CENTRAL ENVIRONMENTAL AUTHORITY
MALIGAWATTE NEW TOWN
COLOMBO

HIKKADUWA HOTEL AREA WASTE DISPOSAL STUDY

FINAL REPORT

BY

DEVENCO (LANKA) LIMITED
138, OLD ROAD, NAWALA.

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— *PRE - FEASIBILITY* —

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CONTENTS

1.0 Introduction

1.1 Background

Hikkaduwa Tourist Village has developed around what was earlier the Hikkaduwa Rest House (now Coral Gardens Hotel) on account of the attraction of the sea bathing facilities and the beautiful coral beds in the vicinity. The development however has been unplaned and ad-hoc in nature, with the result that the essential facilities of water supply and sewerage have not been taken care of adequately. The growth is concentrated within a stretch of three kilometers along the main road to Galle, where nearly a hundred hotels, restaurants, guest houses etc., have sprung up. A few of them provide excellent tourist facilities whilst the rest provide facilities of varying degree right down to rental of rooms in private houses.

Pipe borne water supply is inadequate and almost every hotel depends on well water to supplement the pipe supply. A few bigger hotels use pipe borne supply normally with well water supply as stand by. The other hotels use both systems.

The sewerage in all the cases is discharged into septic tanks and the effluent is absorbed by the ground. In a few cases the raw effluent is surreptiously pumped out into the sea in the night. The final outcome is environmental polution.

1.2 Objectives

The objective of this study is to formulate a proposal to mitigate, if not eliminate the environmental pollution by :

a. Reduction of effluent discharge into the ground that feeds the water wells in the area.

b. Formulating an alternative solution to pumping raw effluent to the sea

c. Assessment of merits and demerits of possible treatment options and recommend what could be most suitable to meet the current and future demands.

d. Assessment of the garbage disposal facilities currently in use and recommend improvements where necessary.

2.0 Project Area

Hikkaduwa is a small township in the District of Galle. Originally a sleepy township, now developed into a substantial tourist village on account of certain attributes in the area including the excellent sea and sun bathing facilities. A cluster of tourist hotels, guest houses and restaurants have come-up all within a stretch of three kilometers along the main road. At present there are 56 hotels and guest houses of varying capacity and standards and 42 restaurants catering to the tourists.

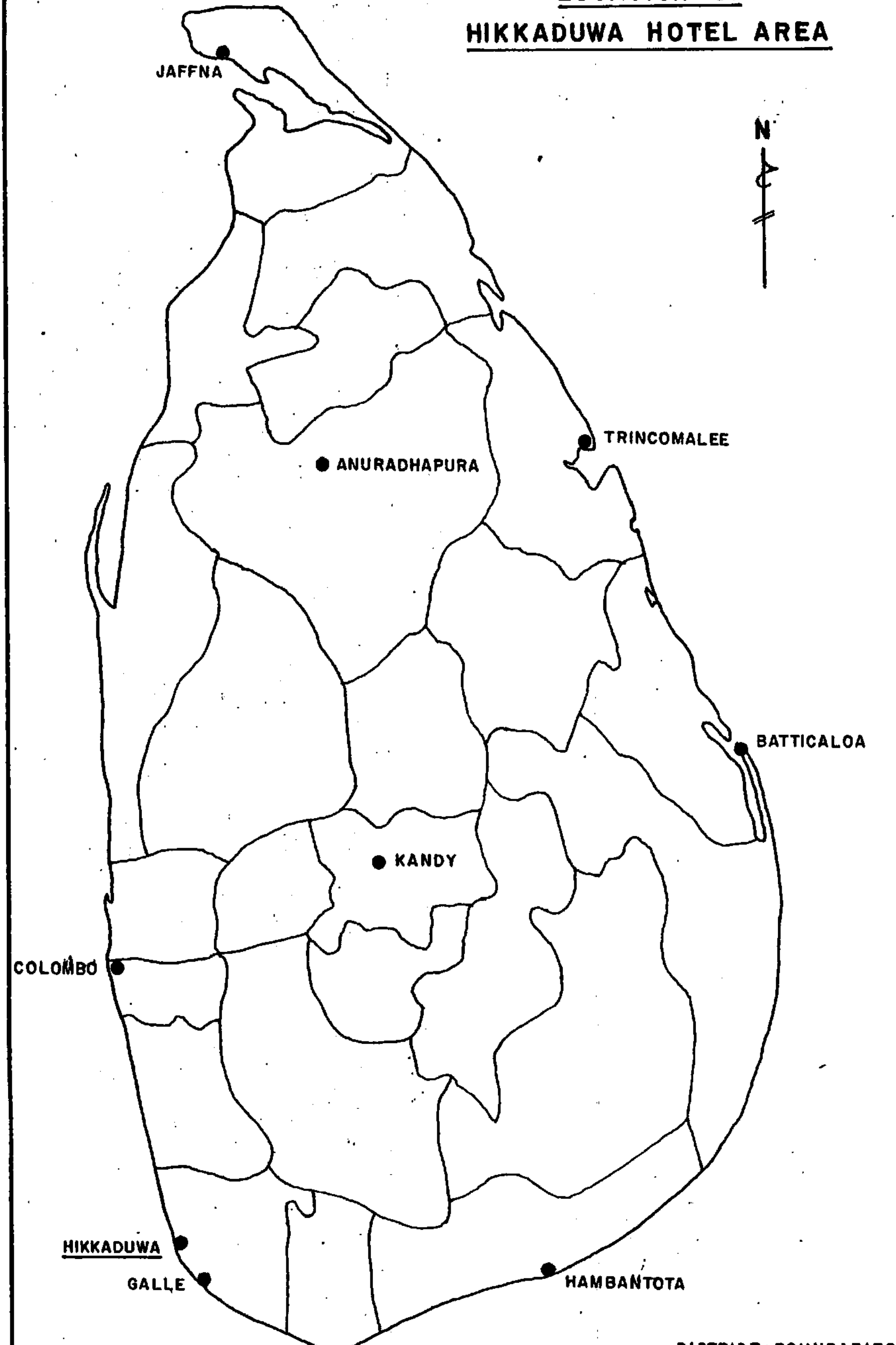
As shown in figures 2.1 and 2.2, in Appendix II, the main road runs parallel to the sea beach about 50 meters inland and a railway line also runs parallel about 100 meters inland from the main road. The tourist facilities lie within this belt of 150 meters between the sea and the railway line. East of the railway line is the old Hikkaduwa village. To the North of the tourist area is the Hikkaduwa township and Hikkaduwa river so that any further development of the tourist facilities will have to be to the South of the present area.

The area is being served by a pipe borne water supply scheme which is inadequate to meet the demand and as a result practically every hotel in the area has its own water wells to supplement the pipe borne supply. The soil is sandy and pervious and the water table is high at 2 meters below ground level.

Spot levels taken in the area, as shown in the drawings in Appendix I, indicate that the main road and the railway line runs on 2 ridges with the land in between them at a lower level causing water logging during the rainy season, until the outlets to the sea are opened up. The numbers marked in the drawings refer to the Hotels, Guest houses and Restaurants listed in Table 2.1. Table 2.1 also indicates the maximum number of occupants in each of this establishments so that the effluent discharge could be estimated. Table 2.2 in Appendix I indicate the land that is presently vacant.

Figure 2·1

LOCATION OF HIKKADUWA HOTEL AREA



3.0 Collection System

3.1 Sewer design options

There are two possible options for the sewer collection system.

Option A is a single spinal collection sewer laid alongside the road starting from the Northernmost point (station 0 at Baddegama turn-off) and ending at the treatment works at the Southernmost point (station 3050 at empty block marked EL 25 of 2183 sq mts in area). Feeder pipes from the hotels will feed the effluent to this main collection sewer at various points. The main collection sewer will have a continuous fall for about 3 kilometers resulting in the effluent having to be lifted up about five meters prior to treatment. The size of the sewer will have to be increased progressively to accomodate increasing load of effluent.

The advantage of this option is in that all the operation and maintenance activities are concentrated in one location at the treatment plant.

The disadvantages of this option are:

Greater depth of excavation for pipe laying and manholes,

Larger diameter pipes being required (150mm to 500mm),

More work in water logged conditions.

The option B is to have the sewer in three sections. A lift station in the middle of each section will pump the effluent direct to the treatment station. Please see the schematic diagrams in figure 3.1 illustrating these two possibilities and Appendix II.

The advantages of this option are:

Ease of construction,

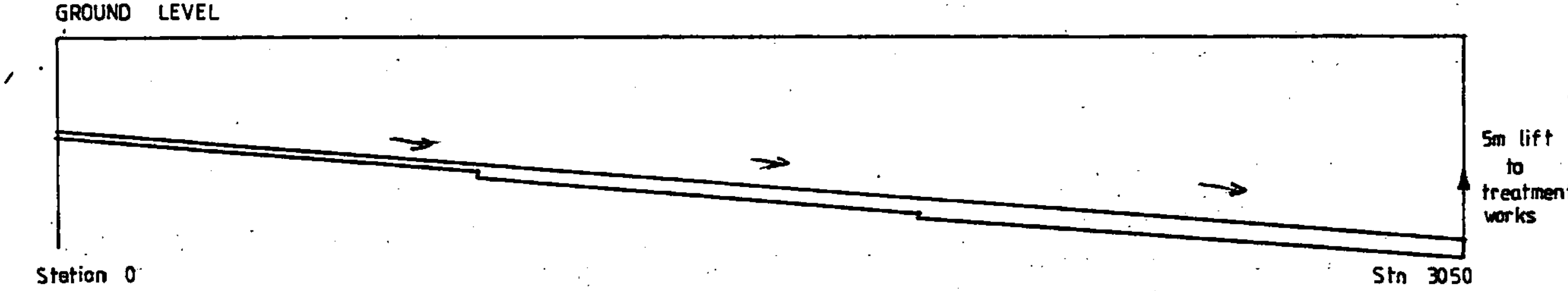
Less water to handle during construction,

Smaller diameter pipes and hence lower capital cost.

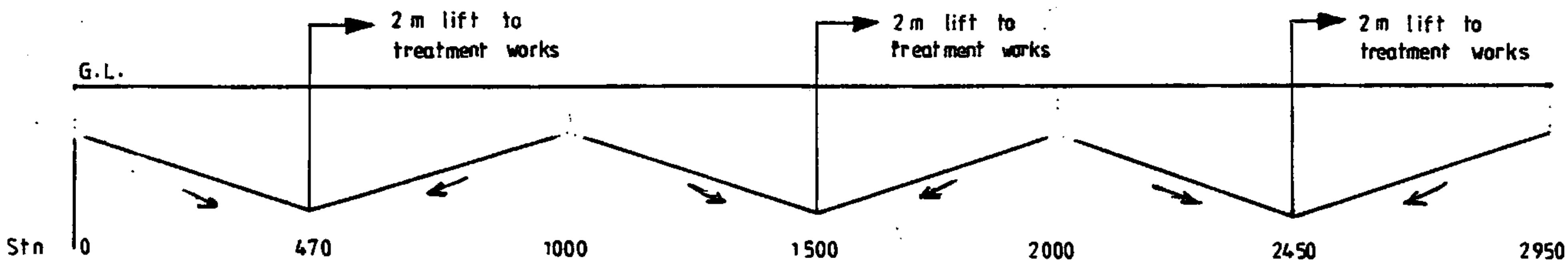
The disadvantages are in the extra pumping and cost of force mains required.

FIGURE 3.1 COLLECTION OPTIONS

Schematic diagrams



OPTION A



OPTION B

3.2 Cost of Options

The indicative cost of the two option have been estimated as follows: (Please see Appendix I)

Option A - Rs 73.735 million

Option B - Rs 47.470 million

including the capitalised operation and maintenance costs.

3.3 Recommendation

Option B is recommended taking into consideration all the advantages of this option.

3.3 Quantum of effluent

Records of water consumption were not available in most of the establishments particularly on account of fact that well water too was being used to supplement the pipe borne supply. However, correct records were being maintained at the Coral Gardens Hotel from which the average consumption of water per person per day could be worked out.

Maximum consumption of water per month 4350 Cu. Meters.
Maximum number of beds 320
Occupancy rate 67%
Staff and other personnel 305

Therefore, from this data the consumption per day per person works out to 0.28 Cu. Meters. If we assume the effluent discharged to the sewer to be 70% of the water consumption, the effluent per person per day will be 0.20 Cu Meters. On this basis the effluent into different sections of the sewer could be calculated. Please see Table 3.3.

Table 3.3

Station	Peak Population Hotel sector	Peak Population Private	Effluent/cmpd
0 - 500	571	62	127
500 - 1000	975	62	207
1000- 1500	776	62	168
1500- 2000	395	130	106
2000- 2500	285	62	70
2500- 3000	218	62	56
		Total	734

The hourly peak load in the most congested section will be

207 x 1/24 x 3 = 27 cu mts per hour.(This assumes a factor of 3 for peaking.)

In order to allow for future expansion of the facilities it is proposed that the sewer be designed to carry this peak load in each 500 meter section of the sewer, amounting to a total of 1242 cmpd.

4.0 Effluent Treatment

4.1 Hydraulic loading

As indicated in section 3.0 of this report, the hydraulic loading has been estimated at 734 cmpd with a peak load of 27 cmph. Please see appendix I for further data.

4.2 Biological & chemical loading

Three samples of effluent were analysed at the University of Moratuwa and the results are shown in Table 4.1.

4.3 Industrial effluent

There are no industries in the study area discharging any industrial effluent. Hence this factor is not taken into account in the computations.

4.4 Principles of treatment

Treatment has to be carried out in two stages of primary and secondary treatment. The primary treatment consists of:

grease traps,
screens,
grit channels,
primary sedimentation tanks.

The secondary treatment consists of:

anaerobic methods,
aerobic methods,
discharge into the sea (sea outfall)

Please see figure 5.1 - Flow diagram for treatment.

The study area is an important and congested area attracting many tourists all round the year. In this context the treatment of the sewage should be carried out in a manner that it could cause least disturbance to the inhabitants in terms of hygienic and environmental pollution, particularly in eliminating smell and fly problems. In this respect anaerobic methods of treatment have to be ruled out.

TABLE 4.1

<u>Results of Water Quality Tests for Hotel Wastewater - Hikkaduwa</u>

Date of collection of samples - 23.11.93

Date of reporting - 01.12.93

Test	SV_1	SV_2	CS_1
COD mg/l	508	728	316
BOD_5^{20} mg/l	120	290	152
NO_3^- mg/l	0.00	0.00	0.00
NO_2^- mg/l	0.00	0.00	0.00
PO_4^- mg/l	5	10	8
pH	5.30	6.08	5.04
Conductivity / mho / cm	1150	1550	5000
Suspended Solids mg/l	180	208	102
SO_4^- mg/l	149.8	108.6	219.8
Ammonia (NH3)mg/l	0.96	1.2	0.72

SV_1 - Seaview Hotel sullage sample (waste line)

SV_2 - Seaview Hotel sewage sample (from manhole)

CS_1 - Coral Sands Hotel sullage sample

Tested by Department of Civil Engineering,
University of Moratuwa.

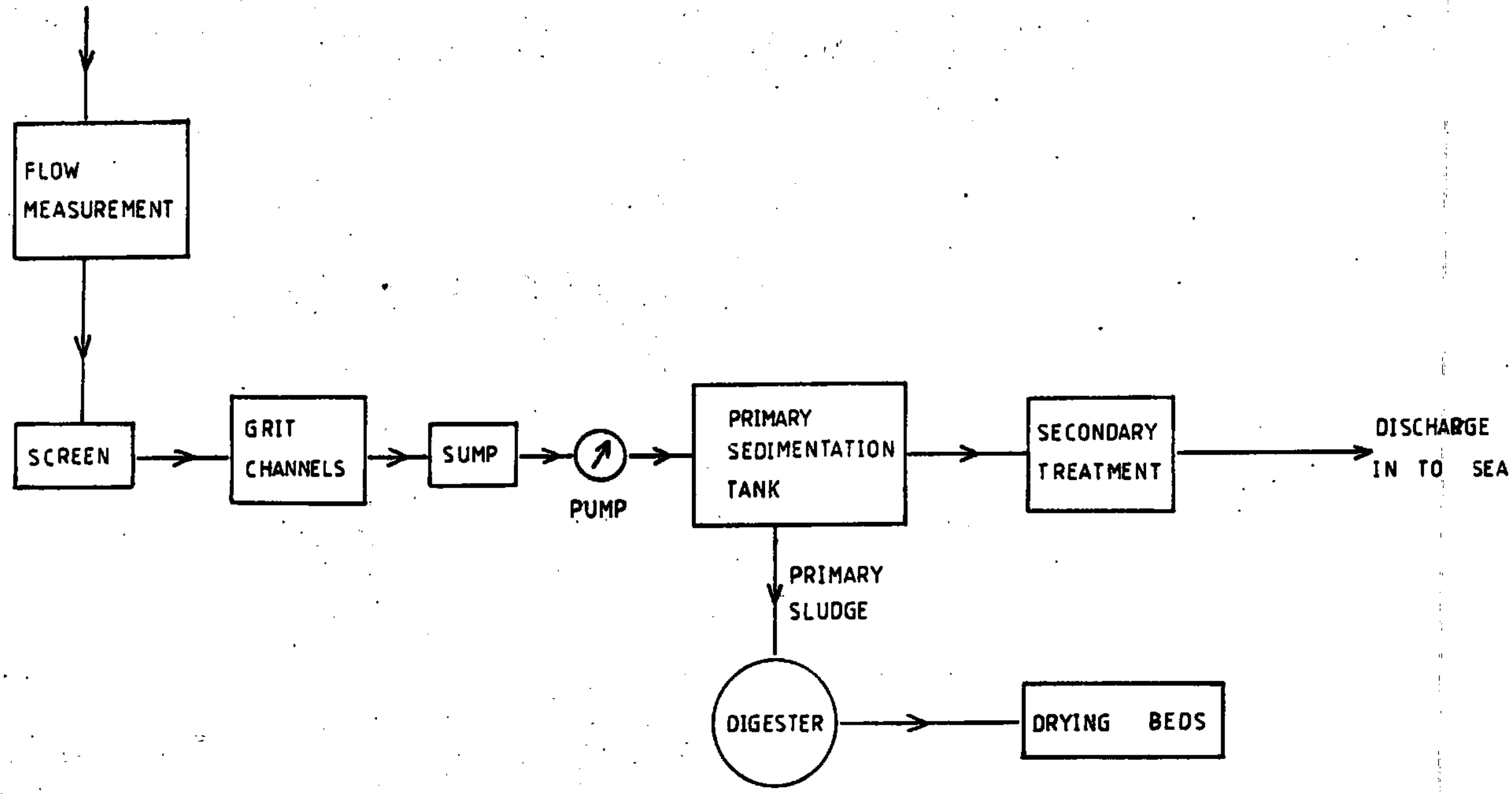


FIGURE 5.1 - FLOW DIAGRAM FOR PRIMARY AND SECONDARY TREATMENT

Two methods that would be open for consideration are:

Aerobic biologocal methods
Sea outfall

One of the most important aspects is the preservation of the marine sanctuary in this area. In this context injection of raw sewage into the sea any where in the vicinity has to be ruled out. Even if this was the only option available, a comprehensive environmental impact assessment has to be carried out prior to considering such a method (outside the scope of this study).

Therefore the only method left for consideration is the aerobic treatment and perhaps a sea outfall for the treated effluent.

Aerobic biological methods of treatment essentially consists of aeration lagoons with or without mechanical aeration. The area of land required for non-mechanical aerated lagoons is comparatively large and cannot be found in this location. Therefore, in this location mechanically aerated logoons have to be adopted.

There are three types of mechanically aerated processes to be considered.

Activated Sludge Treatment
Oxidation Ditch
Aerated Lagoons

The application of these three processes, along with the preliminary and primary treatment that is common to all three, is examined and evaluated in chapter 5.

4.5 Treated Effluent

The treated effluent by any of these methods will have BOD and SS values of about 20 mg/l and could be discharged into any water course. It is recommended that it be discharged into the sea through a short (500mtrs) outfall. Alternatively it could be discharged into an infiltration pond provided sufficent land (about 10,000 sq.mts) could be obtained.

5.0 Proposed Treatment Processes

The treatment plant is tentatively designed on the following data:

Hydraulic loading from the sewer system	750 cmpd
Average biochemical oxygen demand (BOD)	300 mg/l
Average suspended solids content	350 mg/l

5.1 Preliminary treatment

Grease traps - Suitably designed grease traps should be installed at the source before the sewage inters the sewer system. This is necessary as the kitchen waste water is likely to contain excessive fat that should be removed without allowing it to enter the treatment process.

Bar screens - Bars placed either vertically or at an angle of 45 degrees to prevent any oversize particles entering the treatment system.

Grit channels - The grit channels designed for a maximum horizontal velocity of 0.34 m/s will have the following dimensions:

length	20.4 m
Width	0.5 m
liquid depth at peak flow	0.1 m

The length is based on a minimum retention time of 1.0 minute. This could be reviewed at final design stage.

The proportional weir at the outlet from the grit channels has to be designed to ensure constant velocity of the flow in the channel at varing depths of flow.

Sump - Capacity of the sump is designed for storage of 10 minutes at peak flow.
capacity = 10.4 cu mts
dimensions - 2.0 m x 2.0 m x 2.6 m water depth.

Please see figure 5.2 - Priliminary and Primary Treatment.

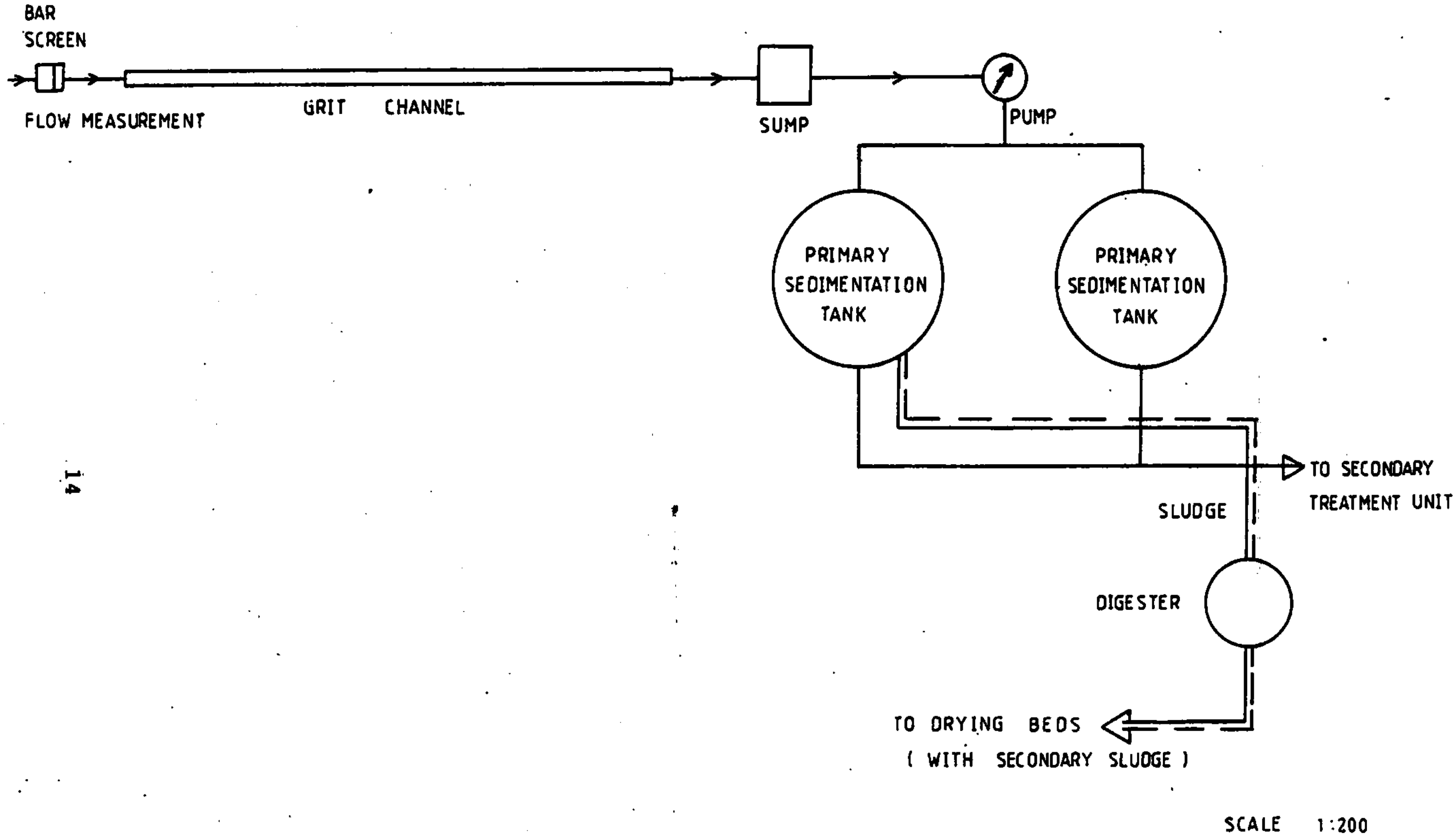


FIGURE 5.2 PRELIMINARY AND PRIMARY TREATMENT

5.2 Primary treatment

Primary treatment consists of primary settlement and handling primary sludge.

Primary settling tank (PST) -

PST isdesigned for a detention time of 2 hours at peak flow (2Qd)

Two identical circular tanks are proposed, each of 6.3 m in diameter and 3.0 m in depth. Allowing for 0.5 m for freeboard and 0.5 m for sludge collection, the effective depth is 2.0 m.

The overflow rate is 750/A = 24 cu mts per m^2-d.
where A is the surface area of the tank.

The allowable limits are 20 - 82 m^3 / m^2 -d

Primary sludge handling -

Primary sludge will be pumped into an anaerobic digester and the digested sludge will be dried on drying beds, along with any secondary sludge.

Assuming that the primary treatment removes 60% of the solids the weight of primary sludge produced will be:

$$0.6 \times 350 \times (750 \times 1000)/ 10^6 = 157.5 \text{ kg/day}$$

Assuming that the sludge contains 5% solids of specific gravity 1.47,

The volume of raw sludge produced = 1.17 cu mts per day

Assuming raw sludge to give 20% of digested sludge, the volume of digested sludge to be dried on the beds = 0.23 cu mts per day.

Assuming that the primary treatment removes 60% of the solids and 30% of the BOD, the effluent after treatment will have :

average BOD	of	210 mg/1
average solids (S.S)	of	140 mg/1

The preliminary and primary treatment conponents are shown in Figure 5.2.

5.3 Secondary treatment

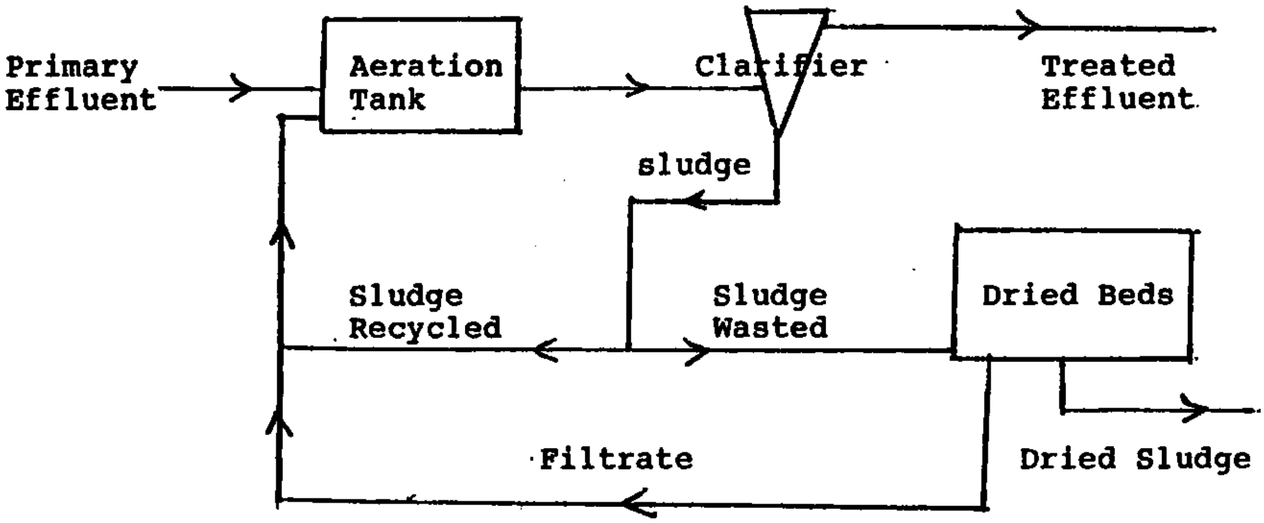
There are three options to be considered in secondary treatment, as stated in section 4.4, which are:

Activated sludge treatment
Oxidation ditch
Aerated lagoons

5.3.1 Activated sludge treatment - Option 1

In this option, the waste water after preliminary and primary treatment is subject to activated sludge treatment. The sludge is separated in the clarifier and a portion of the sludge required for maitaining a `mixed liquor suspended solids´(MLSS) content of 3000 mg/l in the aeration tank is recycled back into the aeration tank. The balance sludge is wasted and dried on sludge drying beds along with the primary sludge.

The flow diagram is as follows:



The Aeration Tank Design.

If the BOD and the S.S content of the final effluent from the aeration tank is to be less than 20 mg/l and 30 mg/l respectively, the removal required at the aeration tank are:

BOD -	210 - 20 = 190 mg/l	(ref quality of effluent
SS -	140 - 30 = 110 mg/l	after primary treatment)

It is also assumed that the wastewater flow is 750 cu mts per day and that the MLSS in the aeration tank is 3000 mg/l.

If a detention time of 8.5 hours is assumed, the volume of aeration tank required is (750/24) x 8.5 = 265.6 cu mts
Provide two tanks of 6.7 m x 6.7 m x 3.0 m depth, each.

BOD loading rate = (750 x 210 /1000) / 265.6 = 0.58 $kg/m^3/day$

Aeration Required:

Oxygen required for the aeration process is given by the equation

Oxygen required = Y ds + kd X kg/m^3-day, where

- Y = 0.5 (should be between 0.3 and 0.5)
- ds = BOD removed kg/cu mt
- kd = endogenous coefficient
  0.1 per day (should be between 0.07 and 0.2)
- X = MLSS = 3000 mg/l

Applying this equation the total oxygen required is 152 kg/day

Sludge Production:

Total excess sludge produced is given by the equation

$$dX = Y\,ds - kd\,X$$

Where Y is the yield coefficient = 1.0
(should be between 0.6 to 1.2)
kd is the endogenous coefficient = 0.03
(should be between 0.03 and 1.0)
ds is BOD removed in kg/m^3 per day
X is the MLSS in kg/m^3

Applying this equation dX = 0.44 kg/m^3

Therefore the total excess sludge produced = 330 kg?day.

If the sludge volume index is taken as 100 ml/g and the return sludge concentration (Xr)is 10,000 mg/l,

The volume of sludge wasted = TOTAL EXCESS SLUDGE/ CONCENTRATION

= 330 kg / 10,000 mg

= 33.0 cu mts per day.

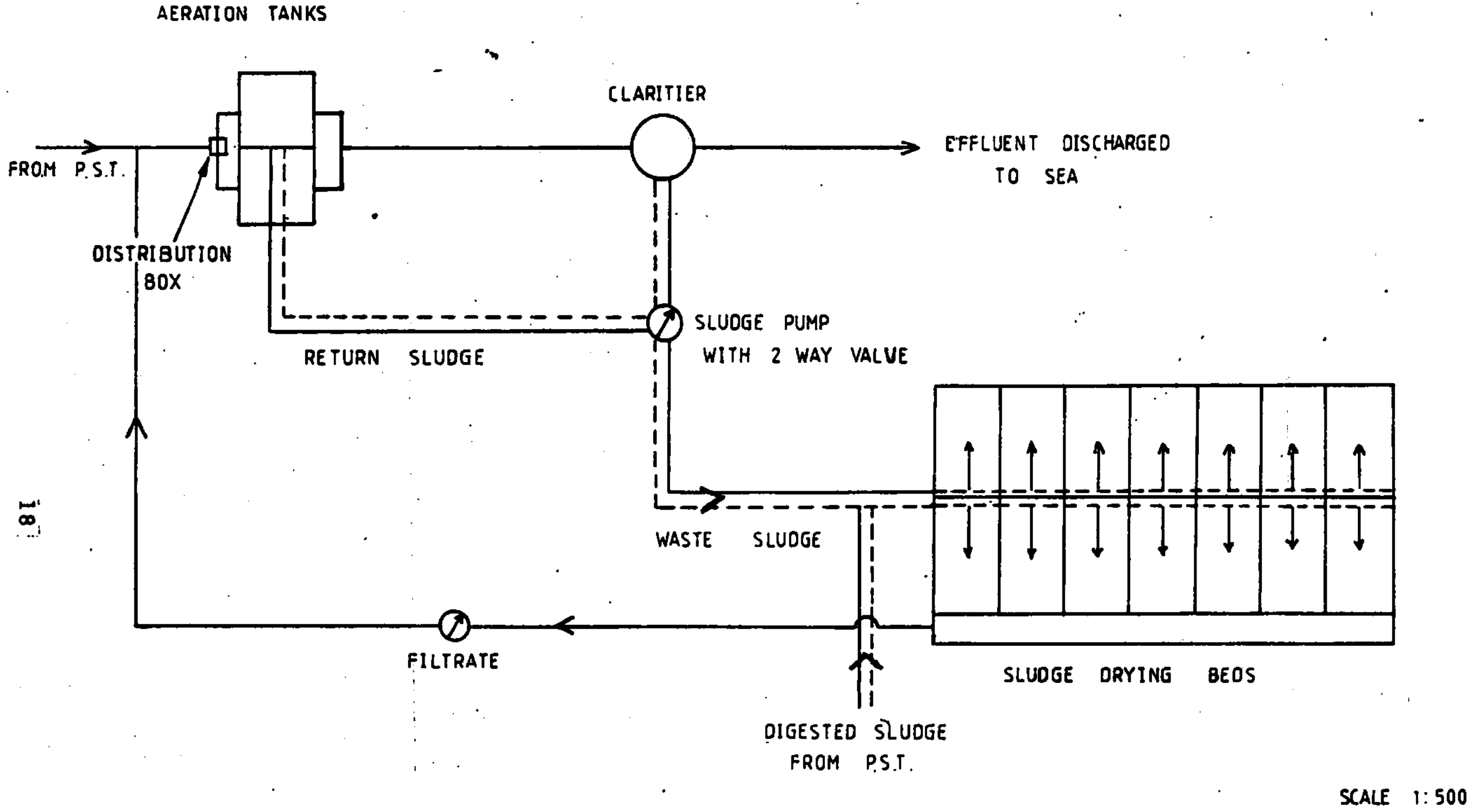


FIGURE 5.3 — SECONDARY TREATMENT OPTION – 1
— ACTIVATED SLUDGE TREATMENT

Sludge recycle ratio = Qr / Q = MLSS / (Xr - MLSS)

= 0.43

Rate of sludge return = 0.43 x 750/ 24
= 13.4 cu mts per hour

Thus, if the same sludge pump is used, sludge could be returned for 21.75 hours and wasted over the balance 2.25 hours every day.

Clarifier:

Assuming the sludge volume index is 100 ml/g and volumetric sludge solids surface loading rate is 0.43/h per sq mt

The surface area of the clarifier required - = 24 sq mts

Provide a clarifier of 5.6 m in diameter and 2.0 m liquid depth.

Sludge Handling:

Volume of sludge wasted from secondary treatment = 33 m^3/day

Volume of sludge from primary settling tank = 1.17 m^3/day

Total volume of sludge to be digested = 34.17

Volume of digested sludge (at 20%) = 6.8 m^3/day

If a feed depth of 3.0 m /year of wet sludge is assumed,

Area of drying bed required = 6.8 x 365 / 3 = 827 sq mts

Use 14 nos of 6.0 m x 10.0 m drying beds.

(Please see Figure 5.3)

5.3.2 Oxidation ditch - Option 2

An oxidation ditch is an extension of the activated sludge treatment process, where the aeration tank is generally shaped like a race track, and the rotors, which are horizontally mounted, impart a horizontal velocity to the water in addition to aeration. Thus the mixed liquor is circulated along the race track shaped ditch and is extracted and clarified in a final clarifier. A part of the settled sludge may be returned to the ditch in order to maintain the required MLSS concentration.

However, for large flow rates such as found in this situation, continuous operation with sludge return is more appropriate.

Total design flow	=	750 cu mts/day
BOD of influent	=	210 mg/l
BOD of effluent	=	20 mg/l
BOD to be removed		190 mg/l

Assuming the organic loading rate of oxidation ditch = 0.2 kg BOD_5 /cu mt

Volume of ditch required = 190 x 1000 x 750/0.2
= 712.5 cu mts

Liquid detention time = 712.5 x 24/ 750
= 22.8 hrs

If Rotor length = 4.0 m
Depth of water = 2.0 m
Median strip width = 0.3 m
(cross section as shown)

Ditch flat bottom width, W_b = 4.3 m

Ditch width at water surface = 6.3 m
Straight wall length = 25 m
End diameter = ditch width = 12.9 m

Total length of ditch at water surface = 37.9 m

Using a cage type rotor -

Oxygen required per kg of BOD = 2.35 kg

Total oxygen required = 190 x 750 x 2.35/1000 = 335 kg/day

If the rotor length is 4.0 mts, the required oxygenation is

335/(24 x 4) = 3.5 kg / hour/ metre length

Please see Figure 5.4.

5.3.3 Aerated Lagoons - Option 3

Aerated lagoons are much less complicated to operate than activated sludge or the oxidation ditch, as there is no necessity to recycle sludge back into the aeration tank. The detention times required are much longer, and therefore larger land areas are required. However, since the aeration in this process is not as intense as in the case of activated sludge treatment, the logoons need not be constructed with reinforced concrete.

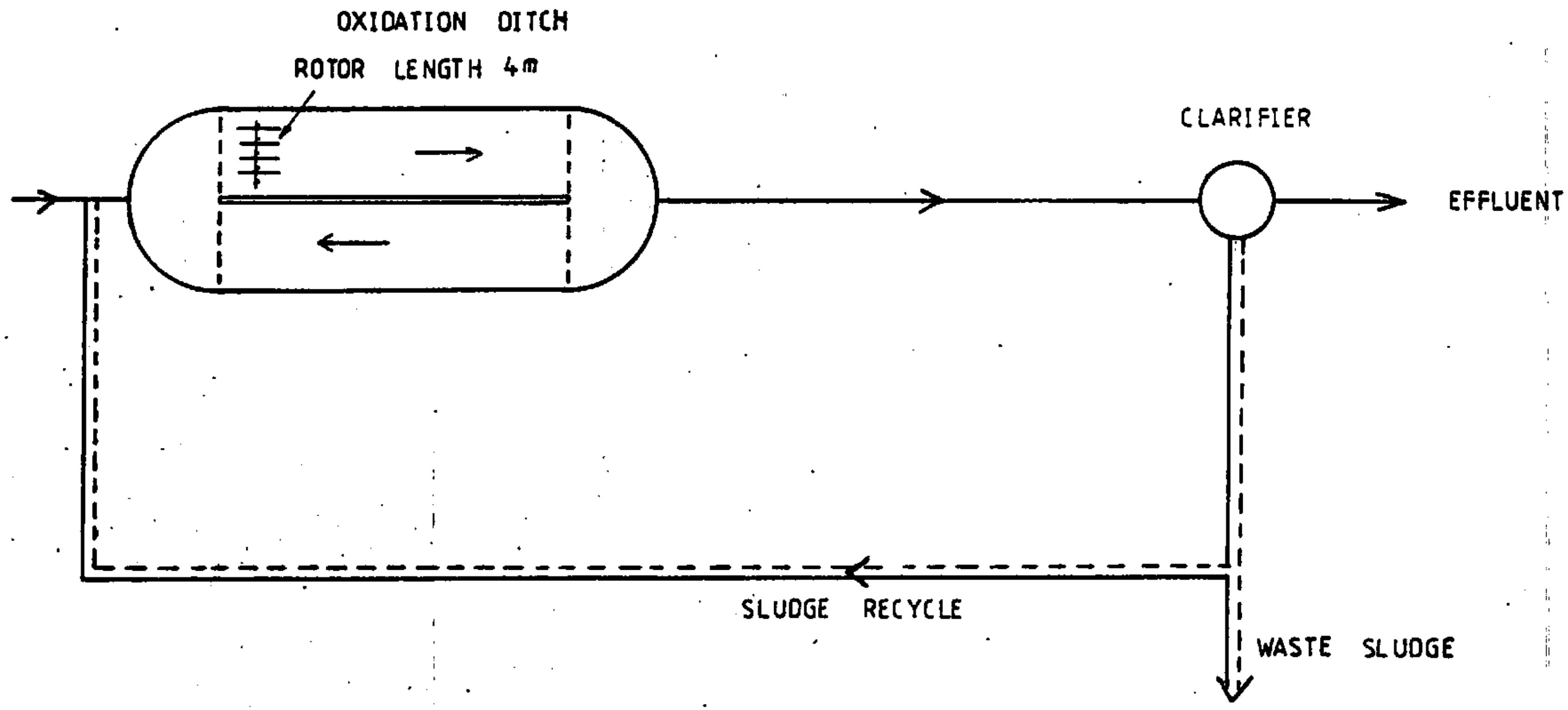


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FIGURE 5.4 : SECONDARY TREATMENT OPTION 2-OXIDATION DITCH

The effluent from the aerated lagoons will be passed through a clarifier and the sludge will be dried with the digested primary sludge, while the supernatant from the clarifier will be suitable for discharge.

Inflow	750	cu mts/day
BOD of effluent	210	mg/l

If	Detention time		=	6 days
	Depth of aeration lagoon		=	2.5 m
	Volume required 750 x 6		=	4500 cu mts
	Surface area required	4500/2.5	=	1800 sq mts

Provide 2 of 15 m x 60 m x 2.5 m tanks.

The temperature of the waste water in the tank, T_w could be calculated from the equation:

$$T_w = (A\,f\,T_a + Q\,T_i) / (A\,f + Q)$$

Where
T_a = ambient temperature = 28 c
T_i = influent temperature = 30 c
f = proportionality factor = 0.5
A = surface area in sq mts
Q = waste water flow rate cu mts/day

Then, T_w = 28.9 degrees c.

The BOD of the effluent, S, may be calculated from the equation

$$S/S_o = 1/(1 + kt)$$

Where
S_o = influent BOD_5
t = detention time
k = BOD rate constant at 28.9 c
$= k_{20}\,(1.07)^{28.9 - 20}$
k_{20} = 2.0/day

Then S = 9.17 mg/l

Total Oxygen required:

The biological sludge produced, $X = Y(S_o - S)$

Where Y = growth yield coefficient = say 0.5
Then X = 100.4 mg/l

The total sludge produced per day, P_x, = 100.4 x 1000/750
= 75.3 kg/day

The total oxygen required will be :

$\{Q(S_o - S)/0.68\} \times 1000 - 1.42\ P_x$ kg per day

= 114.6 kg/day.

Sludge drying beds:

The excess sludge produced will be settled in the clarifier. Since the sludge will be stabilised due to the long detention time of 6 days in the aerated lagoon, the sludge may be dried on drying beds along with the digested primary sludge.

Volume of secondary sludge from aerated lagoons = 0.57 cu mts/day

Volume of digested primary sludge = 0.23 cu mts/day

Total volume for drying = 0.80 cu mts/day

Drying bed area required = 0.80 x 365/3 = 97.3 sq mts

ovide 14 nos 3.5 m x 2.0 m.

Please see Figure 5.5.

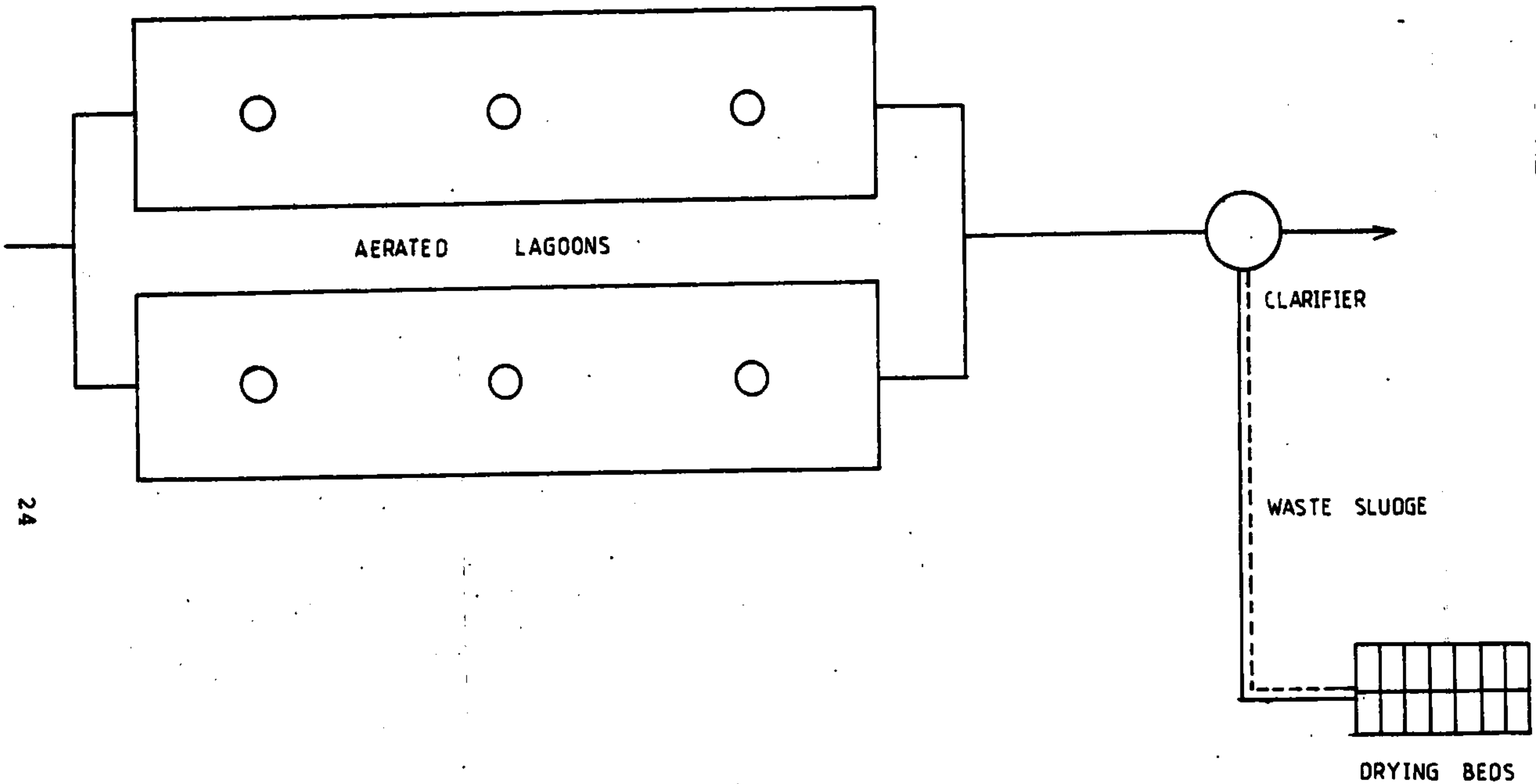

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FIGURE 5.5 SECONDARY TREATMENT OPTION 3
- AERATED LAGOONS WITH CLARIFIER

5.3.4 Comparison of Options

The main characteristics of the three options considered based on which a decision should be taken are given below.

	Option 1	Option 2	Option 3
Land required - nett sq mts	1150	750	2125
- gross	1600	1200	3500
- including future expansion	3000	2000	5500
Aeration requirement kg/day	152	335	115
Technical sophistication	high	high	low
Capital cost Rs Million	14	14	12
Operation & maitenance cost	1.5	2.5	1.0

(Please see Appendix I for further details)

The option 3, aerated lagoons is perhaps the most economical choice but for the fact that a large parcel of land is required.

The operational cost of option 2 is high and the advantage of the lower capital cost will be outweighed. The extent of land required is the lowest.

Therefore, if land is not available for option 3, option 1, activated sludge treatment, is the second best option.

5.3.5 Land acquisition

Therefore, in the first instance the possibility of acquiring 5500 sq mts of land, preferably in the vicinity of blocks marked EL 26, EL 22 or EL 12, in that order, should be looked into. If this not possible investigations should be made to acquire a block of 3000 sq mts. The survey conducted has shown that vacant blocks of this extent are available.

6.0 Municipal Waste Disposal

6.1 Present position

In the absence of any effluent generating industries in the area there is no hazardous waste to deal with. Presence of any hazardous material in the municipal waste is unlikely and even if they do, it will be to an insignificant degree.

Municipal waste (garbage) is generated from three sources, namely house keeping, kitchen and the yard. The waste from these sources were inspected and they could be categorised under the four categories of:

a) Beer and aerated water bottles,
b) Plastic canisters and other receptacles,
c) Waste from food,
d) Yard refuse including husks, waste paper, plastic bags etc.

Beer and aerated water empty bottles are re-used and are returned to the suppliers. This category therefore is not a waste product in the real sense of the word, except those that break during handling, and they do not contribute to `garbage´.

Utilisable plastic canisters and other receptacles are distributed amongst the hotel staff for re-use in their homes for various household needs. Those that cannot be reused, like the plastic mineral water bottles, contribute significantly to garbage output as a large amount of bottled water seems to be consumed due to the poor quality of tap water available.

Waste from food, in the larger hotels in particular, are routed to piggeries as feed for pigs thereby making economic use of this waste product. However, the food waste is not separated from the rest of the garbage at the source. Garbage is delivered at the piggeries where the separation is carried out. The rest of the garbage is strewn about causing serious health problems to villagers residing in the vicinity. The waste dumped at Udumulla village, off Aluthwela road, is an example where the residents complain of the foul smell, fly nuisance and children falling sick often.

The owners of the piggeries collect the garbage at the hotels and the hotel managers have found it convenient to insist on the entire garbage being taken away for any separation ,of pig feed from the rest, to be carried out elsewhere. This has become the main reason for the environmental pollution of the nearby villages as a result of this garbage.

Yard refuse has a significant amount of king coconut husks and empty plastic water bottles.

The garbage that is not collected by the piggery owners are collected by the Pradesiya Saba tractors and are delivered to land owners for fertilising the land. Although the land owners are expected to cover up the trenches into which the garbage is dumped, this is seldom done and the garbage is left exposed causing a smell and fly problem in the area. The estimated daily collection is about two trailer loads or two to three tons. This collection system sometimes fail due to shortcomings in the service and maintenance of the tractor.

6.2 Corrective steps to be taken

First and foremost requirement is to have the hotels and retaurants to maintain separate bins for the waste that could be used as animal feed, so that the farm owners could collect this waste without being saddled with the problem of disposing of the rest of the garbage.

Separate bins could also be maintained for plastic items and a third set of bins for king coconut husks and other refuse. These bins, in sets of three, should be placed at all the collection points, including the hotels, restaurants, strategic places on the main road and the sea beach as well.

The farm owners would be too happy to collect the food waste after it is separated out whilst the other waste could be handled by the administrative authority of the area, Pradesiya saba, in a suitable manner. Incineration, landfill, accelerated composting and recycling are the methods to be considered.

It has been found that incineration of such garbage, with a very high moisture content, is very uneconomical both in capital cost and maintenance & operation. Accelerated composting cannot be considered as there is no market for compost, in the area. Similarly, there are no facilities for recycling paper or plastics at the present juncture.

Landfill, therefore, appears to be the most acceptable method of disposal until an alternative use is found for some of the waste products.

This however, should be carried out in a more organised and responsible manner without causing environmental polution. For this purpose, the Pradeshiya Saba must first acquire a suitable block of land in which it could carry out landfilling or stock-piling without causing environmental polution. The land should be selected giving due regard to the flood levels, polution of water courses, accessability, possible height of fill and the population in the area.

It should then strengthen the collection and transportation system by acquiring additional facilities, as recommended earlier, and finally, the most importantly, allocate sufficient funds for operation and maintenance of the system round the year.

The action to be taken could be summarised as follows:

a) Introduce regulatory measures to separate out garbage at the source,

b) Acquire suitable land for garbage disposal,

c) Introduce collection bins,

d) Strengthen transport system,

e) Ensure adequacy of funds for operation and maintenance year round.

7.0 Cost Estimate

An approximate (indicative) estimate of the items of work to be carried out as recommended in this study is given below.

A Sewerage Project

		Millions
1.0	Investigations, designs, documentation supervision of execution	Rs 7.0
2.0	Sewage collection system	Rs 40.0
3.0	Domestic connections	Rs 5.0
4.0	Treatment facilities	Rs 12.0
5.0	Sea outfall	Rs 5.0
6.0	Contingencies	Rs 8.0
	TOTAL	Rs 77.0

B Garbage Disposal

		Millions
1.0	Garbage bins	Rs 2.0
2.0	Refuse collection trucks	Rs 3.0
3.0	Acquisition of land	Rs 1.0
	TOTAL	Rs 6.0

8.0 Conclusion

There is an urgent need to resolve the waste disposal problems in the tourist hotel area. Introduction of a proper and hygienic sewage collection cum treatment system, that is suitable for the area, is of paramount importance. In the absence of such a system the ground water table is open to polution and so is the sea beach in the vicinity. The marine sanctuary will also be effected thereby destroying the very attributes that has brought the tourists and vacationers to the area in large numbers.

No amount of preaching will help to solve the problem as the hoteliers have no other option but to discharge raw effluent to the ground or to the sea, in the absence of any other arrangement, in order to get rid of it.

Garbage collection and disposal system could be improved by the introduction of certain regulatory measures, acquisition of suitable land for garbage disposal and strengthening the collection and transport facilities.

Another requirement is to have a satisfactory pipe borne water supply system by augmenting the existing scheme to the required capacity (outside the scope of this study). The hotels and the resident population will not have to depend on water wells, that are open to pollution, to supplement their needs.

A two pronged solution, supply of adequate pipe borne water on one hand and waste collection and disposal as outlined in chapters 3.0 to 7.0 in this report on the other, will make Hikkaduwa a safe resort. Action has to be taken on:

a) Acquisition of land for a sewage treatment plant site as recommended in this report.

b) Design and preparation of contract documents for:

   i) a sewer system, collecting and delivering sewage at the probable treatment plant site,
   ii) treatment plant,
   iii) sea outfall for treated effluent.

c) Construction of sewage collection, treatment and disposal works.

d) Improving garbage disposal system as recommended.

APPENDIX I

a) list of hotels and capacity

b) list of presently vacant blocks of land

c) estimates of collection options

d) estimate of treatment options

LIST OF HOTELS, RESTAURANTS AND GUEST HOUSES AT HIKKADUW

		Peak Population
1.	Parrots Paradise Restaurant and Juice Bar	4
2.	Sea Front Restaurant	4
3.	Nanking Restaurent (not functioning)	0
4.	Hikkaduwa Beach Hotel	165
5.	Poseidon Diving Station, Hotel and Restaurent	25
6.	Co-op Beer Garden & Restaurent	5
7.	Dharshana Beach Villa & Guest House	23
8.	Star Fish Inn	20
9.	Coral Sands Hotel	150
10.	Hotel Blue Corals	180
11.	Hotel Sun Sea Sand & Restaurant	36
12.	Coral Reef Beach Hotel	77
13.	Vithana Guest House	0
14.	Mama's Hotel & Restaurant	29
15.	Coral Front Inn	52
16.	Coral Rock Hotel	115
17.	Cray Fish Restaurant	4
18.	Coral Seas Beach Resort	0
19.	Siri Tourist's Holiday Home	8
20.	Coral View Restaurant	10
21.	Roof Top Restaurant (Swiss Hotel)	14
22.	Hotel Sea View and Restaurant	14
23.	Sea View Pizza House	3
24.	Coral Rock Hotel Quarters	40
25.	Hotel Coral Gardens	350
26.	Garden View Restaurant	3
27.	Cake Hut- Deutscher Kuchen	1
28.	The Curry Bowl	32
29.	Sun Beam Reataurant	3
30.	Vijitha Tourist Inn	16
31.	Farm House Restaurant	12
32.	Ozone Tourist Inn	16
33.	Lotus Beach Restaurant & Guest House	11
34.	Hotel Wewala Beach	50
35.	Beach Restaurant	0
36.	Wispering Palms Tourist Restaurant	15
37.	Restaurant Refresh	12
38.	Hotel Lanka Super Corals	330
39.	New Moon Beam Restaurant	1
40.	Hotel Reefcomber	138
41.	Restaurant Tropicana	2
42.	V.I.P Restaurant	0
43.	Hotels Francis	12
44.	Paradise Hotel	62
45.	Nippon Villa Restaurant	77
46.	Blue Fox Restaurant	4
47.	New Hotel Comming up-No name board	0
48.	Richards Sons Beach Inn	22
49.	El-Dorado Restaurant	3
50.	Sam's Surfer's Rest Hotel	4
51.	Hotel Blue Note	29
52.	Budde's Beach Restaurant	76
52-A.	Lion's Paradise	29
53.	Blue Brothers Beach Restaurant	43

54. Villa Paradise	14
55. Devasiri Cafe	9
56. Bandula Beach Resort	0
57. The Tandem Guest House	19
58. Restaurant Tortuga	13
59. Miga Villa Toursit Garden & Guest House	26
60. Lion´s Paradise	20
61. Surfing Beach Guest House	8
62. Beach Villa Munich Cafe	21
63. Ranjith´s (63-A) Step Inn	16
64. Casalanka Guest House and Restaurant	15
65. Blue fox Hotel & Restaurant	16
65-A Nihal Restaurant	1
66. Pop Star Beach Restaurant	2
67. Jupitor Restaurant	2
68. Hansa Surf Hotel	39
68-A Kuku´s Nest Restaurant	2
69. Golden Sand Beach Hotel	25
70. Lotus Garden	9
71. Sun Beach Hotel	30
72. Hemingway´s Beach Restaurant	2
73. Sun Rise Restaurant	2
74. Royal Beach Restaurant	3
75. Silta´s Banana Leaf Restaurant	4
76. Brother´s Spot Restaurant	3
77. Rita´s Guest House & Restaurant	13
77-A Sea Lion Guest House & Restaurant	13
78. Seethani Guest House	30
79. Black Rock Cafe	2
80. International Beach Hotel & Restaurant	27
81. Shara Guest House	14
82. Metropol Restaurant	2
83. Gopa Cabana Beach Restaurant	13
84. Trust Inn & Restaurant	27
85. Blue Moon Beach Restaurant	3
86. Hotel Harmony & Restaurant	34
87. Rainbow Beach Restaurant	3
88. Bermuda Restaurant	6
89. Sunils Beach Hotel	194
90. Green Line Restaurant & Guest House	11
91. Ranmal Rest and Tourist Hotel	21
92. Florida Guest House & Restaurant	8
93. Florida Inn	9
94. Hotel Wide Beach Inn	25
95. Ocean View Cottage	0
96. Thiranagama Beach Hotel	15
97. Pearl Island Beach Hotel	18
98. Beach Cabanas	0
	3120

Note
Peak population is the number of beds plus the staff.

DETAILS OF EMPTY LANDS - EL

Description	Location	Extent
EL-1	0+119	780 Sq.m.
EL-2	0+340	390 Sq.m.
EL-3	0+470	224 Sq.m.
EL-4	0+744	432 Sq.m.
EL-5	0+871	79.2 Sq.m.
EL-6	1+037	735 Sq.m.
EL-7	1+150	713 Sq.m.
EL-8	1+367	525 Sq.m.
EL-9	1+403	1125 Sq.m.
EL-10	1+464	1020 Sq.m.
EL-11	1+524	936 Sq.m.
EL-12	1+780	4720 Sq.m
EL-13	1+780	1680 Sq.m.
EL-14	1+844	438 Sq.m.
EL-15	1+964	725.4Sq.m.
EL-16	2+219	1008 Sq.m.
EL-17	2+227	990 Sq.m.
EL-18	2+300	4320 Sq.m.
EL-19	2+350	400 Sq.m.
EL-20	2+350	550 Sq.m.
EL-21	2+464	1760 Sq.m.
EL-22	2+464	1160 Sq.m.
EL-23	2+830	1056 Sq.m.
EL-24	2+920	544 Sq.m.
EL-25	3+050	2183 Sq.m.
EL-26	4+150	4530 Sq.m.

4. (b) COLLECTION SYSTEM OPTION A

Earth excavation in trenches including shoring, dealing with water, covering up and laying gravity sewers 200mm to 250mm dia 2825 m, to a depth 2m to 8m			
200 mm dia	1000m @ 8750/m		= 8,750,000
250 mm dia	1000m 13,500/m		= 13,500,000
300 mm dia	825m 26,250/m		= 21,656,000
Well point dewatering system		allow	= 10,000,000
Reinstatement of road 2825 @ 750/m			= 2,118,750
Supply and lay DI sewer Force mains 150mm dia	1000 m @ 2750/m		= 2,750,000
Constructing 50 manholes			= 3,000,000
Constructing one pumping station with submersible pumps 7.0 kw			= 1,800,000
Contingencies			= 6,425,000
Total			70,000,000
Cost of O x M per year			= 500,000
Present value of 20 yrs O x M costs at 12% discount rate			= 3,735,000
Grand Total			73,735,000

4.0 (a) COLLECTION SYSTEM OPTION B

Earth excavation in trenches including shoring, dealing with water, covering up and laying gravity sewers 200mm dia 2825 m, to a depth 2m to 6m @ 8750 per m	= 24,718,750
Reinstatement of road 2825 @ 750/m	= 2,118,750
Supply and lay DI sewer Force mains 150mm dia 3000 m @ 2750/m	= 8,250,000
Constructing 50 manholes	= 1,000,000
Constructing 3 pumping stations with submersible pumps 7.0 to 4.0 kw	= 2,000,000
Contingencies	= 1,912,500
Total	40,000,000
Cost of O x M per year	= 1,000,000
Present value of 20 yrs O x M costs at 12% discount rate	= 7,470,000
Grand Total	47,470,000

COMPARISON OF TREATMENT OPTIONS

	I	II	III
Acquisition of land	3.000	2.000	5.500
Wall and buildings	0.940	0.860	1.120
Preliminary and Primary treatment works	0.900	0.900	0.900
Secondary treatment civil works	2.126	3.690	2.244
Mechanical component	6.000	5.000	1.436
Contingencies	1.040	1.550	.800
	14.000	14.000	12.000
O x M as per year	1.5	2.5	1.0
O x M Capitals at 12% for 20yrs	11.20	18.67	7.47
	25.20	32.67	18.47

APPENDIX II

a) figure 2.2 - map of study area

b) location of hotels with respect to the road

c) proposed collection system

FIG 2.2 MAP OF HIKKADUWA HOTEL AREA

SCALE 1:4000

BIGGER HOTELS IN THE STUDY AREA

4	Hikkaduwa Beach Hotel
9	Coral Sands Hotel
10	Hotel Blue Corals
11	Hotel Sun Sea Sand
12	Coral Reef Beach Hotel
15	Coral Front Inn
16	Coral Rock Hotel
25	Hotel Coral Gardens
34	Hotel Wewala Beach
38	Hotel Lanka Super Corals
40	Hotel Reefcomber
44	Paradise Hotel
51	Hotel Blue Note

Note

Please refer drawings in Appendix II for exact location of all the hotels

PLAN SHOWING MAIN ROAD AND LOCATION OF HOTELS (SHEET 1 OF 3)

NOTES :-

1. CIRCLED NUMBERS INDICATE LOCATION OF HOTELS, RESTAURANTS Etc. PLEASE REFER LIST FOR FURTHER PARTICULARS.
2. DISTANCES MEASURED FROM BADDFGAMA TURN OFF SOUTHWARDS.
3. TBM OF 100 LOCATED ON TURNOFF ISLAND.

KEY :-

SHEET 1		SHEET 2		SHEET 3	
A	B	C	D	E	F
0	900	1700	2600	3400	4200 Mtrs.

PLAN SHOWING MAIN ROAD AND LOCATION OF HOTELS (SHEET 2 OF 3)

NOTE :-

PLEASE SEE NOTES AND KEY IN SHEET 1 OF 3

PLAN SHOWING MAIN ROAD AND LOCATION OF HOTELS (SHEET 3 OF 3)

NOTE :-

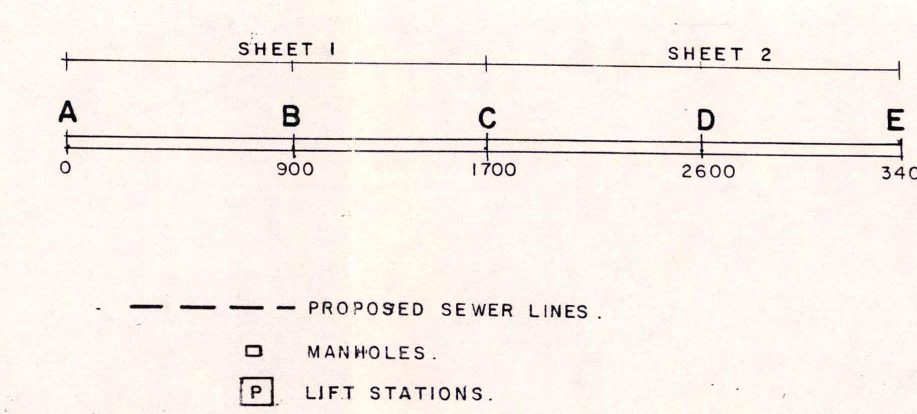
PLEASE SEE NOTES AND KEY IN SHEET 1 OF 3

PLAN SHOWING PROPOSED SEWER LINES AND TREATMENT PLANT SITE (SHEET 1 OF 2)

NOTES :-

1. CIRCLED NUMBERS INDICATE LOCATION OF HOTELS, RESTAURANTS Etc. PLEASE REFER LIST FOR FURTHER PARTICULARS.
2. DISTANCES MEASURED FROM BADDEGAMA TURN OFF SOUTHWARDS.
3. TBM OF 100 LOCATED ON TURN OFF ISLAND.

KEY :-



PLAN SHOWING PROPOSED SEWER LINES AND TREATMENT PLANT SITE (SHEET 2 OF 2)

NOTE :–

PLEASE SEE NOTES AND KEY IN SHEET 1 OF 2

A literature survey and interviews were conducted to obtain maps and other information of the area with respect to the current and future development and other connected problems.

The following personnel were interviewed:-

Mr. S Wijeratne - Chairman, Hikkaduwa Provincial Office
Mrs. Kumari Basnayake - Planning Officer, UDA - Hikkaduwa
Mrs. Nalini Karunaratne - Planning Officer, Galle Municipal Council
Mrs. J C Sawanadasa - Ceylon Tourist Board
Mr. D S Athukorala - Ceylon Tourist Board
Mr. Jayathilake - General Manager, Ceylon Hotels Corporation
Mr. Sumith de Alwis - Asst. Director Marketing & Research, Ceylon Tourist Board
Mr. S M C D Senaratne - Chief Engineer, NWSDB

Hotel managers, shop keepers and residents.