saturation”, at least in the ordinary acceptation of the term. This might apply to the Indus, or the Ganges water at that time; but the canal water is practically little more than *coloured* by the red soil of the hills during the monsoon, which is proved by the comparatively small deposit in the existing settling tanks of the Cantonment Water Works, even at that time. This, indeed, is only to be expected, as the water is drawn from a large lake, in which most of the original silt *must* have been deposited.

*Taxation for
Sanitary
Works is
reasonable.*

53. In this country there is a sentimental feeling against any form of charge for water used; but this is only suited to a most primitive form of society. So long as each person draws the water they require, by buckets from a well, little exception can be taken to such a theory, especially as they would take care not to waste it; but when people are grouped together, and find that by uniting, and having one supply to serve them all, much time and labour are saved, it is only reasonable that those who have no longer to give their labour, should share in the expense of doing that which saves them their former labour; especially as they then waste far more water than they formerly did, and the actual charge is such a very light one when spread over the year. A water-tax is actually a payment for a commodity supplied; and there is no more reason why the Municipality should spend money in giving this free to the people, than that they should give flour, or meat free to every one. Similarly, a drainage tax is a payment for an important service rendered, just as for lighting, education, &c. For the poorer classes, from whom it is difficult to collect *direct* taxes, a moderate increase of the Octroi will probably be considered as the only way to get a fair contribution from them for Drainage and Water Works.

*Colonel
Ducat's
opinion on
the site for a
Farm. (Para.
53.)*

54. I have already dealt with the statements made in the President's para. 53, so I need only repeat that the pumping is only really to a point about $3\frac{1}{2}$ miles distant; and that the advance in our knowledge in the last 8 or 10 years entirely controverts what was originally suggested about a farm. As Colonel Ducat's name is mentioned, I need only refer to the last para. of his own remarks, Appendix E of my previous Address; which shows how his opinion has changed with the further information *now* available on a subject which has only been comparatively recently investigated.

*House
Connections,
and W. C's.
in India.
(Para. 54.)*

55. As regards para. 54. of the President's Memo., there are several misconceptions. Mr. Snow has informed both of us that the long delay about house connections in Bombay was *solely* due to the obstruction of the houseowners on the Corporation, who did not want to have to incur expenditure, and preferred their own interests to those of the public. The Municipal Commissioner has now, I believe, under the Infectious Diseases Act, taken up the matter himself; and $1\frac{1}{4}$ lakhs are entered in this year's budget for the purpose. Even in the crowded streets of Bombay, they anticipate being able to do 15 connections a day with the sewers now laid; and in Poona there is no reason why this rate

should not be trebled, if all the materials are ready beforehand ; and the work up to the house-wall is carried out concurrently with the sewers, so as to save having to open up the road surface again. In Bombay, this work is to be done by a Firm, holding a contract for it ; and the cost is eventually to be recovered from the houseowners, although in most cases it will have to be paid for from Municipal funds in the first instance. Over 17, 000 house-connections are now to be made there, as fast as they can be carried out, in the area in which the new system of drainage has been established. When the revised District Municipal Act is passed, (which will probably be this Monsoon), there can be no possibility of such obstruction here. Also, the houseowners here will only have to pay a small yearly amount, instead of a lump sum down. If this had been applicable to Bombay, the opposition of the houseowners would probably have been much less. I have consulted some of yourselves, and also some of the Ahmedabad Commissioners, and I am informed that there is no caste, or religious prejudice against the use of a W. C. : in fact, it is said to be very much the other way, as the *bhangies* can then be excluded from the houses. A suggestion has been made that W. C's. may produce typhoid ; but historical evidence is entirely opposed to this. The disease was known in Europe in 1412, was described in 1612, and was common in 1734 ; but Joseph Bramah only invented the W. C. in 1798, and it only came into general use between 1828-53. In Nottingham, one in 101 houses that had pail closets were attacked with this disease, but only one in 360 houses with W. C's. In Belfast, the figures were one in 108, and 400, respectively. It is, therefore, evident that the W. C. has *not* been an active agent in the propagation of the disease ; and, in fact, a well-conducted sewerage system, with its accompanying system of W. C's, have together greatly circumscribed the area of its action. In Poona we have not got high and extensive chawls, as in Bombay, occupied by hundreds of different families, with no common interest in the drainage arrangements of the houses ; so we shall not have anything like the same difficulty about maintaining these house-connections. Under the revised District Municipal Act, these house-connections can easily be carried out promptly ; and therefore only a very small number of *bhungies* will be required. Even supposing there is any great delay, a few night-soil depôts can be constructed in central places, as in Bombay, at no great cost ; and the cart contents flushed into the sewers there, instead of being removed to a considerable distance ; so that a *much* smaller number of carts would suffice. This need not, however, be anticipated, for the reasons I have given ; but, in any case, the Rs. 40,000 per annum, or even any large portion of it, will *not* have to be retained ; any more than that the expenditure on the scheme will be 40, or 50 lakhs, or any larger sum.

*Supposed
extra outlay
on the
Drainage
Scheme.*

56. I now come to the President's statement showing the supposed extra outlay. As regards :—

Item 1, see para. 26 ante. The total cost will not be even half of 10 lakhs; and any Municipal loss will be a yearly charge, and not an addition to the capital cost.

Item	2. Provided for, see Para. 27 ante.	
"	3. " "	28 "
"	4. " "	26 "
"	5. " "	29 "
"	6. " "	30 "
"	7. " "	31 "
"	8. Not required, see Para. 32	" "
"	9. Provided for, see Para. 33	" "
"	10. Not required, see Para. 34	" "

The public will have to spend nothing on Item 2, as the *whole* is debited to the Drainage Scheme, as suggested by the Sub-Committee; nor on Item 8; and on Items 1 and 4, they will merely have to pay a small *yearly* sum, about the same as they *now* pay for special privy service. You may safely assume that the effluent will *at least* suffice for the area proposed by Mr. Mollison. He is an expert on such matters, and his opinion has been verified by the experiments at Kirkee, and Matoonga. I have, moreover, shown Mr. Fudumjee and Mr. Nagurkar the details on which the cost of the land for the farm is based, and they are now satisfied that it is *amply* sufficient.

57. Finally, in the "Rough Estimate of Receipts and Expenditure" attached to the President's Memo., under the head of "Expenditure," Items 2, 3, 4, 5, and 6, are much too large. A correct Financial Statement has been drawn out, and is attached as an Appendix.

*Effect of
Nitrates on
Sugarcane.*

58. As regards Appendix A of the President's Memo., (the extracts given in which are from books 50, 17, and 15 years old!), the opinions of Dr. Leather and Mr. Mollison are given in the papers attached to the Memo.; but, as the President was not satisfied with these, I referred the extracts to the Agricultural Department of the United States of America, which has been for many years experimenting with various manures for sugarcane on a very large scale, as it is such an important crop in the Southern States. The Secretary replied that Mr. L. Wray, (the author of the principal extract given by the President), is well known, and respected there; but that since he wrote his book (50 years ago!), their knowledge of plant-food had received a wonderful evolution; and he considered that the effluent, (of which I sent him the analysis, *vide* page 62 of my former Address), is admirably adapted for sugarcane. Dr. Leather, in a late report on the Kirkee experiments, says he is convinced that it is a *perfect* manure for sugarcane; and he also analysed it. You have thus the opinions of three independent experts, all *independently* and another from their *up-to-date* knowledge; and these are

confirmed by the actual result of the Kirkee experiment. It is true that the colour of the goor from the first boiling was not good, but that was chiefly because (owing to Dr. Leather being unable to come to Poona at a later date) the cane had to be crushed before it was quite ripe; and the upper parts had, therefore, an undue proportion of glucose in them; which necessitated overboiling, and a slight burning of the goor, which caused the dark colour. The subsequent boiling, three weeks later, produced a much better coloured goor; but, in even the first case it crystallised without adding lime, or anything else; and the valuation of it by some Dalals and other experts, on the spot, was that the value of even the first lot was only one, or one-and-a-half rupees per pullah less than that of the poudrette goor; and for the second boiling, the relative values were Rs. 16-12, and Rs. 17-4 per pullah, as sold in the market; whilst the quantity from the effluent was about 10 per cent. *more* than that from poudrette. Mr. Mollison has given full details in his Note, which is attached as an Appendix. Of course, experience must be got as to the best method of application of the effluent, just as it had to be formerly got about poudrette; but the Manjri experiments will give us this knowledge before the farm is started. The reason that the effluent plot was not ripe as soon as the poudrette and farmyard plots was, that the former had only water, and no manure, for the first fortnight, until the shoots had well started. Both theory and practice have, therefore, proved that in the purified effluent you have a valuable asset which will go far towards paying for your Drainage and Water Works, *provided* that it is used intelligently, and by a specially-trained farm manager, as suggested. See para. 72.

59. As regards Appendix B of the President's Memo., it is a pity that the Municipality did not take some practical steps to carry out the experiment referred to in the second para., instead of being satisfied with a mere suggestion. Self-help is essential in such matters, and this was a matter that especially concerned yourselves.

60. Appendix C of the President's Memo. is simply theoretical. Where one is dealing with a population of 1,50,000, or more (in the City, and Sadar Bazaar), a large and unknown number of whom are children of *all* ages, it is a dangerous thing to generalise from the data obtained by weighing the excreta of a few persons; and it is much safer to argue from actual results obtained. The Matoonga Leper Asylum may fairly be taken as a small section of a town, and the sewage from it will be similar to yours; if anything, it is *stronger*; and yet it *has* been applied undiluted (but purified), at the rate of 5,000 gallons per acre per day, and with no irrigation water whatever, for several years to land with the greatest profit; and, the longer it is applied, the better the land becomes. Again, the quantities of night-soil, urine, and water, actually put into the septic tank, (from which the effluent was taken to the Kirkee Farm), represent 4 oz., 30 oz., and 15 gallons per head, *vide* page 62 of my former Address.

Suggested experiment with night soil.

Supposed strength of the Poona sewage.

stronger than the amounts given in the President's Appendix C, viz. 7 oz., 30 oz., and 20 gallons; and yet, as you know, this effluent *has* been applied, *undiluted*, to both fodder crops and to sugarcane, with most successful results, for a whole year. Dr. Leather has also analysed the soil of the field there; from the effluent sugarcane plot, as well as from the part that had no manure, which latter is, therefore, in the same state as the effluent plot was in at first; and he finds that the difference is slight, and, if anything, in favour of the effluent. His analysis and report are given as an Appendix.

61. Both Dr. Leather and Mr. Mollison inform me that the *intelligent* application of the effluent to the Manjri land cannot possibly have anything but a beneficial effect; as the excess of the manurial elements is taken up and stored by the land, to its benefit. This has been proved at the Government Farm at Manjri, by Dr. Leather; who, by repeated analysis of the soil, has found that the land on which their sugarcane experiments are carried out is getting richer every year, from the excess of nitrogen put into it over what the crop takes up; the same thing has occurred at the Matoonga Farm, as I have already said.

*The Revised
Drainage
Scheme.*

62. I now come to the revised Drainage Scheme itself, which is very much the same as the one sketched out in para. 89 of my former Address, for the sewage farm; except that the pumping station is at the site suggested by the President, instead of at the Fitzgerald Bridge. Although the Shone System has been reduced to a minimum, we must still have four Ejector stations; but they are of a much smaller capacity than before.

63. The governing point of the scheme is the lowest available level of the bed of the nullah adjoining the Pumping Station, into which nullah the "Emergency Outlet" from the Tank Sewer must emerge. The sewers of the greater portion of the city converge to a 36-inch Intercepting Sewer; whilst those of the extreme eastern portion, together with those of the Cantonment, converge to a 24-inch Intercepting Sewer, which joins the 36-inch sewer at the Balancing Tank Sewer, just south of the Pumping Station; this enables us to do away with the Inverted Syphon for the Manik Nullah, of the former scheme.

*Balancing
Tank Sewer.*

64. Allowing for the Grit and Screening Chambers, and the Suction Sump for the engines, the remaining available length of the Balancing Tank Sewer is 700 feet. Taking the capacity of this Tank Sewer to be equal to $7\frac{1}{2}$ per cent. of the future maximum flow in 24 hours, as suggested by Mr. Santo Crimp, we get the following calculation:—

Est. Pop. in 1931.		Gals. per head.		Gals. of Sewage per day.
1,70,479	×	20	=	3,409,590

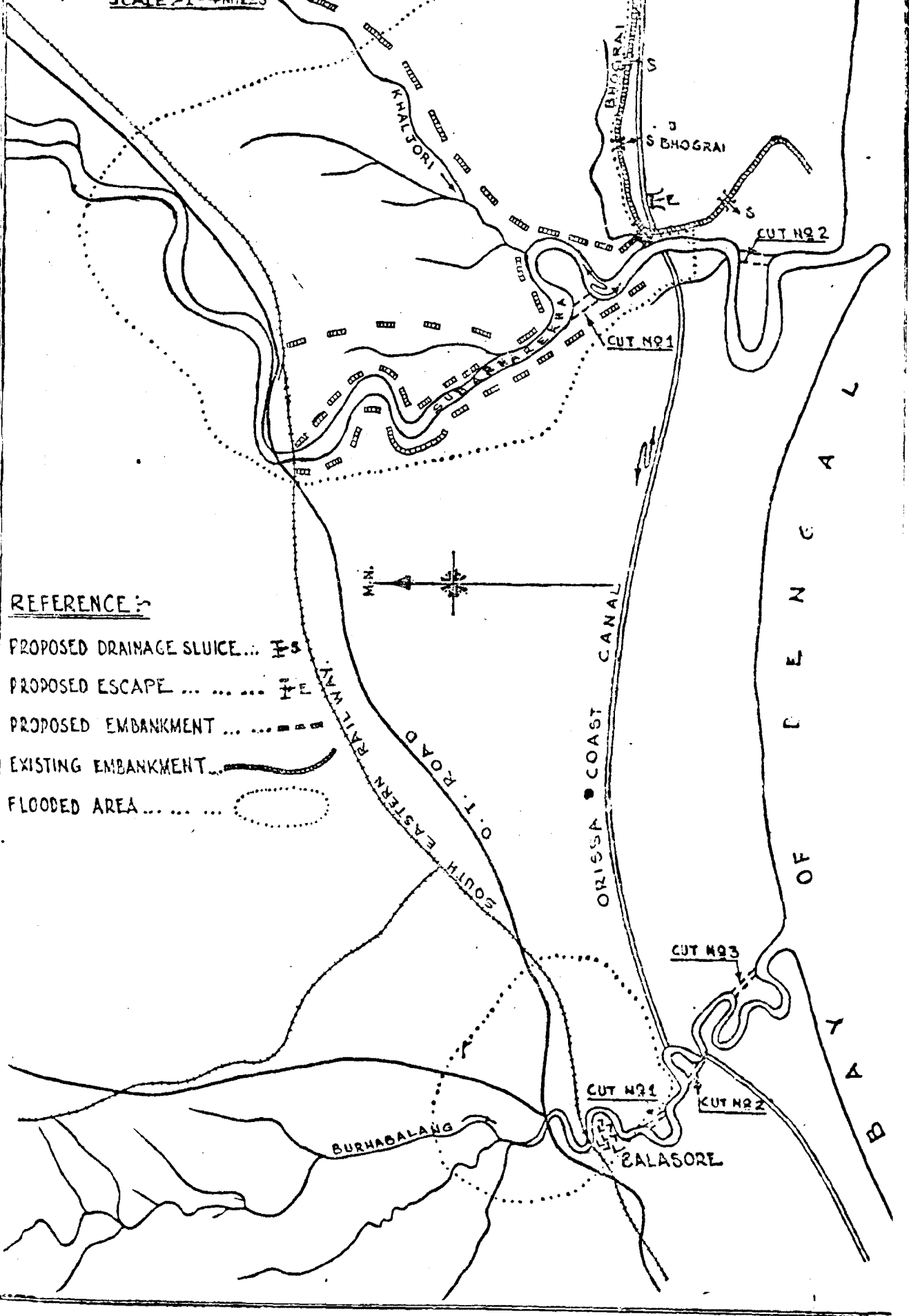
and $7\frac{1}{2}$ per cent. of this quantity is 2,55,718 gals., or 40,915 cub. feet; which is the available capacity of the Tank Sewer as regards the City.

Therefore, if we get:— $40,000 \times 20 = 800,000$ gals.; and






MAP SHOWING THE PROPOSED SCHEMES IN SUBARNAREKHA AND BURAHBALANG BASINS

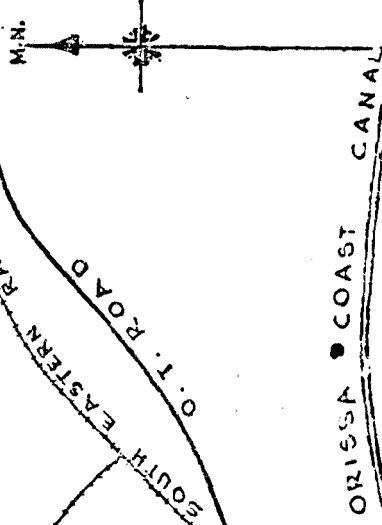
PLAN NOS VI & VII

SCALE: 1" = 4 MILES



REFERENCE :-

- PROPOSED DRAINAGE SLUICE ...  IS
- PROPOSED ESCAPE ...  IE
- PROPOSED EMBANKMENT ...  ES
- EXISTING EMBANKMENT ...  ES
- FLOODED AREA ...  FA



OF DENGA B

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