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# POONA SEWERAGE SCHEME

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AN  
ADDRESS

TO

THE MUNICIPALITY OF POONA

BY

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and  
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## APPENDIX A.

**Note by the Chief Engineer, Public Works Department,  
on the Poona City Drainage Scheme.**

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The City of Poona extends for about 2 miles in length, along the right bank of the Mutha river, immediately above its junction with the Mulla river ; and extends in depth for about  $1\frac{1}{2}$  miles, up to the Mootha Mulla canal which forms its southern boundary. The fall of the ground from the canal to the river is about 90 feet, or an average slope of about 1 foot in every hundred feet ; while the fall from the extreme south-western corner of the City, along the Mutha river to its junction with the Mulla river, is about 20 feet, giving roughly a slope of about 10 feet per mile.

The population of the City in 1891 was 114,965, and the increase per annum of the previous 10 years was 1,554.

2. A tributary of the Mutha river, called the Nagzeri nulla, flows from South to North, and joins that river close to its junction with the Mulla river. This nulla forms the Eastern boundary of the City, and separates it from the Cantonment, the Saddar Bazar, and the European quarters.

The Cantonment is situated at the extreme South, its site being about 100 feet higher than the highest part of the City. The distance from the Southern end of the Cantonment, to the river, is about 3 miles. The first half mile is covered by the Cantonment, built on ground falling 60 feet in that length, or at an average rate of about  $2\frac{1}{2}$  feet in every hundred feet ; then comes the Saddar Bazar, extending for about a mile, and built on ground falling about 50 feet in that distance, or at the rate of nearly 1 foot in every hundred feet ; and finally comes the European quarter, extending for about another mile, with an average fall of about 1 foot in every hundred feet.

The population of the Sholapur and Saddar Bazars in 1891 was 26,815, and the increase per annum of the previous 10 years was 348.

3. From the above, it will be seen that the City site, as well as the Cantonment and Saddar Bazar, admit of being easily and efficiently drained towards the river ; where, on arrival, the sewage has to be disposed of in a sanitary manner.

The Sanitary Engineer, in the accompanying papers, makes two proposals with regard to this, *viz.*, (1) the disposal of the crude sewage by pumping it on to a sewage farm ; and (2) to treat the sewage biologically. The lines of drainage for City, Cantonment, and Saddar Bazar are very similar in both cases.

4. For proposal (1), the following are the main features of the drainage scheme :—

A large intercepting sewer is to be constructed, beginning at the South-Western end of the City and extending along the right bank of the Mutha river to its junction with the Mulla river, and then along its right bank to the *Wellesley Bridge*, near the *Bund Gardens* ; into this sewer will gravitate the whole sewage of the City, Cantonment, and Saddar Bazar (and European quarters if required), except that from four small low-lying portions of the City, which will require to be raised. This raising is proposed to be done by means of four of Shone's ejectors. The sewage on its arrival at the Wellesley Bridge outfall will there be pumped up to a sewage farm situated on the Nagar road, and there utilised to irrigate crops.

The estimated cost of this scheme comes to Rs. 20,68,608 ; and the annual working expenses to Rs. 33,000, to which has to be added Rs. 1,40,000, the sum annually required for 30 years to pay interest and sinking fund on the money borrowed for carrying out the project, including the interest on loans during construction ; making a total annual charge against the Municipality of Rs. 1,73,000.

5. The following are the main features of proposal (2) :—

The sewage of three-fourths of the City will gravitate into an intercepting sewer, which is to be constructed parallel to the Mutha river and at a distance of about half a mile away from it ; its outfall being situated close to the river bank, to the North-West of the Railway Station, and on the site of the present Plague Camp. The sewage of the Cantonment and Saddar Bazar will gravitate to this sewer, joining it about 3,000 feet from the outfall. The remaining portion of the City, viz., that situated along the river bank, is to be divided into four districts, the sewage from which will be raised by means of Shone's ejectors. The sewage from three of the districts will be discharged into flushing tanks, situated on, and commanding, the intercepting sewer ; while that of the fourth will be discharged direct into the sewer, about 1,200 feet from the outfall. The whole sewage, on its arrival at the outfall, is to be treated biologically ; first it will flow into 8 specially designed tanks and there be acted on by anaërobic microbes ; and from these it will pass through 16 filters filled with 4 feet of burnt clinker, in which it will be acted on by aërobic microbes, the effluent can then either be passed direct into the river, or be pumped up to a farm and there utilised for irrigating crops. The estimated cost of this scheme, without an effluent farm, is Rs. 18,13,584 ; and its annual working

expenses will be Rs. 12,000, to which has to be added Rs. 1,30,000, the annual sum required to pay off the loan ; thus the total yearly cost of dealing with the sewage will be Rs. 1,42,000. If the scheme is combined with a farm for utilising the effluent, then the estimated cost comes to Rs. 28,00,000, the annual working expenses to Rs. 33,000, and the yearly cost to Rs. 2,13,000 ; which includes Rs. 1,80,000, the annual sum required to pay off the loan in 30 years. The farm, however, is estimated to bring in an annual revenue of Rs. 2,10,000. Deducting this from the above, we get the yearly charge against the Municipality for disposing of the sewage of City and Cantonment to be Rs. 3,000.\*

The above is a brief sketch of the arrangements proposed for the collection and disposal of the sewage of the City.

6. The sole object of a City drainage scheme is the removal of the sullage and sewage of its inhabitants. The most important points, therefore, in a scheme of this nature, are the connections of the houses, public latrines, and urinals with the sewers. The Sanitary Engineer proposes that the Municipality should carry out these connections from borrowed money, recovering the actual cost, plus interest, from the house-owners, by levying a monthly charge of Re. 1 per house so connected. This is a proposal which cannot be too strongly supported ; as unless house connections are properly and speedily carried out, a drainage scheme can never be a success ; and the above proposal will ensure this.

7. The next important point is the conveyance of the sullage and sewage as quickly as possible to a suitable outfall, where it can be finally disposed of in the most sanitary manner possible. I have not had time to go closely into the details of the several sewers, &c., but, from the Sanitary Engineer's report, I am perfectly satisfied that in both the schemes they have been designed in close accordance with the latest sanitary knowledge ; their capacity is, I consider, adequate for the present and future requirements ; and their gradients are such as will ensure a continuous flow without any risk of deposit ; while ample and efficient arrangements are provided for thorough flushing.

That sewers can, without any difficulty, be laid as water-tight in this country as in England has been clearly demonstrated in the case of the Ahmedabad drainage, where I have personally seen sewers, several hundreds of feet in length, successfully tested.

With carefully laid sewers, combined with properly trapped and constructed house connections, there will be no danger to the inhabitants.

8. Comparing the two schemes, I have no hesitation in recommending that which provides for the biological treatment of the sewage, and for the final disposal of its effluent on a farm.

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\* Note.—This was written before Mr. Mollison's Report had been received.



The biological treatment of sewage is *the* treatment now advocated by all the highest Sanitary experts in England, and is being adopted in all new schemes of drainage. The experiments which are being carried out at Poona as regards the manurial value of the effluent after being biologically treated, and which I have inspected, in my opinion prove that the effluent is very valuable ; and I would strongly recommend its being utilised as proposed, in which event there is no doubt that it will prove very remunerative to the Municipality.

9. As pointed out by the Sanitary Engineer, the most essential factor in ensuring that a sewage or effluent farm will be a success, is the employment from the first of a *trained* and competent man to look after it. This is very clear from a comparison of the farms at Ahmedabad and Karachi, with both of which I am personally acquainted. I would, therefore, strongly recommend that the Sanitary Engineer's proposal for getting a suitable man out from England should be adopted, and that he should be trained for this special work under Mr. Mollison.

10. I concur entirely with the Sanitary Engineer in his remarks regarding the present unsatisfactory state of the drainage of the Sholapur and the Saddar Bazárs ; and would advise strongly, that their drainage, the proposals for which are approved, should be carried out at the same time as that of the City.

11. In conclusion, I would add that, considering the permanent nature of the work proposed, 30 years would appear to be a reasonable period in which to repay the loan ; especially as the works provide for the future population in 1931.

The following four statements are attached for information :—\*

- (1) Comparative Statement, showing cost of disposing of the Sewage of Poona City.
- (2) Loans required—Ordinary Sewage disposal, with farm.
- (3) Loans required—Septic Tank—Disposal without effluent Farm.
- (4) Comparative Statement showing probable annual cost of disposing of Poona City Sewage by (1) Ordinary Sewage farm, and (2) Septic Tanks.

S. B. DOIG, M. INST. C. E.,

9th August 1899.

Chief Engineer, P. W. Department.

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\* See Note on previous page. For Revised Statement of Cost, &c., see Appendix D.

## I.

## Comparative Statement showing cost of disposing of the Sewage of Poona City.

Items as per abstract.	Septic Tank Proposal without Effluent Farm.	Cost Rs.	Items as per abstract.	Ordinary Sewage Farm proposal including Farm.	Cost Rs.
	Rs.			Rs.	
1	Sewers, Manholes, etc. ...	5,56,486	1	Sewers, Manholes, etc. ...	6,45,211
2 to 8	Manholes, Flushing Tanks, etc. ...	1,79,737			
9	Iron Sewage Mains. ...	95,865	2	Air and Sewage Mains ...	2,01,948
10	„ Air Mains ...	37,804			
		8,69,892			8,47,159
11	Syphon for Nagzari Nulla ...	37,990	3	Syphon for Nagzari Nulla ...	37,990
12	Engine House for Air Compressing Plant ...	17,876	5	Engine House for Air Compressing Plant ...	17,876
13	Four Ejector Chambers ...	10,719	7	Four Ejector Chambers ...	10,719
14	Chimney Shaft ...	9,290	6	Chimney Shaft ...	9,290
15	Septic Tanks, etc. ...	5,50,544	4	Air Compressing Plant ...	2,40,000
16	Ejectors, Machinery, etc. ...	3,54,750	8	Major Collecting Sewer ...	90,012
17	Land Compensation. ...	36,000	9	Rising Main ...	2,70,000
		9,41,294	10	Sewage Farm ...	2,25,000
	Deduct—As per Abstract ...	1,43,230	11	Pumping Engines... ..	2,40,000
		7,98,064			10,66,012
	Add—Establishment and Tools and Plant at 4 per cent. ...	69,753		Establishment and Tools and Plant at 4 per cent. ...	79,562
	Total Cost ...	18,13,584		Total Cost ...	20,68,608
	Working Expenses ...	12,000		Working Expenses ...	33,000

## II.

## LOANS REQUIRED.

## Ordinary Sewage Disposal, with farm.

1st year—Drainage ...	...	...	10,00,000	
		Total ...	10,00,000	10,00,000
2nd year—Drainage ...	...	...	6,50,000	
Farm ...	...	...	2,25,000	
Interest and Sinking Fund on 10 lakhs ...	...	...	63,630	
		Total ...	9,38,630	19,38,630
3rd year—Drainage ...	...	...	1,12,046	
Interest and Sinking Fund on 19 lakhs ...	...	...	1,20,897	
		Total ...	2,32,943	21,71,573
4th year—Interest and Sinking Fund on 22 lakhs, say ...	...	...	1,40,000	
Working Expenses ...	...	...	33,000	
Total yearly cost ...	...	...	1,73,000 (1)	

## III.

## LOANS REQUIRED.

*Septic Tank Disposal, without effluent farm.*

1st year—Drainage scheme ... ..	10,00,000	
Total ... ..	10,00,000	
2nd year—Drainage ... ..	6,50,000	
Interest and Sinking Fund on 10 lakhs ... ..	63,630	
	7,13,630	
Total ... ..	17,13,630	
3rd year—Drainage ... ..	1,63,000	
Interest and Sinking Fund on 17 lakhs ... ..	1,08,171	
	2,71,171	
Total ... ..	19,84,801	
4th year—Interest and Sinking Fund on 20 lakhs ... ..	1,30,000	
Working Expenses ... ..	12,000	
Total yearly cost ... ..	1,42,000 (2)	

*Septic Tank Disposal, with effluent farm.*

First three years as per abstract—

4th year—Interest and Sinking Fund on 28 lakhs ... ..	1,80,000	
Working expenses ... ..	33,000	
Total yearly cost... ..	2,13,000 (3)	

## IV.

## COMPARATIVE STATEMENT SHOWING

*Probable annual cost of disposing of Poona City Sewage by—*

(1) Ordinary sewage farm, and (2) Septic Tanks.

	Yearly cost.
	Rs.
1—Ordinary Sewage Farm ... ..	1,72,000
2 { (a) Septic Tanks without Farm ... ..	1,42,000
{ (b) { " with " ... 2,13,000 } ... 3,000	
{ Deduct— Probable Revenue from Farm. 2,10,000 }	

S. B. DOIG, M. INST. C.E.,  
Chief Engineer, P. W. Department.

9th August 1899.

## APPENDIX B.

**A Note on Establishing a Sewage Effluent Farm near Poona, and on the results of Experiments with purified sewage on various crops, by J. A. Mollison, Deputy Director of Agriculture.**

In the following report I propose to give the results of experiments which were undertaken at the Poona Government Farm, to test the manurial effect, on sugarcane and various fodder crops, of the effluent of sewage which had undergone Bacterial treatment in a septic tank and filter beds in Poona City. These experiments, and further experimentation, are important; because, if the Bacterial method of purifying sewage is applied to the whole of Poona City and Cantonments, such sewage effluent in a large quantity will be available, and probably will be used as a source of manure supply, and of irrigation for land in the neighbourhood of Poona.

2. I will first endeavour to define the conditions favourable for the suitable establishment of a Sewage Effluent Farm. It is probable that purified sewage will show its best results on sugarcane. The cultivation of this crop is, and I think rightly, prohibited within one mile of the Cantonment boundary. The same prohibition would probably apply to crops of any description irrigated with sewage. If land is taken up for a Sewage Farm, it should, I think, be under the canal; because an additional supply of pure water for irrigation may from time to time be necessary, even though the sewage be fully sufficient for the area acquired. The most suitable sugarcane land is near Manjhri, 6 to 8 miles from Poona. It is medium black soil of moderate depth (2 to 3 feet), with a substratum of murum. The combination of such soil above, and porous murum below, secures natural drainage; an important consideration in the case of land which is continuously irrigated. The land for a Sewage Farm should, if possible, be in one block; and the surface should slope so that sewage can be distributed easily. Land of sufficient extent, and having the above requirements, can be obtained about six miles from Poona, adjacent to the Sholapur road and under command of the Canal.

It is not only suitable for sugarcane, but also for such other crops as are likely to succeed under sewage irrigation. It grows sugarcane now, and will in consequence be expensive. The distance from market is considerable, and the disposal of produce will be somewhat more costly than from land situated nearer Poona.

8. Assuming that the ordinary strength of the Poona purified sewage will be in the ratio of 15 to 20 gallons of water per head of population, the effluent of the sewage from the Poona City and Cantonments will, with a normal population, be sufficient to irrigate probably 550 to 600 acres of sugarcane. This calculation is based upon the results of experiments at Manjhri, which were carried out by the Agricultural Department to determine the amount of irrigation water required to give the *best* results, the water being given at moderately short intervals.

The best results were got with 34 waterings in 12 months, and the irrigation water used was equal to 49 inches of rainfall, the additional actual rainfall during that period being about 30 inches. During the monsoon the least amount of irrigation will be required ; and it is impossible that the whole of the purified effluent can be economically disposed of on an area of 600 acres of sugarcane at this season. In any case, a larger area, suitable for sugarcane, must be taken up; because sugarcane cannot be continuously grown on the same land. In the Poona district the crop must be planted at a particular season. The best planting season is between December and March. The crop is propagated in the first instance from "sets" (short pieces of cane). Sugarcane thus planted, ripens in 12 months. When harvested, a stubble should be left. Young shoots spring from the stubble, or root-stocks, and grow into a crop of "Ratoon" cane. The Ratoon crop, if healthy, is fully as profitable as the first crop ; and the cost of sets, and of the preparatory tillage, is saved. These items amount to about Rs. 80 or 90 per acre. A second Ratoon crop is not usually profitable, because it generally becomes unhealthy and patchy. Therefore, two years after the first planting, the crop should be grubbed up. This would probably be in January or February. There is ample time between this date and the following June, to thoroughly clean and fallow the land. In June I would sow a rain-crop of fodder-jowar, which, if helped during breaks in the rains by sewage irrigation, would produce a heavy and profitable crop. A fodder-crop of this class could be reaped in two months ; and another grown, and harvested in October or November. The land could then be again got ready for sugarcane by December or January ; a very favourable time for planting.

The rotation would, therefore, be :—

275 acres of new cane	}	Irrigated fully with effluent in the fair season, and lightly in the rains.
275 „ „ Ratoon cane		
275 acres of fodder-jowar	}	Two crops taken between June and November, and irrigated as required with the effluent.

4. It will be seen further on, that effluent irrigated fodder-crops were grown very successfully at the Poona Farm on light soil. Therefore, I advise that, *in addition* to the above area, about 100 acres of light soil be obtained, on which the effluent could be advantageously used during rainy weather in the monsoon.

A sufficient area of this kind of soil can be obtained near the sugarcane land which I have referred to. Crops which are grown on this kind of soil in the Poona district often fail, owing to deficient rainfall; and are generally poor, because the soil rarely gets enough monsoon rain. Two or three waterings with the effluent during the monsoon would be of great advantage. In any case, failing this provision, it would, I think, be necessary to turn the effluent into the river during heavy monsoon rain, or so long as the sugarcane soil continues sodden, or wet. The disposal of the effluent in this manner would, of course, be wasteful.

5. I have already referred to the necessity of having the Effluent Farm under the control of canal irrigation. The necessity for canal irrigation would not often occur ; and presumably, under a special agreement, a small charge would be made by the Irrigation Department for each watering, as required. When sugarcane is first planted, irrigation is required at short intervals (every three or four days) for two or three weeks, in order to encourage the eyes to produce shoots. Frequent effluent irrigation at this stage might prove harmful. The crop makes slow progress when young, and it is possible that purified sewage, if applied regularly at this stage, might prove too strong for the young plants. There was some indication of this in a plot at the Poona Government Farm. A green mould formed on the surface of the soil, and the young plants became slightly unhealthy. The application of effluent water was stopped for three weeks, and one watering of canal water was given instead. The crop then became, owing to this change, vigorous in growth and exceedingly healthy in colour. Afterwards the effluent irrigation was continued with beneficial effect. Sugarcane, when it has made some progress, is an exceedingly gross feeding crop, requiring much manure and much water ; and after it is three months old, I think that even heavy applications of the effluent would be beneficial.

6. The next point to which I wish to direct attention is the probable value of the purified sewage, as a supplier of manure and water, for sugarcane and other crops. As regards its value for sugarcane, we have no conclusive proof yet. All that I can say is, that a plot manured and irrigated with the effluent on the Poona Farm, bears favourable comparison with similar plots heavily and expensively manured with (1) Poudrette, and (2) Farm yard manure, and irrigated with canal water. The value of the effluent for quick growing fodder crops has been clearly demonstrated (see tabulated statement attached to this report).

7. In estimating the probable value of the effluent for sugarcane, we have to consider how much a good cultivator of sugarcane expends on manure and water. Poudrette may be taken as a basis of calculation. When the Poona sewage system is complete, no poudrette will be produced, and purified sewage will be available instead. Poudrette is ordinarily worth about Rs. 7 per ton. I have known it dearer, and cheaper, in recent years. There is now no caste objection to its use, and ordinary labourers freely handle it. It is bulky, and therefore costly to transport. Experiments instituted by the Agricultural Department several years ago, have conclusively proved that poudrette at Rs. 7 per ton is a cheap and effective manure, in comparison with other manures ordinarily available. We have, however, proved that certain oil-cakes, rich in nitrogen, are cheaper and more effective. The sugarcane growers have, at last, appreciated this conclusion ; and are now beginning to use safflower, and other cakes, which they did not previously employ. They, however, still depend to a considerable extent upon poudrette for their manure supply. The best crops are grown from an application which costs about Rs. 200 per acre. The cost of canal irrigation will be about

Rs. 50 per acre (the water-rate being Rs. 40 per acre). Irrigation from a well, if bullock and manual labour is charged at the ordinary hiring rates, will exceed Rs. 100 per acre. The cost, therefore, of manure and water for a sugarcane crop will be at least Rs. 250 per acre, and may be more. The question is, can the purified sewage be proved to be a profitable substitute? It probably can, but no decided answer can yet be given. All I can say definitely is, that the effluent is exceedingly quick-acting. I am of opinion also, that if the purification on a large scale is as complete as that produced under the experiments, there will be no fear of injury by irrigation as continuous as that practised with canal, or well water.

8. The quick-acting manurial effect of the purified sewage is not difficult to comprehend. The comparative manure experiments instituted by the Agricultural Department at Manjhri some years ago, proved that nitrogen, in an immediately available form, was the most-important plant-food required by sugarcane. The Agricultural Chemist to the Government of India proved by analyses, that a very heavy crop of sugarcane can take up only about 100 pounds of nitrogen per acre; whereas, in practice, we have found that the best results are got from quick-acting manures which, in an application for an acre, contain at least 350 pounds of nitrogen. Less will, undoubtedly, suffice in the case of the effluent, because it would be applied by degrees; and the Manjhri experiments clearly proved that manure was economised when given as a top-dressing, rather than as a full application before plantation. Plants can only take up nitrogen through their roots, in the form of nitrates; and this is the immediately available form. Organic nitrogen, or any unoxidized compound of nitrogen, in the soil is converted into nitrates by Bacterial agency, in a manner which need not here be referred to. The Bacterial treatment of sewage in a septic tank and filter beds induces somewhat similar changes. If purification is complete, the albuminoid nitrogen of sewage is changed so that nitrates are formed. The analyses of samples of the Poona effluent show that purification has not been quite complete, but the purification has so far progressed that the nitrogen has mostly been converted into ammonia salts and nitrites. The further oxidisation of these compounds into nitric acid, or nitrates, would occur rapidly in any Indian soil. Moisture, warmth, and the presence of a mineral base like lime, will accelerate the change. From these facts we may conclude that the effluent is quick acting as a manure; and I can state positively, from observing the effect on a crop, that such is the case.

9. The analyses of the Poona purified sewage show a variable composition. It, however, may be concluded that if nitrogen is present in sufficient quantity for the full requirements of a sugarcane crop, the other important manurial ingredients, such as phosphoric acid and potash, will also be present in sufficient quantity. The analyses show considerable proportions of chlorine; chlorides in large quantities, continuously applied, might prove harmful to vegetation, but I do not anticipate any risk on this account.

10. The analyses being somewhat variable, I have not attempted to work out the actual weight of nitrogen which could be given by irriga-

ting sugarcane for a year with the purified sewage. But it is certain, I think, that the amount will be fully sufficient for the requirements of a heavy crop, but not excessive.

11. I think we may reasonably conclude that the purified sewage can be advantageously employed for certain crops in certain kinds of soil in India. I must, however, make the following reservation, *viz.*, that unless the proposed farm is under the capable supervision of a thoroughly practical agriculturist, with considerable Indian experience, it is extremely likely to prove a dead failure. The Poona Municipality must get its effluent farm in the first instance, and it must also arrange for capable supervision. If the value of purified sewage is fairly demonstrated on such a farm, ordinary cultivators will, in a few years, be found willing to take the stuff, at its value as a source of manure and irrigation; but in this case a Superintendent of proved capabilities need not lose his occupation, as more effluent will be available each year, with the increase in population and water-supply; and be available for sale, unless the Municipality wish to extend their own farm. There is also full scope elsewhere for the sanitary improvement of Indian cities, and the development, on practical lines, of such farms.

12. We ought to investigate with some degree of minuteness the probable cost of growing sugarcane, irrigated by means of purified sewage; and, as a basis of calculation, I give below the details of expenditure incurred in growing newly planted cane at our Manjhri experimental station, in 1898-99. The crop was manured with poudrette. Several of the other comparative plots which had been manured with other kinds of manure, gave better results at less cost. But the outturn from the poudrette plot may be considered a full average for high class cultivation as practised by the best cultivators. The land had been under cultivation with sugarcane for some years. It was in good condition, and a very heavy application of manure was not necessary.

	Cost of cultivation per acre.		
	Rs.	a.	p.
13. Preparatory tillage, including ploughing three times, clod crushing, levelling, harrowing, collecting weeds, ridging and forming beds and water channels for irrigation ... ..	42	7	0
Cost of "sets" and planting . . . . .	47	8	0
Hand weeding (six times during year)... ..	14	1	0
Earthing up cane, digging and forming new beds in June and July, by contract ... ..	9	0	0
Cost of labour in applying irrigation water; crop irrigated 30 times ...	9	6	0
Miscellaneous expenses, proportionate cost of erecting gural, tying up cane, making water-courses, use of cane mill, and watching ...	14	6	0
Harvesting cane and making jagri, at contract rate of Re. 1 for each pan boiled ... ..	65	0	0
Carting cane from field to gural ... ..	6	2	0
Carting jagri to Poona, toll and Municipal taxes ... ..	10	4	0
	Rs.	a.	p.
Cost of poudrette, carting of same, and application ...	190	2	0
Charge for canal-water by Irrigation Department ...	40	0	0
	230	2	0
Total cost of cultivation ...	448	4	0
Yield 10,060 pounds of jagri. Value per acre... ..	Rs.	620	9 7



14. The rate for jagri was very variable. At the beginning of the season (1898-99) it was Rs. 22 and 23 per pullah of 246 pounds. Later in the season the price fell considerably. The average price obtained, fairly early in the season, for the jagri produce of our experimental area was at the rate of 16·21 pounds per rupee ; and the above outturn figures are calculated at that rate. It is fair, however, to notice that within recent years the price has been as low as Rs. 11 or 12 per pullah, when the market was temporarily overstocked ; and at that price, the outturn per acre noted above, would have been worth less than Rs. 500 per acre. Goor is a perishable article, which is difficult to store ; and an ordinary cultivator, having no means of storage for a large quantity, is compelled to sell his produce at once. If the Municipality, on their proposed farm, provide accommodation for storage, and adopt the Guzerath method of storing goor in earthen ware chatty pots, there would be no need to sell the produce at any particular season, and a good market rate could be eventually ensured ; and, therefore, it is certain that Rs. 15, or more, per pullah, for their goor would always be obtained. At that price, an acre of good sugarcane would leave a *clear* net profit of from Rs. 300 to 400 per acre, if the value of manure and water, or purified sewage, is left out of account. A good crop of Ratoon cane (which is grown at considerably less cost), would, I think, be quite as profitable, if not more so.

15. I have already referred to the experiments conducted at the Poona Government Farm to test the effect of the effluent on various fodder-crops. The crops which were selected for experiments had been thoroughly tested on the Farm in previous years, on various descriptions of soil ; and it had been proved that they yielded heavily, matured quickly, and produced excellent fodder, on almost any kind of soil in good condition, in a favourable season. The soil of the field selected was light, and of fair depth. It was also clean ; but only in moderate condition, no manure having been applied during the two previous years. Two of the experimental crops (lucerne and guinea-grass) are perennial ; and the cost of sowing, or planting, is heavy as compared with the preparatory tillage for the other crops. Lucerne will, however, yield 12 cuttings during a year, and guinea-grass 8 cuttings ; so that the heavy initial outlay can soon be recovered. The other crops grow so quickly that certainly three, and probably four crops could be grown in succession, with effluent irrigation, in the course of a year. The frequent cultivation of the same crop on the same land might be objected to, as likely to induce an unhealthy condition. That objection would be overcome by a capable Manager, who would find it advantageous to practise rotation of crops. Various pulse crops, such as wal, chola, udid, mug, &c., would be excellent for the purpose. These pulse crops would, I think, thrive under effluent irrigation, and might be allowed to grow to maturity ; or the pods might be plucked early, and sold as green vegetables, and the fodder cut green.

16. The experimental plots treated with the purified sewage were

thrice irrigated with it. Although the extent of this irrigation was not great, the effluent was strong; stronger in fact than would be the case in actual practice on a large scale; and I concluded from the vigour of growth, and general appearance of the crops, that the soil had received sufficient to bring the crops to maturity. Canal water, in addition to the effluent, was given as required. The chief object of the experiment was to test the value, on light soil, of purified sewage in comparison with heavy dressings of poudrette and Farm yard manure.

17. I epitomize the results in the appended tabulated statement. The plan of experiment can be clearly seen from it.

J. A. MOLLISON,  
*Deputy Director  
of Agriculture.*

*Analysis of Poona Sewage Effluent, by the Chemical Analyser to  
Government on 26th July 1899.*

	"A" from Coke Filter. "B" from Clunker "	Parts per 100,000.	
		A	B
Chlorine ... ..		15.50	15.80
Ammonia ... ..		7.50	9.00
Albuminoid Ammonia ... ..		0.32	0.36
Nitrites ... ..		11.50	28.75
Total solids ... ..		67.00	80.00
Oxygen absorbed in 4 hours... ..		15.20	19.20

*N.B.*—The Crude Sewage Mixture, put into the Septic Tank, consisted of:—

Solid Nightsoil	... ..	8½ pounds.
Urine ... ..	... ..	6 gallons.
Water	... ..	490 do.

representing the ordinary town sewage, (with a water supply of 15 gallons per head) of 33 persons. This was kept in the Tank for 24 hours, and in the Filters for 2 hours, and then the above effluent was drawn off. The Tank effluent has a *very* slight odour; but the Filter effluent has none whatever. Daily samples have been stored in bottles since the beginning of May, but none of them have shown the slightest signs of secondary decomposition during the ensuing three months,

Comparative Manure and Irrigation Experiments with various Fodder Crops ; all Crops sowed, or planted, on 8th May 1899.

Manure.	Crop.	Date of Harvesting.	Outturn per Acre.	Cost of Cultivation per Acre.	Gross Value of Outturn per Acre.	Remarks.
Irrigated four times with the effluent. The water of the 81,500 gallons of sewage being equal to, approximately, 4" of rainfall.	Guinea-grass	... 30th June ...	Lbs. 6,160	Rs. a. p. 70 4 8	Rs. a. p. 93 8 0	When fairly established, this crop will yield eight cuttings in a year. It requires plenty of manure and water, and seems to thrive uncommonly well under effluent irrigation. Worth, in Poona, 150 lbs. per rupee.
	2nd cutting ditto	... 5th Aug. ...	7,868	5 15 8	41 7 0	
	3rd ditto	... 2nd Sept. ...	6,216	5 15 8	41 7 0	
	Lucerne	... 18th July ...	4,564	91 0 0	141 6 0	The third cutting had to be made prematurely for this report; but the weight can be compared with the time of growth. Can be cut 12 times in a year. The first cutting was, as usual, insignificant. The rapidity with which the crop produced a 2nd cutting is noteworthy. Lucerne is easily saleable in Poona at 100 lbs. per rupee.
	2nd cutting ditto	... 7th Aug. ...	9,576	5 15 8	73 10 0	
	3rd ditto	... 3rd Sept. ...	7,364	5 15 8	73 10 0	
	Sundhia Jowar	... 1st July ...	22,316	16 10 0	89 4 0	As regards the third cutting, see Note above. This fodder is valued at 250 lbs. per rupee, but would probably be easily saleable at a dearer rate. Stalks very long and very fine. Cut in full flower, 53 days after sowing. Four crops in succession can easily be grown in a year. The second crop from the stubble shows that it would be better to sow fresh seed each time.
	2nd cutting	... 30th Aug. ...	10,164	15 5 0	40 10 0	
	Nilwa Jowar	... 4th Aug. ...	32,536	22 0 4	108 7 0	Stalks coarser than Sundhia, and not worth so much as fodder. Valued at 300 lbs. per rupee. Took 88 days between seed time and harvest. Cut when in flower. Only three crops, at most, could be taken in a year.
	Second growth promising.					
	American Sorghum	... 13th July ...	36,764	18 8 4	122 8 0	An excellent fodder, equal in value at least to Nilwa. Matures quickly. Cut 66 days after sowing. Valued at 300 lbs. per rupee. This fodder is very sweet, and has much leaf growth.
	(Amber variety.)					
Second growth promising						
American Sorghum	... 18th July ...	34,188	21 2 4	114 0 0	Was reaped 71 days after sowing. Other remarks same as for the Amber variety.	
(Collier variety.)						
Second growth promising.						
Maize	... 15th July ...	51,576	27 9 0	129 0 0	An extraordinary heavy crop, which was reaped 68 days after sowing. Stalks very coarse. Fodder valued at 400 lbs. per rupee, and doubtful whether it would be readily saleable at that price; but the corn itself would be valuable as maize.	

Comparative Manure and Irrigation Experiments with various Fodder Crops ; all Crops sowed, or planted, on 8th May 1899.—(continued.)

Manure.	Crop.	Date of Harvesting.	Outturn per Acre.	Gross Value of Outturn per Acre.	Remarks.
			lbs.	Rs. a. p.	
Manured with 20 tons Farm yard manure per acre, and irrigated as required with canal water.	Guinea-grass ...	1st July ...	3,752	61 3 0	Farm yard manure showed, as usual under irrigation, a slow acting effect. The value of the manure will be better seen in subsequent crops. The 2nd cuttings of Lucerne and Guinea-grass indicate that these crops are now getting benefit from the manure applied. Second growth of Nilwa and Sorghums very poor.
	2nd cutting ...	5th August ...	5,432		
	3rd ditto ...	2nd Sept. ...	4,788	31 15 0	
	Lucerne ...	19th July ...	3,472	115 0 0	
	2nd cutting ...	7th August ...	8,036		
	3rd ditto ...	3rd Sept. ...	6,440	64 7 0	
	Sundhia Jowar ...	3rd July ...	12,992	52 0 0	
	2nd cutting ...	31st Aug. ...	5,824	23 4 0	
	Nilwa Jowar ...	6th August ...	19,348	64 8 0	
	Sorghum (Amber) ...	21st July ...	20,580	68 10 0	
Sorghum (Collier) ...	24th July ...	16,688	55 10 0		
Maize ...	17th July ...	17,724	44 5 0		
Manure per acre 20 tons Poudrette, with irrigation from the canal as required.	Guinea-grass ...	2nd July ...	5,040	96 11 0	These figures show that only in the case of Lucerne are the outturn results better than in the effluent plots. The inferences to be drawn are, that the effluent is extremely quick acting ; and is more valuable as a direct application, than a heavy and expensive dressing of Poudrette. The effect of the Poudrette will, like that of Farm yard manure, extend to future crops. This is evidenced to some extent by the heavy 2nd cut obtained from the Lucerne plot. Second growth of Nilwa and Sorghums poor.
	2nd cutting ...	5th August ...	9,464		
	3rd ditto ...	3rd Sept. ...	9,128	60 13 0	
	Lucerne ...	19th July ...	6,188	182 13 0	
	2nd cutting ...	7th August ...	12,096		
	3rd ditto ...	3rd Sept. ...	8,848	88 8 0	
	Sundhia Jowar ...	6th July ...	21,980	87 15 0	
	2nd cutting ...	31st Aug. ...	8,932	35 11 0	
	Nilwa Jowar ...	4th August ...	32,760	109 3 0	
	Sorghum (Amber) ...	20th July ...	34,076	113 9 0	
Sorghum (Collier) ...	24th July ...	33,460	111 8 0		
Maize ...	16th July ...	35,070	87 11 0		

Note.—The cost of cultivation, and rates per rupee, are as shown on previous page.

## APPENDIX—C.

## ABSTRACT

OF

## CITY DRAINAGE SCHEME

FOR

## Septic Tank Project.

## Recapitulation of Estimates.

Estimate. No.		Amount. Rs.
1	Laying pipe and masonry sewage lines, and Inverted Syphon under Railway ... ..	5,56,486
2	Constructing 965 Manholes... ..	1,31,522
3	„ 113 Flushing Manholes ... ..	17,391
4	„ 44 Automatic Flushing Tanks ... ..	22,229
5	„ 1 Automatic Flushing Tank of 6,000 gallons capacity. ... ..	2,256
6	„ 1 ditto ditto 22,000 ditto ... ..	3,677
7	„ 45 Five-inch Inlet Ventilating shafts ... ..	869
8	„ 6 Twelve-inch Outlet do. do. ... ..	1,793
9	Laying Cast-Iron pipes for Sewage Mains ... ..	95,865
10	„ „ „ „ Air Mains ... ..	37,804
11	Inverted Syphon (24" Cast-Iron pipes) across Nagzeri Nalah ... ..	37,990
12	Constructing Air Compressing Station ... ..	17,876
13	„ 4 Ejector Stations ... ..	10,719
14	„ Chimney Shaft ... ..	9,290
15	„ 8 Septic tanks and 16 Filter beds, and Iron work. ... ..	5,50,544
16	Machinery of Ejectors, Air Compressing Plant, and Ventilating Shafts, &c. ... ..	3,54,750
17	Three-fourths share of Land Compensation for Outfall works ... ..	36,000
	Total ...	Rs. 18,87,061
<i>Deduct—</i>		
	$\frac{1}{2}$ of the cost of Septic tanks and Filters ... ..	1,37,636
	Difference of cost between a 42" and 39" sewer 1,760 feet long ... ..	554
	Difference of cost between a 27" and 24" Inverted Syphon 1,260 feet long, under the G. I. P. Railway ... ..	5,040
	Total deduction ...	Rs. 1,43,230
	Total after deduction ...	Rs. 17,43,831
	Establishment charges, and Tools and Plant, at Rs. 4 per cent. ... ..	69,753
	Grand Total...	Rs. 18,13,584

ABSTRACT  
OF  
**ALTERNATIVE POONA CITY DRAINAGE PROJECT**  
WITH  
**SEWAGE FARM AT SITE No. 3.**

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	Rs.
Primary and Secondary Sewers, Manholes, Flushing Tanks, and Masonry of Ventilating Shafts ; but excluding masonry of Major Collecting Sewer	6,45,211
Air and Sewage Mains, Sluice and other Valves, &c. ... ..	2,01,948
Inverted Syphon for Nagzeri Nallah ... ..	37,990
Air Compressing Plant, Ejectors and Ventilating Shafts ... ..	2,40,000
Engine House for Air Compressing Plant ... ..	17,876
Chimney Shaft ... ..	9,290
Four Ejector Chambers ... ..	10,719
Major Collecting Sewer ... ..	91,012
Share of Rising Main to Farm (cost of 22-inch) ... ..	2,70,000
Three-fourths share of Sewage Farm ... ..	2,25,000
Ditto of Pumping Engines and Engine House, Covered Reservoirs and Grit Chambers ... ..	2,40,000
<b>Total ... Rs.</b>	<b>19,89,046</b>
Establishment, and Tools and Plant, at 4 per cent. ... ..	79,562
Add yearly instalments on loans for three years of construction ... ..	1,50,000
<b>Total ... Rs.</b>	<b>22,18,608</b>
<i>Working Expenses.</i>	
Share of Pumping to Farm... ..	21,000
Coal, &c., for Air Compressors ... ..	8,000
Repairs and Supervision ... ..	3,000
<b>Total ... Rs.</b>	<b>32,000</b>

15000  
2068608

## ABSTRACT.

Quantity.	Items.	Rate.	Per	Amount.	
		Rs. a.		Rs.	dec.
	<i>Estimate for Laying Sewage pipes, etc., in the City of Poona—</i>				
.....	Excavation ... ..	.....	...	97,444	...
.....	Refilling trenches and making up road surface ... ..	.....	...	24,361	...
1,52,118 r. ft.	Laying 7" glazed stoneware pipes..	}	.....	3,60,925	...
45,097 "	" 9" " " ..				
18,767 "	" 12" " " ..				
4,049 "	" 15" " " ..				
8,581 "	" 18" " " ..				
519 "	" 21" cast-iron spigot and socket pipes ..				
1,260 "	" 27" cast-iron turned and bored pipes ..				
.....	Culvert for pipes under G. I. P. Railway line ... ..	.....	...	1,000	...
.....	Cement moulded concrete in 39" and 42" Sewers, including centerings ... ..	.....	...	46,216	...
.....	Raising road, Sections Nos. 11 and 15 ... ..	.....	...	40	...
		Total ... Rs.		5,29,986	...
		Add—Contingencies at 5 per cent... ..		26,499	...
		Grand Total ...Rs.		5,56,486	...
	<i>Estimate for 965 Ordinary Manholes on the Sewer lines for the City of Poona—</i>				
9	Manholes 3' deep... ..	95 0	each.	855	...
48	" 4' " ... ..	102 0	"	4,896	...
149	" 5' " ... ..	109 0	"	16,241	...
221	" 6' " ... ..	116 0	"	25,636	...
128	" 7' " ... ..	124 0	"	15,872	...
100	" 8' " ... ..	131 0	"	13,100	...
90	" 9' " ... ..	138 0	"	12,420	...
61	" 10' " ... ..	145 0	"	8,845	...
39	" 11' " ... ..	152 0	"	5,928	...
30	" 12' " ... ..	160 0	"	4,800	...
28	" 13' " ... ..	167 0	"	4,676	...
18	" 14' " ... ..	174 0	"	3,132	...
12	" 15' " ... ..	181 0	"	2,172	...
4	" 16' " ... ..	188 0	"	752	...
6	" 17' " ... ..	196 0	"	1,176	...
7	" 18' " ... ..	203 0	"	1,421	...
5	" 19' " ... ..	210 0	"	1,050	...
4	" 20' " ... ..	217 0	"	868	...
1	" 21' " ... ..	224 0	"	224	...
2	" 22' " ... ..	232 0	"	464	...
2	" 23' " ... ..	239 0	"	478	...
1	" 25' " ... ..	253 0	"	253	...
		Total ... Rs.		1,25,259	...
		Add—Contingencies at 5 per cent... ..		6,263	...
		Grand Total ...Rs.		1,31,522	...





ABSTRACT  
OF  
CANTONMENT DRAINAGE SCHEME  
FOR  
SEPTIC TANK PROJECT.

	Rs.
Total of works in Cantonments ... ..	1,41,858
Add one-fourth cost of Septic Tank and Filters ... ..	1,37,638
Extra cost of Outfall Sewer, from junction of Cantonment Main Sewer with City Major Collecting Sewer ... ..	5,594
One-fourth share of Land Compensation for Outfall works ... ..	12,000
Total ...	2,97,088
Establishment, and Tools & Plant, at 4 per cent. ... ..	11,884
Grand Total ...	3,08,972
2,400 House connections, at Rs. 125 ... ..	3,00,000

A tax of Rs. 10 per annum for each house will cover the interest at 5 per cent. and Sinking Fund for 20 years on this latter amount. To cover Contingencies, the rate may be one rupee per month for each Connection and Water Closet.

WORKING EXPENSES.

Repairs and Supervision ... ..	Rs. 1,000
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ABSTRACT  
OF  
ALTERNATIVE PROJECT FOR CANTONMENT  
DRAINAGE PROJECT  
WITH  
SEWAGE FARM AT SITE No. 3.

	Rs.
Sewers, &c., as before ... ..	1,41,858
2,100 feet extra 18-inch sewer to junction ... ..	12,600
Difference between 39 and 42-inch sewer from junction to Outfall ... ..	3,210
One-fourth of Machinery and Works at Outfall ... ..	80,000
Difference between 22 and 24-inch Cast-iron Rising Main to Farm ... ..	36,000
One-fourth share of Sewage Farm ... ..	75,000
	3,48,668
Establishment, and Tools and Plant, at 4 per cent. ... ..	13,947
Total ...	3,62,615

WORKING EXPENSES.

Share of Pumping to Farm ... ..	7,000
Repairs and Supervision ... ..	1,000
Total ...	8,000

## ABSTRACT.

Quantity.	Items.	Rate.	Per.	Amount.
		Rs. a.		Rs. dec.
	<i>Cantonment Drainage Scheme.</i>			
	Estimate for Laying pipe sewers, constructing ordinary and flushing manholes and Automatic flushing tanks and inlet ventilating shafts in the Cantonment of Poona in connection with the Drainage Scheme.			
	Excavation... ..	.....	...	19,245 ...
	Refilling trenches and making up road surface ... ..	.....	...	4,811 ...
36,683 r.ft.	Laying 7" stoneware pipe ... ..	.....	...	} 77,203 ...
4,130 "	" 9" do. do. ... ..	.....	...	
3,520 "	" 12" do. do. ... ..	.....	...	
1,020 "	" 15" do. do. ... ..	.....	...	
3,710 "	" 18" do. do. ... ..	.....	...	
7 No.	Manholes 3 feet deep ... ..	95 0	each.	665 ...
11 "	" 4 " " " ... ..	102 0	"	1,122 ...
33 "	" 5 " " " ... ..	109 0	"	3,597 ...
26 "	" 6 " " " ... ..	116 0	"	3,016 ...
22 "	" 7 " " " ... ..	124 0	"	2,728 ...
26 "	" 8 " " " ... ..	131 0	"	3,406 ...
14 "	" 9 " " " ... ..	138 0	"	1,932 ...
11 "	" 10 " " " ... ..	145 0	"	1,595 ...
6 "	" 11 " " " ... ..	152 0	"	912 ...
5 "	" 12 " " " ... ..	160 0	"	800 ...
5 "	" 13 " " " ... ..	167 0	"	835 ...
3 "	" 14 " " " ... ..	174 0	"	522 ...
3 "	" 16 " " " ... ..	188 0	"	564 ...
1 "	" 19 " " " ... ..	210 0	"	210 ...
1 "	" 20 " " " ... ..	217 0	"	217 ...
12 "	Flushing Manholes, 5 ft. deep ... ..	142 0	"	1,704 ...
6 "	" " 6 ft. " ... ..	149 0	"	894 ...
12 "	Automatic flushing tanks 6' average depth, at heads of 7" sewers ... ..	451 0	"	5,412 ...
1 "	Automatic flushing tank 5' average depth, at the heads of 9" sewers ... ..	553 0	"	553 ...
13 "	5" Inlet Ventilating shafts... ..	18 0	"	234 ...
13 "	5" Cast-Iron pipes for ventilation of above, with adjustable caps ... ..	225 0	"	2,925 ...
			Total...Rs.	1,35,103 ...
			Add Contingencies at 5 per cent...Rs.	6,755 ...
			Grand Total	1,41,858 ...

## ESTIMATE

FOR

## HOUSE CONNECTIONS

and additions to existing Privies to turn them into  
Water Closets.

				Rs.
1	“Hindustan” pattern pan, with polished top and foot rests, and trap.			}
1	3-gallon Syphon Flushing tank with ball cock, fitted on brackets 12" X 4" X 4" by screws, and fixed to teak wall blocks	...	...	
8	Ft. of 1½ inch lead pipe from tank to pan	...	...	
	Plumber's work, and fixing pan on trap with red lead	...	...	
1	India-rubber cone, with red lead and binding wire, &c., to make joint of pipe to pan water tight; and clamp to fix pipe to wall.	...	...	92
	Ventilating and anti-syphonage pipes	...	...	7
	Water connection to tank	...	...	8
	Masonry work for privies, as at Ahmedabad, say	...	...	18
Total...				Rs. 125

## ESTIMATE

FOR

## EFFLUENT FARM

NEAR HADAPSAR.

*Revised in accordance with Mr. Mollison's suggestions.*

				Rs.
	Land compensation for 925 acres, including the necessary buildings, &c.	...	...	4,00,000
34,000	Feet of 24-inch Cast-iron Rising Main, including laying, with all Reflux and Sluice Valves, and Masonry Distributaries	...	...	5,00,000
	Pumping Machinery, including erection, and Engine House	...	...	2,70,000
	An open Storage Reservoir at each end : each reservoir consist- ing of two Compartments, each 100 X 100 X 11 feet	..	...	30,000
Total ..				Rs. 12,00,000

APPENDIX—D.  
FINANCIAL STATEMENT.

EXPENDITURE  
ON  
DRAINAGE SCHEME.

1st Year—	£	
Stoneware pipes ... ..	13,000	} To be purchased in England, f. o. b. Bombay.
Air and Sewage Mains and Valves ...	15,000	
Machinery and Ejectors, &c. ...	16,000	
Fittings for Septic Tanks and Filters ...	6,000	
	Total ... £50,000, say	Rs. 7,50,000
Customs Duty and carriage of above ...		64,000
Engine House, Chimney, Tanks and Filters ...		2,00,000
Land Compensation ... ..		36,000
	Total ...	Rs. 10,00,000
2nd Year—		
Pipe-laying and Manholes, &c. ...		3,50,000
Machinery and Ejectors, Erection, &c. ...		1,00,000
Fittings for Tanks and Filters ...		40,000
Local work on do. and Engine House and Chimney...		1,60,000
	Total ...	Rs. 6,50,000
3rd Year—		
Completion of Pipe-laying, &c. ...		1,63,000
	Grand Total ...	Rs. 18,13,000

EFFLUENT FARM.

*Revised in accordance with Mr. Mollison's report.*

1st Year—		
Machinery and Engine House ... ..		Rs. 1,00,000
2nd Year—		
Machinery and Engine House ... ..		1,00,000
Rising Main ... ..		3,00,000
	Total...	Rs. 4,00,000
3rd Year—		
Machinery and Erection and Engine House...		70,000
Rising Main ... ..		2,00,000
Storage Reservoirs ... ..		30,000
Land Compensation, Farm buildings, &c. ...		4,00,000
	Total...	Rs. 7,00,000
	Grand Total...	Rs. 12,00,000

### LOANS REQUIRED.

1st Year—	Rs.
Drainage Scheme ... ..	10,00,000
Farm ... ..	1,00,000
Total...	Rs. 11,00,000
2nd Year—	
Drainage Scheme ... ..	6,50,000
Farm ... ..	4,00,000
Interest and Sinking Fund on 11 lakhs of 1st year, at 5 per cent. for 30 years, say ... ..	70,000
Total...	Rs. 11,20,000
3rd Year—	
Drainage Scheme ... ..	1,63,000
Farm ... ..	7,00,000
Interest and Sinking Fund on 22 lakhs of 1st and 2nd years, say... ..	1,43,000
Total...	Rs. 10,06,000
Grand Total, say...	Rs. 32,26,000
4th Year—	
Interest and Sinking Fund on above total ... ..	2,09,851
Working expenses, including pumping to Farm and Air Compressing... ..	33,000
Total say...	Rs. 2,43,000

### NET REVENUE FROM FARM.

*Revised in accordance with Mr. Mollison's Report.*

550 acres sugarcane at Rs. 300 ... ..	1,65,000
275 „ Fodder crops at Rs. 150 ... ..	41,250
100 „ „ „ „ 100 ... ..	10,000
Saving on Poudrette manufacture ... ..	40,000
Total...	Rs. 2,56,250

Net profit per annum for Drainage Scheme after completion, and allowing for cost of Farm Superintendent, and his Office ... ..	Rs. 7,000
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*N.B.*—No account is taken of the 10 lakhs which will have to be borrowed in the 3rd year for House Connections, as the Interest and Sinking Fund on it (which will be due in the next and succeeding years), will be more than covered by the rate to be levied on the houses served, at one rupee per month.

## APPENDIX E.

**Remarks on Poona Sewerage and Sewage Disposal, by  
Colonel W. M. Ducat, R. E., Late Deputy Chief  
Engineer Inspector, Local Government Board,  
London.**

As a past Executive Engineer, Poona, and one who designed a scheme of sewerage and sewage disposal for the City, I may, perhaps, be allowed to offer the following remarks on the sanitary works there, which, I understand, are now in contemplation.

For very many years past the principal streets and roads in the City of Poona have been provided with sewers, or drains, of the worst possible description; *viz.*, old stone-built drains, rectangular in section, without any pretension to being water-tight, and with almost every defect of fall, ventilation, inspection, flushing, &c., that a sewer can have. I have seen some of these sewers opened, and found them absolutely full to the surface with sewage sludge in an advanced and most offensive and dangerous state of decomposition. So long as these old Sewers remain permeating the City, acting as Gas retorts for the distillation of most deadly sewer gases; and the subsoil around them, on which dwelling houses stand, is saturated with leakage from them; the City of Poona can never be a safe place to live in; and it will be impossible to eradicate any plague, or disease, that has once taken hold of the place; so that it is indeed well that Government has taken the matter in hand, and intend to have the City properly sewerred.

Whether the scheme of sewerage to be adopted be that I gave to the City some 15 years ago, or whether a revised scheme has been prepared, the general outline must be much the same; and the cheapest and most convenient site for the outfall must be the land lying between the Sassoon Hospital, the Sungum, and the River. On this land, unless it has been much curtailed by building operations since I knew it, there is space enough for a pumping station, purification works, and everything necessary for the effective and inoffensive disposal of the sewage of the City. The pumping station should be placed well in the centre of the plot of land, so as to be as far as possible from the Hospital, the public road, or the river; but if the works are properly designed, there should be no offence from them, and no danger whatever to health.

The method of disposal of the sewage requires careful consideration. On no land in, or around Poona, will it be desirable to use *crude* sewage for irrigation purposes; either from the point of view of purifying the sewage on the land, or the utilization of the value of sewage for irrigation. In all sewage there is a considerable amount of solid matter, or sludge, and this solid matter is liable to collect on the surface of heavy land, such as that near Poona, and form a coating which will interfere with the oxidisation of the soil below; and thus prevent the nitrification and purification of the sewage, through the land; and the sludge itself, adhering to the growing crops on the land, might become a serious source of danger to health. To ensure the absolutely safe and efficient disposal of the sewage, it should first be purified through an aerated bacterial self-acting filter; by means of which all the organic putrescible matter in the sewage (which constitutes the danger in the case of mere broad irrigation with crude sewage), is converted into Nitrate Salts, no longer putrescible, or objectionable, yet still containing all the manurial value of the crude sewage. The effluent from an aerated bacterial filter can thus be turned direct into any stream without the least objection, or offence; or it can, when so desired, be used most advantageously for irrigation, without the slightest risk, no matter how dangerous the original sewage may have been.