2.3 Survey of Trade Wastes

2.3.1. General

To obtain basic data information for discussing treatment method of trade wastes, survey was performed as to wastewater quantity and quality including colletion of general information of factories such as industry category, factory scale, factory distribution, and future expansion plan.

The gneral information of factories was collected through questionnairs and visits referring to a factory list provided by MPKS.

The survey of waste quality was carried out, referring to general information of factories.

2.3.2. Results of the Survey

(1) The Results from Questionnairs and Visits Mailing address of questionnairs were obtained by the lists written below, as well as the factory licence list in MPKS.

- Kawasan Perusahaan Mergong Pringkat I
- Maklumat-Maklumat mengenai Syarikat-Syarikat Yang Diluluskan Dikawasan Perusahaan Bakar Arang, Tikan Batu, Kulim, Mergong II, Kuala Kedah, (Perbadaran Kemajuan Negeri Kedah, Feb. 1979)

Factory visit was also carried out. Table B-19 show the number of factories visited. Composition of industry category and general information of factories are shown in Table B-10, 11, respectively.

As shown in Table B-9, 123 factories out of 205 factories on the list were surveyed including factories planned to be located in Mergong or Kuala Kedah Industrial Estate.

In the Study Area, most factories are found to be located in the Mergong Industrieal Area. Major industrial categories are

Table B-9 The Number of Factory Surveyed

Area		No. of Questionnair Sent	No. of Questionnair Recovered	No. of Factories Visited	Total
Alor Setar	Mergong	197	12	80	80
	others		37	13	40
Kuala Kedah		8	3	0	3
Total		205	52 (Recovery 24.5 %)	93	123

Table B-10 Factory Distribution

Code	Industrial Category	Plan						Present Aspect							
		K. Kedah		Mergong I		Mergong (Total)		K. Kedah		Mergong I		Out of Mergong		A. Setar	
		Number of factory	Ratio (%)	Number of factory	Ratio	Number of factory	Ratio	Number of factory	Ratio	Number of factory	Ratio	Number of factory	Ratio	Number of factory	Ratio
01	Food	7	87.5	21	19.3	36	18.9	3	100	7	8.8	10	43.5	17	16.5
02	Chemical	1	12.5	3	2.8	3	1.6	0	0	0	0	1	4.3	1	1.0
03	Rubber and Plastics	0	0	5	4.6	15	7.9	0	0	4	5.0	1	4.3	5	4.9
04	Metal Plate Works	0	0	15	13.8	22	11.6	0	0	6	7.5	3	13.0	9	8.7
05	Electric Good	0	0	4	3.7	8	4.2	0	0	4	5.0	0	0	4	3.9
06	Machinery	0	0	3	2.8	5	2.6	0	0	2	2.5	1	4.3	3	2.9
07	Other Manufacturing	0	0	22	20.2	36	18.9	0	0	10	12.5	2	8.7	12	11.7
08	Selling	0	0	0	0	6	3.2	0	0	12	15.0	0	0	12	11.7
09	Storehouse	0	0	0	0	1	0.5	0	0	10	12.5	0	0	10	9.7
10	Car Repair Workshop	0	0	34	31.2	56	29.5	0	0	20	25.0	3	13.0	23	22.3
11	Other Service Business	0	0	2	1.8	2	1.1	0	0	5	6.3	2	8.7	7	6.8
Total		8	100	109	100	190	100	3	100	80	100	23	100	103	100
Remarks						unknown 7		Questionnaire		visiting		Questionnaire and visiting			

Table B-11 The Results through Questionnaire

Location	No. (A: A.Setar (K: K.Kedah	Code	Product	Area (m^2)	Employee	Water Comsuption (m^3/d)	Production	Future Expansion
A. Setar	A-1	01	Rice	1.024	12		80,000 case/yr	No
	A-2		Rice	1.018	39	4	-	No
	A-3		Feed	1.377	8		-	No
	A-4		Feed	-	4		36 ton/yr	No
	A-5		Coffee	280	8	0.5	180 kg/d	Yes
	A-6		Coffee	680	14	0.7	2.4 ton/yr	Yes
	A-7		Noodle	736	7		0.7 ton/d	No
	A-8	03	Plastics	735	4	3.5	M$80,000/yr	No
	A-9		Cussion Repair		7	3.6	120 pieces	No
	A-10		Footwear	11,000	750	55.0	-	No
	A-11	04		126	5		-	No
	A-12				5	1.4	-	No
	A-13			1.150	5		-	No
	A-14				20	1.5	-	Yes
	A-15	05	Refrigi-lator	418	126		-	No
	A-16		Electric parts	2,280	110	3.6	1,500,000 pcs/yr	
	A-17	07	Furniture		10	4.4	-	No
	A-18	10		604	5	2.5	-	No
	A-19				20	7.3	-	No
	A-20			1,011	4	1.8	-	No
	A-21				2	0.1	-	No
	A-22			1,300	4	2.4	-	No
	A-23			1,014	1		-	No
	A-24			1,002			-	No
	A-25			111	7	2.3	-	No
	A-26				14		-	No
K. Kedah	K-1	01	Frozen Marine Products	2,023 (6,075)	60	55	218 ton/yr	Yes
	K-2		Fish Meal	6,070 (4,050)	47	68	200,000 ton/yr	No
	K-3		Fish Powder	(5,400)	45	50	2,850 ton/yr	Yes

shown in the planning list light industries and service business such as food manufacturers, metal plate works, woodworks, storehouses, and car repair workshop.

These industries require relatively less amount of water and their waste load is also small. Although food manufacture discharges slightly strong wastes, scale of factories is small, mostly less than 1 m^3/day of water consumption.

Water pollution in Mergong Area is found to be mainly caused by waste oil discharged toether with washing wastes and illegal wastes from repair workshops.

Except Mergong Area, relatively small factories are scattered in the Study Area for manufacturing food and for metal plating and car repairing works. Water pollution is causing to sorrounding area by car repair workshops, not influencing as far as Mergong Area due to their isolated location.

In Kuala Kedah, factories are for sea fish processing, namely fish meal or fish powder used animal for feeding or as fertilizer. These industrids generally discharge large amount of strong wastes.

(2) Results of Waste Quality Survey

Water samples were taken from roadside drains which received trade wastes discharged by factories in Mergong and Kuala Kedah Area. The results are shown in Table B-12.

In Mergong Area, trade wastes are little in quantity and weak in quality. Food manufacturing factories which are expected to discharge relatively strong wases, show almost similar waste quality to domestic wastes.

Although waste oil discharged from car washing workshops spoils appearancess, it does not impair water quality so much due to relatively large amount of water usage.

Factories which do not have the process for car washing, discharge only domestic wastes into roadside drains, which are mostly covered by illegally dumped waste oil spoiling both appearence and water quality causing anaerobic condition.

Table B-12 The Results of Trade Wastes Quality Survey

Area	Category	Date	Time	Temp. (°C)	pH	DO (mg/l)	BOD (mg/l)	SS (mg/l)	Cl^- (mg/l)	Remarks
K. Kedah	01 Marine Products Processing	25/6	10:25	32.3	7.4	0	2,350	324	1,840	0.48 m^3/min
A. Setar (Mergong)	01 Food	8/7	10:00	28.4	6.3	0	74.5	57.0	53.3	
	03 Rubber and Plastics	8/7	10:11	29.0	7.5	8.6	12.1	24.0	151	0.14 m^3/min
	04 Metal Plate Working									
	05 Electric Goods	8/7	9:30	27.6	7.7	0.7	11.2	14.0	67.0	
	10 Car Repair Workshop with washing process	8/7	9:30	27.9	7.1	0	14.8 (480)	30.0	72.0	( ): Surface water including oil film
	without washing process		9:50	29.9	7.2	0	458 (4,960)	4,230	45.0	- do -

Oil affects biological waste treatment. Careful attention should be paid to separate waste oil from wastes in each factory and/or installing some oil separating facilities at the entrance of treatment plant in case of joint treatment.

In Kuala Kedah, factories discharge large amount of strong wastes from sea fish processing factories not including harm substances.

2.3.3. Discussion about Joint Treatment

(1) Alor Setar Area

Mergong Area has been developed as an industrial area. According to the developing plan, many new factories are planned to be located there. Relocation of existing factories into the area will be also carried out intensively. Therefore, a joint treatment of trade and domestic wastes should be discussed for the Mergong Industrial Area.

Industry categories appeared in Mergong Phase I and waste quality are shown in Table B-13. A little stranger water quality is projected than those obtained by survey, which has been sampled from roadside drains.

Since light industry is projected dominant the waste strength is considered weak and does not cause serious difficulties towards joint treatment. However, waste oil discharged into sewer pipe, prevents oxygen transfer from air to the waste causing anaerobic condition as well aa danger of explosion.

In addition, the waste oil flowed into the treatment facility will adhere to the biomass to weaken their activity and to prevent oxygen transfer.

As waste oil is not emulsified but easy to float, it should be trapped within each factory and/or installation of oil trapping facilities is mandatory at the entrance of treatment facility.

(2) Kuala Kedah Area

Kuala Kedah Industrial Area has been developed for sea fish processing mainly into fish meal and fish powder. At present, theree factories are in operation.

Table B-13 Trade Wastes Projection in Mergong Area

Code	Category	Composition (%)	Area (ha)	Number of sample	Average water Consumption (m^3/ha/d)	Waste Quality (Roadside Drain) BOD(mg/l)	Waste Quality (Roadside Drain) SS (mg/l)	Waste Quality Projected BOD (mg/l)	Waste Quality Projected SS (mg/l)
01	Food	8.8	10.3	3	21.7	74.5	57.0	150	150
02	Chemicals	0	-						
03	Rubber and Plastic	5.0	5.9	3	58.9	12.1	14.2	30	50
04	Metal Plate Working	7.5	8.8	2	20.8	11.2	14.0	30	50
05	Electric Goods	5.0	5.9	1	12.5	11.2	14.0	30	50
06	Machinery	2.5	2.9						
07	Other Manufacturing	12.5	14.6	1	60.9				
08	Selling	15.0	17.6						
09	Storehouse	12.5	14.6						
10	Car Repair Workshop	25.0	29.2	6	24.3	14.8	25.1	30	50
11	Other Services Business	6.2	7.2						
	Total	100	117.0	16	Av. 33.2	Av. 19.9	Av. 20.8	Av. 45	Av. 62.5

Generally sea fish processing industry discharges a large amount of strong wastes because fatty substances and protains contained in fish are discharged during washing and processing. However, it does not include harmful matters for biological treatments.

Two cases of joint treatment of trade and domestic wastes is discussed as follows:

Case I	:	Joint treatment without pretreatment of trade wastes
Case II	:	Joint treatment with pretreatment of trade wastes

The pretreatment method discussed herein is plain sedimentation, which is easy to maintain and comperatively cheaper than other alternative facilities to construct.

Influent BOD values into community treatment facility without pretreatment (Case I) are estimated to be 262 mg/l in 1979 and 633 mg/l in 2000 shown in Table B-14 while influent BOD values to the treatment facility through pretreatment facility (Case II) are estimated to be 238 and 532 mg/l for 1979 and 2000 respectively.

Table B-14 Projection of Influent Quality in Kuala Kedah

Case	Year	Effluent Quantity and Quality of Trade Wastes			Influent Quantity and Quality into Community Treatment Facility								Remarks
		Flow	BOD	SS	Flow	Ratio of Trade Wastes	BOD	Ratio of Trade Wastes	SS		Ratio of Trade Wastes		
		(m^3/d)	(kg/d)	(kg/d)	(m^3/d)	(%)	(kg/d)	(%)	(mg/l)	(kg/d)	(%)	(mg/l)	
I	1979	173	346	86.5	2869	6.0	752.6	46.0	262	493.1	17.5	172	
	2000	1559	3118	779.5	6144	25.4	3890.4	80.1	633	1551.9	50.2	253	
II	1979	173	277	43.3	2869	6.0	683.6	40.5	238	449.9	9.6	159	Sludge: 43
	2000	1559	2444	390	6144	25.4	3266.4	76.4	532	1162.4	33.6	189	(kg/d):390

Note:

(1) Case I : Joint treatment without pretreatment of trade wastes

(2) Case II: Joint treatment with pretreatment of trade wastes

(3) Influent includes ground water of 723 m^3/day

2.4. Additional Water Quality Study

2.4.1. Septic Tank Effluent

(1) The Results of Survey

Four septic tanks with known dates were selected in consultation with the counterpart of MPKS among these septic tanks, the oldest one has been in operation these five years. The results of the survey are shown in Table B-15.

Septic tank of Akademi Utama treats mainly urine from a daytime school. The effluent contains very few coliforms with high pH value due to breaking down of urea to ammonia. Also it shows low value of BOD and SS, indicating a good functional condition for treatment.

Other septic tanks have a few compartments and/or filtrating bed after septic tanks. Effluents from these septic tanks show satisfactory quality by this anaerobic treatment process, producing effluent of BOD 70 mg/l and SS 120 mg/l from one of flate operating one and half years and effluent of BOD 40 mg/l and SS 35 mg/l from one of semi-detached house operating five years.

Dilution by flushing and frequency of toilet using are esteemed from Cl^- concentration data of Alor Malai Flats which is estimated to have 960 dwellers.

Cl^- concentration before filtration is 100 mg/l, not diluted by rain and/or ground water. Dilution is estimated at 55 times, assuming Cl^- 5500 mg/l for raw excreta, approximately 14 l of water is flushed at a time, and per capita per day toilet usage is estimated as approximately 4 times.

BOD removal, excluding influence by dilution effect, is calculated in a range of 50 to 70 %, indicating reasonable values by anaerobic treatment.

Sludge production is estimated by desludging individual septic tank at Taman Muhibbah. Accumulated sludge during five years is found to be 60 cm thick in a first compartment which is 1.4 m deep, occupying 40 % of tortal first compartment volume. Sludge looks well digested and is 0.3 m^3 in volume and approximately 97 % in moisture.

Table B-1 5 The results of Septic Effluent Survey

Place	Description				Effluent Quality							Remarks
	Influent	Process	Use	Date	Temp.	pH	BOD_3	CDM_{mn}	SS	Cl^-	Coliform	
			Yr.		°C		mg/l	mg/l	mg/l	mg/l	C/ml	
1. Taman Pumpong	. Isolated house	3-Septic Compartments	0.5	15/7	31.0	7.6	36.6	55.7	18.0	38.0	4,600	. Upper: 2nd Compartment
	. Excreta				30.7	7.8	16.3	16.5	10.0	24.0	10	. Lower: 3rd compartment
2. Akademi Utama	. School	1-Septic Compartment	0.5	15/7	29.0	11.0	9.6	28.9	24.4	400	1	. Mainly treating area
	. Excreta											
3. Alor Malai Flats	. Flat	1-Septic Compartment, Filtration Bed	1.5	11/7	30.0	8.1	115	136	155	100	6,800	. Upper: before filtration
	. Excreta						70.6	108	117	68.0	2,600	. Lower: after filtration
4. Taman Muhibboh	. Semi-detached house	2-Septic Compartments	5.0	16/7	29.4	7.8	90.3	124	110	67.0	90,000	. Upper: 1st compartment
	. Excreta				28.8	7.6	36.5	72.0	34.0	49.0	7,300	. Lower: 2nd compartment

This family consists of two adults and two children with ages ranging from 2 to 6, Per capita per sludge production is estimated to be 30 l/cap/yr..assuming only two adults are using the septic tank.

(2) Discussion

"Drainage, Sanitation and Sanitary Plumbing By-Laws 1976" provide detailed design criteria for newly constructed septic tanks.

According to this criteria, volume of a septic tank should be more than 1.8 m3 and capable to reserve the waste water for one day, with per capita per day wastes volume of 230 l/cap/d. Therefore, these septic tanks treating both sullage water and excreta will be installed in newly constructing house.

For a new area-wide housing development, Ministry of Health has a guideline to install a communal treatment plant, no matter what process it may be, but it should treat both sullage and excreta.

These policies are intended to treat sullage, which has been discharged without any treatment, together with excreta, to contribute water pollution control until the completion of a comprehensive sewerage treatment system.

Bucket system in suburbs will be improved to pour-flush latrine which consists of pour-flush latrine and night soil pit, according to the guideline. This is intended to improve sanitary conditions in rural area, and will prevent illegal dumping of night soil to public water corses.

Septic tank usually does not require major operation and maintenance work, except desluding. Accumulated sludge, which reduces effective volume in tanks and lowers effluent quality, should be removed periodically, for example, once a year as outlined in the BY-Laws. However, due mainly to insufficient number of desludging lorries and narrow access roads, it seems difficult to desludge every septic thank once a year. The results of survey show that approvable effluent quality and sufficient tank volume against sludge production. Therefore, effluent quality will be acceptable desludging once several years.

2.4.2. Public Market

The water quality survey was carried out at "Pasar Besar" which was the biggest public market in the Study Area. The result are shown on Table B-16.

The high BOD value in the table is mainly attributed by the discharge of bleading of the killed poultry and fish. Effluent quality from the market will be improved to a certain level by preventing the blood discharge into drains.

Table B-16 Waste Quality at the Public Market

Date	Time	Temp. (°C)	pH	DO (mg/l)	BOD_3 (mg/l)	SS (mg/l)	Cl^- (mg/l)	Remarks
9/7	8:11	-	-	0	5,140	520	-	3.6 m^3/hr
	15:00	30.0	6.8	0	624	855	-	5.4 m^3/hr Floor washing effluent

APPENDIX C

LAND USE AND POPULATION

1. Present Population and its Distribution

1.1 Present Population

Present population (1979) in the Study Area is estimated to be 139,600 on the assumption that overall annual growth rate, composite of both natural and social growth rates, is assumed to be 3.5% between 1970 and 1975, and 4.0 % between 1975 and 1979 as shown below ;

Year	Annual Growth Rate (%)	Population in Study Area
1970		* 100,439
1975	3.5	119,300
1979	4.0	139,600

Note: * based on the 1970 Census

The natural annual growth rate between 1970 and 1979 is taken to be approximately 2.7% applying the same percentage rate for Kota Setar in the Kedah-Perlis Development Study Report (Ref. No.1, Appendix A), thus the total natural growth population between 1971 and 1979 plus the 1970 population being 127,654 persons.

The social growth population, which is considered to be approximately three-fourths of the population residing in the newly built houses between 1970 and 1979, is assumed to be 11,946 persons as shown in Table C-1.

The number of houses increased between 1970 and 1979 are listed in Table C-2 with reference numbers in Figure C-2.

1.2 Population Distribution in 1979

The 1979 population estimated at 139,600 is distributed on the bases of the following considerations:

(1) population is distributed in the 1970 census enumeration blocks.

(2) the population in the newly built houses between 1970 and 1979 in Table C-2 and Figure C-2 is distributed in the blockes where houses were built.

(3) subtracting the population in (2) above from the total population of 39,161 (= 139,600 - 100,439) increased between 1979, the remaining population is distributed in the 1970 census enumeration blocks in proportion to those in 1970.

The population distributed in line with the above consideration is shown in Table C-1, together with area and population density of each enumeration block.

2. Future Population Forecasts in Previous Study Reports

Table C-3 Population Forecast of Alor Setar Area in the Previous Study Reports

Year	Population of Alor Setar estimated in Kedah-Perlis Development Study		Population of Study Area estimated in Preliminary Study for Sewerage (**)	
	Population	Annual Growth Rate (%)	Population	Annual Growth Rate (%)
1980	150,300	-	138,800	
1985	-	-	177,100	5.0
1990	222,500*	-	215,500	4.0
1995	-	-	256,000	3.0
2000	-	-	296,800	3.0

Note: (1) *: Area of the population forecast is 2,208 ha (or 5,520 acres), but the area is not identical
(2)**: Population of Kuala Kedah and Mergong Industrial area are not included.

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Growth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
1.	1459	1791	-	-	1791	29.54	61	C.R.
2.	2464	3025	-	-	3025	9.55	317	R.
3.	2005	2461	-	-	2461	13.54	182	C.R.
4.	934	1147	-	-	1147	11.45	100	R.
5.	270	27	-	-	27	21.78	1	I.
6.	533	654	-	-	654	39.14	17	R.P.
7.	0	-	98	539	539	20.00	27	R.P.
9.	873	1072	-	-	1072	36.14	30	R.P.
10.	259	318	-	-	318	10.76	30	R.P.
11.	580	712	-	-	712	20.19	35	R.P.
12.	269	330	-	-	330	31.60	10	P.
13.	641	787	-	-	787	18.30	43	R.P.
14.	910	1117	-	-	1117	3.76	297	R.
15.	789	969	-	-	969	3.94	246	R.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Growth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
16.	1300	1596	-	-	1596	12.25	130	R.P.
17.	405	497	-	-	497	30.23	16	P.
18.	160	196	-	-	196	12.80	15	P.
19.	308	378	-	-	378	11.62	33	R.
20.	63	77	-	-	77	9.53	8	P.
21.	801	983	-	-	983	23.91	41	R.S.
22.	26	32	99	544	576	28.22	20	R.P.
23.	572	702	-	-	702	19.26	36	R.M.
24.	381	468	-	-	468	9.64	49	R.P.
25.	889	1091	77	424	1515	38.02	40	R.P.
26.	1210	1486	208	1144	2630	17.66	149	R.
27.	1064	1306	179	984	2290	23.87	96	R.
28.	458	562	-	-	562	109.71	5	R.P.
29.	626	769	226	1243	2012	21.34	94	R.P.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Growth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
30.	592	727	274	1507	2234	93.25	24	R.P.S.
31.	379	465	-	-	465	47.56	46	P.
32.	1287	1580	-	-	1580	61.32	26	R.P.
33.	522	641	-	-	641	38.52	17	R.V.
34.	340	417	-	-	417	17.62	24	R.V.
35.	501	615	-	-	615	14.04	44	R.V.
36.	563	691	-	-	691	78.28	9	P.
37.	317	389	-	-	389	86.98	4	P.
38.	319	392	-	-	392	25.98	15	P.
39.	835	718	-	-	718	45.20	16	P.
40.	768	943	-	-	943	18.20	52	P.I.
41.	70	462	-	-	462	43.60	11	V.I.
42.	731	897	7	38	935	6.65	141	R.I.
43.	623	765	7	38	803	7.00	115	I

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Growth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
44.	225	276	8	45	321	10.54	30	R.V.
45.	1818	2232	68	374	2606	16.17	161	R.
46.	499	613	114	627	1240	21.18	59	R.
47.	709	870	36	198	1068	19.99	53	R.P.
48.	835	1025	36	198	1223	14.56	84	R.P.
49.	906	1112	107	588	1700	11.98	142	R.
50.	892	1095	-	-	1095	6.04	181	R.
51.	589	723	-	-	723	16.48	44	R.
52.	701	861	43	237	1098	10.24	107	R.
53.	729	895	49	269	1164	8.52	137	R.
54.	874	1073	-	-	1073	4.81	223	R.
55.	793	974	186	1023	1997	49.45	40	R.P.
56.	518	636	39	215	851	15.47	55	R.
57.	587	721	7	39	760	6.39	119	R.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Grwoth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
58.	340	417	28	154	571	20.87	27	R.P.
59.	385	473	-	-	473	3.20	148	R.
60.	90	110	-	-	110	10.56	10	S.
61.	525	645	-	-	645	10.31	63	R.
62.	642	788	-	-	788	2.35	335	R.
63.	398	489	12	66	555	18.03	31	R.
64.	683	839	-	-	839	10.40	81	R.
65.	677	831	-	-	831	6.06	137	R.
66.	1023	1256	-	-	1256	8.01	157	R.
67.	1142	1402	-	-	1402	6.02	233	R.
68.	671	824	-	-	824	5.17	159	R.
69.	939	1153	-	-	1153	5.63	205	R.
70.	646	793	-	-	793	6.45	123	R.
71.	381	468	-	-	468	3.14	149	R.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
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Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Growth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
72.	895	1099	-	-	1099	14.44	76	R.V.
73.	795	976	-	-	976	8.43	116	R.V.
74.	459	564	-	-	564	6.62	85	R.S.
75.	753	924	-	-	924	8.37	110	R.S.
76.	811	996	-	-	996	4.02	248	R.
77.	951	1168	-	-	1168	6.84	171	R.C.
78.	1507	1850	-	-	1850	6.30	294	R.C.
79.	311	382	-	-	382	6.36	60	R.C.
80.	818	1004	-	-	1004	13.23	76	R.
81.	2362	2900	-	-	2900	13.23	219	R.
82.	1260	1547	-	-	1547	8.72	177	R.V.
83.	834	1024	-	-	1024	4.71	217	R.
84.	2034	2497	-	-	2497	6.12	408	C.
85.	674	827	-	-	827	4.67	177	C.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Grwoth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
86.	768	943	-	-	943	9.00	105	C
87.	782	960	-	-	960	7.81	123	R.C.
88.	738	906	-	-	906	5.83	155	R.
89.	635	780	-	-	780	12.00	65	Railway
90.	678	832	-	-	832	4.10	203	R.
91.	814	999	-	-	999	17.61	57	R.P.
92.	458	562	-	-	562	18.04	31	S.R.
93.	798	980	-	-	980	11.08	88	R.
94.	573	703	-	-	703	5.63	125	R.
95.	717	880	-	-	880	9.90	89	R.
96.	787	966	-	-	966	12.44	78	R.S.
97.	602	739	-	-	739	7.18	103	R.
98.	630	773	70	385	1158	12.14	95	R.
99.	668	820	-	-	820	7.00	117	R.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Grwoth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
100.	616	756	-	-	756	9.46	80	R.
101.	842	1034	-	-	1034	9.71	106	R.
102.	744	913	-	-	913	5.56	164	R.
103.	1101	1352	-	-	1352	13.71	99	C.
104.	764	938	-	-	938	12.73	74	C.R.
105.	858	1053	-	-	1053	4.23	249	C.
106.	183	940	-	-	940	12.88	73	C.
107.	616	756	-	-	756	4.96	152	C.
108.	632	776	-	-	776	7.47	104	C.
109.	772	948	-	-	948	7.15	133	C
110.	635	780	-	-	780	2.79	280	C.
111.	645	792	-	-	792	5.07	156	C.
112.	931	1143	-	-	1143	6.21	184	C.R.
113.	968	1188	-	-	1188	6.24	190	C.R.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Grwoth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
114.	1208	1483	-	-	1483	8.69	171	C.
115.	918	1127	-	-	1127	12.20	92	C.
116.	1301	1597	-	-	1597	20.89	76	R.C.S.
117.	1256	1542	-	-	1542	5.09	303	R.
118.	255	313	-	-	313	3.24	97	R.
119.	781	959	24	132	1091	7.27	150	R.
120.	793	974	18	99	1073	12.56	85	R.V.
121.	1043	1280	73	401	1681	38.58	44	R.
122.	943	1158	-	-	1158	8.74	132	R.
123.	1615	1983	96	528	2511	44.14	57	R.V.
124.	880	1080	-	-	1080	17.08	63	R.
125.	213	262	-	-	262	11.16	23	R.
126.	552	678	-	-	678	27.85	24	V.
127.	387	475	-	-	475	5.89	81	V.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Growth Population from 1971 to 1979 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
128.	64	79	-	-	79	4.75	17	V.
129.	481	591	-	-	591	16.97	35	R.
130.	643	789	-	-	789	12.55	63	R.
131.	560	688	-	-	688	6.37	108	R.
132.	440	540	9	50	590	12.66	47	R.V.
133.	611	750	-	-	750	20.66	36	R.P.
134.	254	312	387	2129	2441	78.89	31	R.
135.	497	610	-	-	610	19.39	31	R.
136.	315	387	-	-	387	8.74	44	R.
137.	790	970	-	-	970	5.22	186	R.
138.	509	625	1	6	631	15.16	42	R.
139.	19	23	235	1292	1315	28.18	47	R.
140.	925	1136	-	-	1136	7.03	162	R.
141.	454	557	54	297	854	26.06	33	R.S.

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

Table C-1 1979 Population and its Density in the Census Enumeration Blocks

Census Enumeration Block No.	Population in 1970	Natural Growth Population from 1971 to 197 plus 1970 population (1)	*Number of houses increased Between 1970 and 1979	Social Growth Population increased Between 1970 and 1979 (2)	Total Population in 1979 (1) + (2)	Area (ha)	Population Density (Person/ha)	Classification by land use
Paddy								
River								
Railway	0	0	-	-	0	910.01	0	
etc.								
TOTAL :	100439	123787	2875	15813	139600	3300.0	58.4	

Note: (1) refer to Figure C-1
(2) * based on MPKS data
(3) No of people in a family is assumed to be 5.5 persons per household
(4) R: Residential C: Commercial I: Industrial P: Paddy
S: School M: Mosque & other religious use V: Vacant & Open Space

SCALE
1 : 30,000

0 0.5 1.0 KILOMETER

0 0.5 1.0 MILE

LEGEND

- Boundary of Study Area
- 0 Person / ha
- 1 - 49 Persons / ha
- 50 - 99 Persons / ha
- 100 - 149 Persons / ha
- 150 - 199 Persons / ha
- 200 - 249 Persons / ha
- 250 - Persons / ha
- Railway
- River

Note : Refer to Table C-1

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

ESTIMATED POPULATION DENSITY IN 1979

FIGURE C - 1

Table C-2 No. of Houses Built and Population Density in Developing Area by Each Period

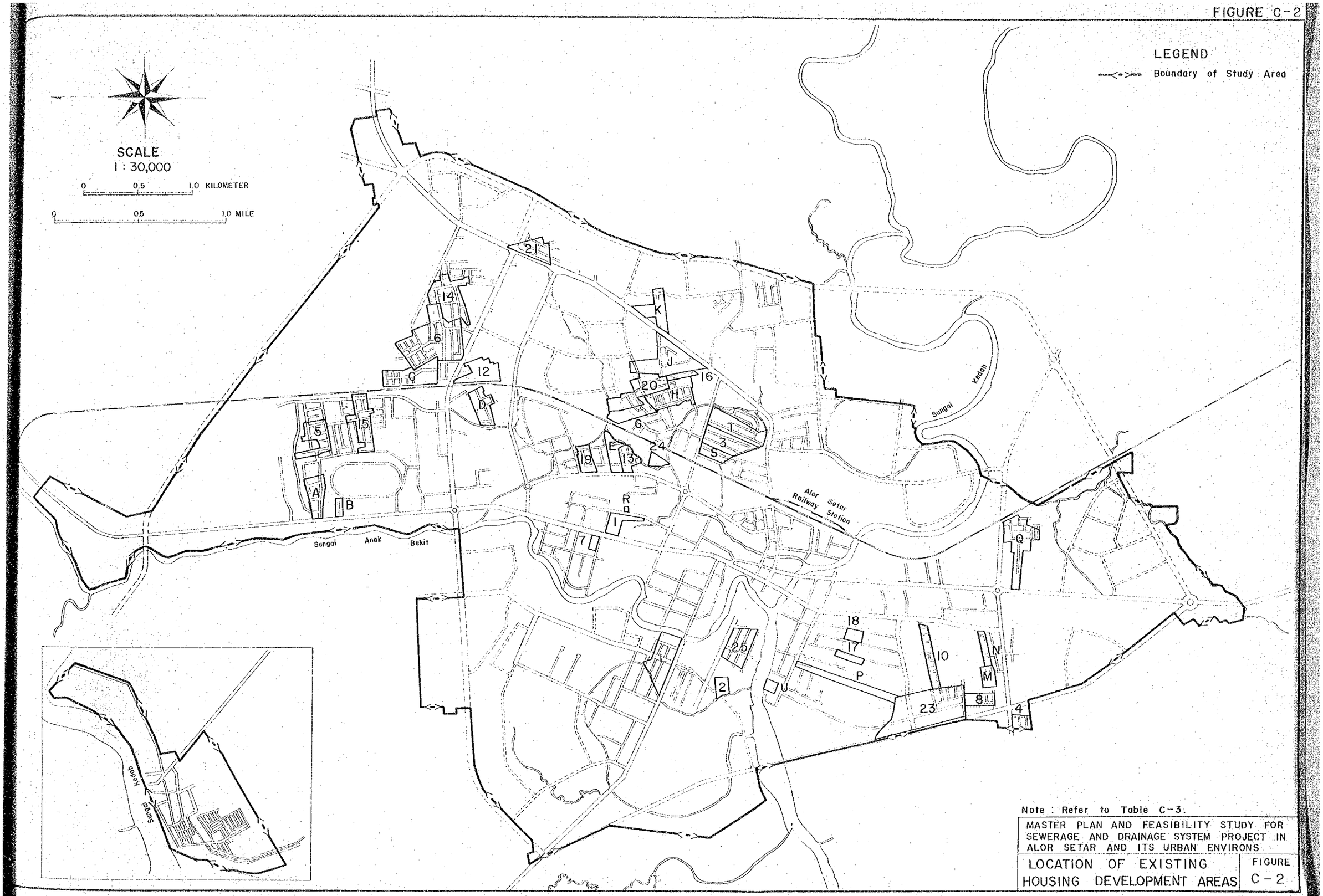
Ref. No. in Figure C-2	Name of Existing Housing Development Area	Area (ha)	No. of Houses Built			Ultimate Population Density (Persons/ha)
			Before 1969	Between 1970 - 78	Including future plan	
1.	Taman Tunku Habsah	1.95	0	66	66	186
2.	Taman Thean Peng	1.88	0	68	68	199
3.	Taman Sentosa	6.87	0	70	70	56
4.	Taman Sofiah	1.77	0	28	28	87
5.	Kawasan Perumahan Taman Lumba Kuda	7.70	0	221	242	173
6.	Taman Uda	21.57	0	235	235	60
7.	Kawasan Perumahan Jalan Kampong Pisang	0.87	0	18	18	118
8.	Taman Sri Manis	2.91	0	39	80	151
9.	Taman Datin Noorkiah	3.00	0	66	66	121
10.	Taman Selamat	4.23	0	120	120	156
11.	Taman Bunga Raya	2.30	0	72	72	172
12.	Taman Syed Mohamad	5.66	0	54	54	52
13.	Taman Stadium	3.01	0	53	66	121
14.	Taman Muhibbah	10.68	0	274	282	145
15.	Taman Golf	7.97	0	166	178	123
16.	Taman Merbok	1.63	0	20	38	128

to be continued

Ref. No. in Figure C-2	Name	Area (ha)	No. of Houses Built			Ultimate Population Density (Persons/ha)
			Before 1969	Between 1970 - 78	Including future plan	
17.	Taman Air Puteh	1.48	0	43	63	238
18.	Taman Nylor Setali	1.71	0	49	49	158
19.	Taman Daruliaman	3.16	0	20	44	77
20.	Taman Setia Berjaya	2.33	0	77	124	293
21.	Taman Jaya	4.61	0	82	82	98
22.	Taman Dato' Kumbar	3.85	0	99	99	142
23.	Taman Berjaya	23.15	0	98	494	117
24.	Taman Tunku Abdul Majid	1.59	0	24	42	145
25.	Taman Mahawangsa	7.93	0	114	114	79
26.	Rumah Pausa Alor Malai	1.20	0	144	144	660
A	Taman Malaysia	5.45	70	9	79	80
B	Taman Pumpong	1.16	20	0	20	95
C	Rancangan Rumah Murah Jl. Sultanah	8.58	147	0	147	94
D	Sri Taman	5.09	115	1	128	138
E	Taman Mahkota	4.17	30	0	30	40

to be continued

Ref. No. in Figure C-2	Name	Area (ha)	No. of Houses Built			Ultimate Population Density (Persons/ha)
			Before 1969	Between 1970 - 78	Including future plan	
F	Tamon Loh Joo Huat	1.72	30	18	48	153
G	Kawasan Perumahan Jl.	10.61	127	107	245	127
H	Taman Lan Sun	8.88	107	144	268	166
J	Kawasan Perumahan Jl. Shariff	12.75	129	116	272	117
K	Kawasan Perumahan Batu 2, Jl. Langgar	5.92	130	0	152	141
L	Kawasan Perumahan Sbg. Jl. Putera	18.76	266	22	318	93
(M N)	Taman Lam Fong Taman Malid	4.46	92	7	99	122
P	Taman Bahagia	5.73	26	107	133	128
Q	Taman Bee Bee	10.56	259	12	271	141
R	Kawasan Perumahan Jl. Tunku Abd. Halim	1.13	26	12	38	185
S	Lorong Merpati	2.90	53	0	53	101
T	Kawasan Perumahan Jl. Ghouse	8.21	82	0	82	55
U	Rancangan Rumah Murah TongKang Yard	1.50	59	0	59	217
	Total :	252.54	1768	2875	5380	21.3



Note : Refer to Table C-3.

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

LOCATION OF EXISTING HOUSING DEVELOPMENT AREAS

FIGURE C - 2

APPENDIX D

WASTEWATER QUANTITIES AND QUALITIES

1. Domestic

Three typical residential sections in the Study Area were selected as shown in Figure D-1 and per capita water consumption rates were collected based on the JKR's metre reading record for the past one year as resulted in Table D-1.

Table D-1 Water Consumption Rates in Typical Residential Sections

Name of Place	Type of House	No. of House Unit	Average Per Cap. Water Consumption (l/cap./day)	Range of Per Cap. Water Consumption (Max.-Min.) (l/cap./day)
Kg. Alor Merah	Kampung house	52	173	56 - 345
Taman Uda Taman Muhibbah	Terrace, Semi-detach and isolated houses	52	158	24 - 322
Taman Malaysia	Semi-detach	52	157	26 - 358
Average		-	163	-

Note: Average number of people in a family is assumed to be 5.5.

Considering additional per capita water consumption rate data, one is obtained from JKR in Alor Setar to be 149 litres per day and the other from the house visiting survey on various type houses to be 185 litres per day in average as shown in Table D-2, the rate considered for sewerage plan is 170 litres per day for present condition.

The 2000-year per capita water consumption rate is set to be 230 litres per day considering expected future consumption increase by level-up of living conditions including use for flush toilet system, and further referring to various design criteria cited in Table D-3.

Table D-2 Per Capita Water Consumption Rates Obtained from Various Types of Houses by House Visiting

*Type / Water Consumption (l/day/cap.)	Number of Households						
	Type I	Type II	Type III	Type IV	Type V	Type VI	Total
Less than 100	0	0	3	1	2	1	7
101 - 150	4	1	5	0	2	2	14
150 - 200	3	1	0	2	1	1	8
201 - 250	1	3	2	4	4	1	15
251 - 300	2	2	0	1	3	1	9
301 - 350	0	0	1	2	0	1	4
351 - 400	1	1	0	0	2	0	4
More than 400	0	0	0	6	3	2	11
Total Household No.	11	8	11	16	17	9	72
Total of Population (Person)	69	65	78	131	97	43	483
Average Per Capita Water Consumption (l/day/cap.)	181	176	166	382	228	259	256

Notes: * House Type

I : Kampung house (wooden)
II : One-storied attached terrace house
III : Two-storied attached terrace house
IV : Commercial house
V : Semi-detached ouse
VI : Isolated terrace house

Table D-3 Comparison of Design Criteria for Various Cities

Name of City (or country)	Target Year	BOD (mg/l)	SS (mg/l)	BOD (g/d/c)	SS (g/d/c)	Flow (l/d/c)	Remarks
Butterworh	2000	200	200	46	46	230	Design criteria recommended
Ipoh	2020	200	250	45	54	227	Design criteria
(*) Kuala Lumpur	2002	222	-	60	-	270	Desgin criteria
Seoul	1985	312	374	59	73	232	Design criteria
Japan (**)	2000	-	-	65	59	350	Design manual

Note: (1) * Kuala Lumpur Master Plan for Sewerage and Sewage Disposal; D. Balsour & Sons (1975)

(2) ** Japanese Design Manual for Sewerage System (1972)

2. Commercial

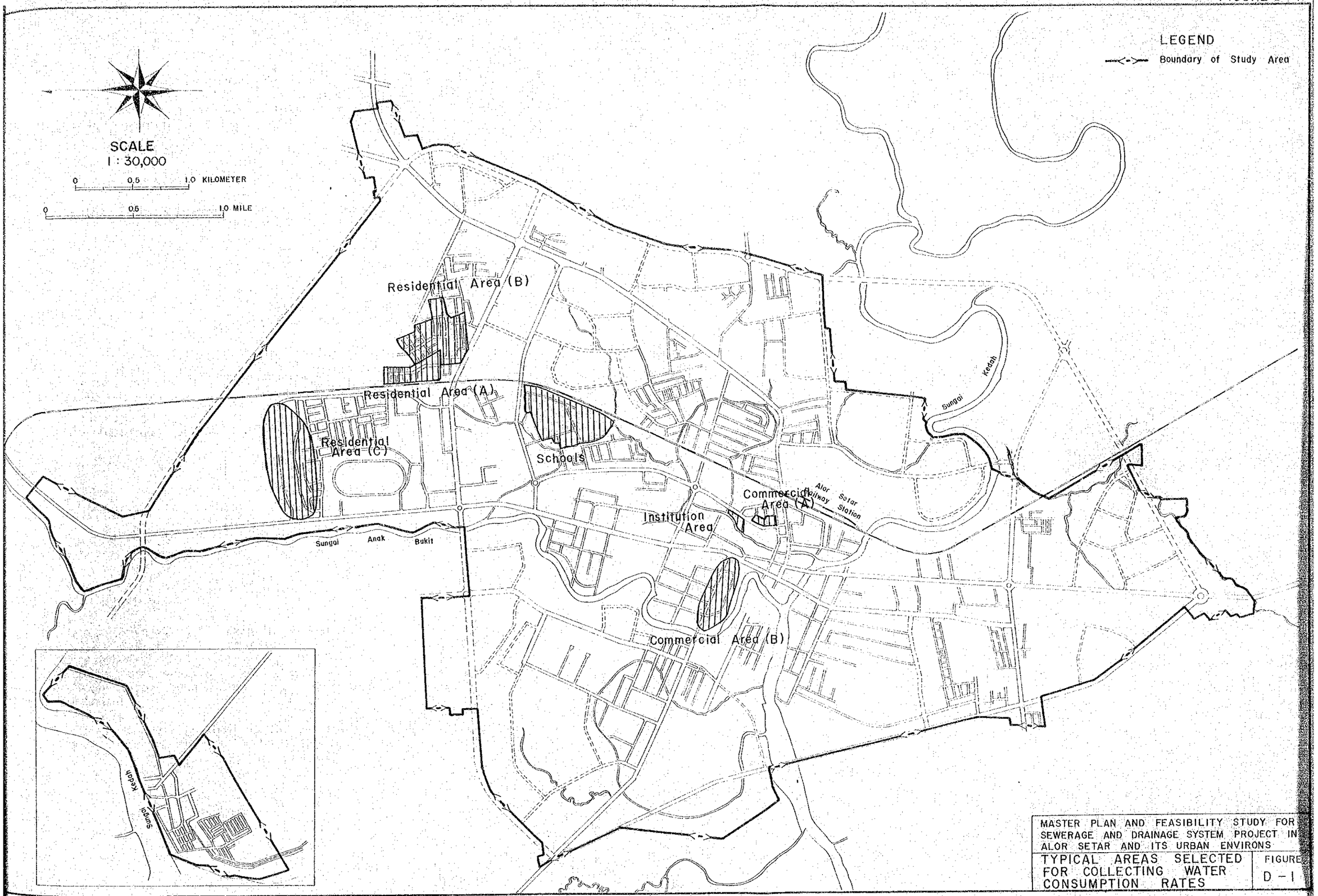
For commercial area, water consumption data were taken from 59 units of various kinds of business in a typical commercial section as shown in Figure D-1 from the JKR's metre reading record for the past one year as resulted in Table D-4.

Table D-4 Water Consumption Rates in Typical Commercial Sections

Name of Place	No. of House Unit	Average Per Cap. Water Consumption (l/cap./day)	Per Cap. Water Consumption (Max.-Min.) (l/cap./day)
Jalan Mahsuri Jalan Putera	59	340	261 - 397

Notes: (1) The present population density in the commercial area is 154 persons per ha.

(2) Average number of people in a family is assumed to be 5.5.



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

TYPICAL AREAS SELECTED FOR COLLECTING WATER CONSUMPTION RATES

FIGURE D - 1

Per capita wastewater rate generated from the commercial area in the year 2000 is assumed to be 460 litres per day, assumed by the same way in the case of residential area in above section.

3. Institutional

Water consumption rates from typical institutional buildings as shown in Figure D-1 were collected as resulted in Table D-5.

It is noted that the present per capita consumption rate of 23 litres per day is considered to continue up to year 2000.

Table D-5 Water Consumption Rates in Typical Institutional Sections

Government Office	Water Consumption (l/day)	Permanent Staff	Per Cap. Water Consumption (l/cap./day)
MPKS, TCP, JKR (Building Section)	5,505	202	27.3
DID, JKR	13,564	704	19.3
LLN	7,390	317	23.3
Average	-	-	21.6

4. Industrial

A total of 103 existing industrial factories is found in the Study Area as summarized in Table D-6; 80 factories in the North Mergong Industrial Area, 3 factories in the Kuala Kedah Industrial Area, and remaining 23 factories in other area, especially along the main roads such as Jl. Sg. Korok and Jl. Langer.

In addition, several large scale factories are being built in the South Mergong Industrial Area.

Table D-6 Distribution of Major Industrial Factories in the Study Area

Category No.	Kind of Industry or Product	Factories and Numbers Located							
		K. Kedah		N. Mergon		Other Area		Total	
		No. of Facotry	Prorata Ratio	No. of Factory	Prorata Ratio	No. of Factory	Prorata Ratio	No. of Factory	Prorata Ratio
01	Foodstuffs	3	100.0	7	8.8	10	43.5	17	16.5
02	Chemical					1	4.3	1	1.0
03	Plastic and Rubber			4	5.0	1	4.3	5	4.9
04	Metal Works			6	7.5	3	13.1	9	8.7
05	Electrical			4	5.0			4	3.9
06	Mechanical			2	2.5	1	4.3	3	3.0
07	Others			10	12.5	2	8.7	12	11.6
08	Whole Sale			12	15.0			12	11.6
09	Warehouses			10	12.5			10	9.7
10	Car Repair			20	25.0	3	13.1	23	22.3
11	Services			5	6.2	2	8.7	7	6.8
Total		3	100.0	80	100.0	23	100.0	103	100.0

The data in the above table reveals that kinds of industries differ significantly between the Kuala Kedah and the North Mergong Industrial Areas, thus discussions are developed independently hereafter.

4.1 North Mergong Industrial Area

Sixteen representative factories were visited, and the result is shown in Table D-7 and Figure D-1.

Table D-7 Industrial Wastewaters Generated from Various Industries in the North Mergong Industrial Area

Category No.	Kind of Industry or Product	No. Sample	Land Area (ha)	Wastewater Generated	
				(m^3/day)	(m^3/day/ha)
01	Foodstuffs	3	0.2398	5.2	21.7
03	Plastic and Rubber	3	1.0536	62.1	58.9
04	Metal Works	2	0.1392	2.9	20.8
05	Electrical Works	1	0.2880	3.6	12.5
06	Others	1	0.0723	4.4	60.9
10	Car Repair	6	0.6742	16.4	24.3
Total		16	—	—	—

The area to be developed in the future in the North Mergong Industrial Area is assumed to be shared by the various kinds of industries in the same rates now being occupied by the various categorical industries in Table D-6, thus amount of wastewater generated by each categorical industry is estimated as shown in Table D-8.

Data, in Table D-7, not covered by the industries categorized in Table D-6 such as Category No. 02, 07, 08, 09 and 11 are supplemented by the data obtained from the Penang Sewerage Project, 1978.

Table D-8 Wastewater Quantities Generated from Net Unit Land of Various Industies

Category No.	Prorate Area (%)	Land Area (ha)	Wastewater	
			(m^3/day/ha)	(m^3/day)
01	8.8	10.3	21.7	223.5
02				
03	5.0	5.9	58.9	347.5
04	7.5	8.8	20.8	183.0
05	5.0	5.9	12.5	73.8
06	2.5	2.9	5.1 (*)	14.8
07	12.5	14.6	60.9	889.1
08	15.0	17.6	9.1 (*2)	160.2
09	12.5	14.6	9.1 (*2)	132.9
10	25.0	29.2	24.3	709.6
11	6.2	7.2	9.1 (*2)	65.5
Total	100.0	117.0	(Av) 23.9	2,799.9

Note: (1) (*1) assumed by the data in the Penang Sewerage Master Report by NSC.

(2) (*2) 9.1 m^3/day/ha is used assuming that per ha workers of 394 and per capita water consumption of 23 litre, used in the case of institutional area.

It should be noted that net industrial land in the Mergong Industrial Area is assumed to be 117 ha excluding the areas occupied by road, open space, etc. from the gross area of 146 ha. Therefore, industrial wastewater generated from unit gross area is estimated to be 19.2 m^3/day/ha (= 2,799.9 ÷ 146, refer to Table D-8).

By the same approach applied for estimating wastewater quantities generated from various industries in the North Merbong Industrial Area wastewater qualities are also estimated as resulted in Table D-9, thus being 58 mg/l for BOD and 94 mg/l for SS.

Table D-9 Wastewater Qualities Generated from Various Industries

Category No.	Wastewater (m^3/d)	B O D		S S	
		Concentration (mg/l)	Waste Load (kg/d)	Concentration (mg/l)	Waste Load (kg/d)
01	223.5	150 (*1)	33.525	150 (*1)	33.525
03	347.5	30 (*1)	10.425	50 (*1)	17,375
04	183.0	30 (*1)	5.490	50 (*1)	9.150
05	73.8	30 (*1)	2.214	50 (*1)	3.690
06	14.8	70 (*2)	1.036	130 (*2)	1.924
07	889.1	70 (*2)	62.237	130 (*2)	115.583
08	160.2	70 (*2)	11.214	130 (*2)	20.826
09	132.9	70 (*2)	9.303	130 (*2)	17.277
10	709.6	30 (*1)	21.288	50 (*1)	35.480
11	65.5	70 (*2)	4.585	130 (*2)	8.515
Total	2,799.9	(Av) 58	162.317	(Av) 94	263.345

Note: (1) (*1) obtainted by actual survey.

(2) (*2) applied from previous data in the Penang Sewerage Study by NSC, 1978.

4.2 South Mergong Industrial Area

Four large scale industries have been underconstruction in the South Mergong Industrial Area with the land areas and estimated future water consumptions as shown in Table D-10 and Figure D-1.

Table D-10 Data Obrained for Existing Four Industries

Name of Factory of Industry	Land Area (ha)	Worker (Person)	Water Consumption	Remarks
Dunlop Malaysia Industries, BHD	8.96	520	454.6 (1980) 909.2 (future)	Tire production, and recovery
Peninsular Paper Mills, SDN, BHD	2.82	8	79 (*1)	Paper (toilet)
Kedah Stramit Industries SDN, BHD	5.28	104	0.25	Partition of shielding board made of rice straw
Slanghter House	4.18		112 (*2)	Cow processed: 14,000 heads/yr and Sheep processed: 60,000 heads/yr
Total	21.24		1,100.45	

Notes: (*1) From Industrial Statistic Book in Japan, 1977

(*2) By NSC data in Japan

Wastewater quantity generated from the remaining future development area in the South Mergong Industrial Area is assumed by applying the same basic wastewater rate (19.2 m^3/day/ha of gross area and 33.9 [$\fallingdotseq$ 1,459 $\div$ 43] m^3/day/ha of net area) used for the North Mergong Industrial Area, thus total wastewater generation in the Area is estimated to be 1,459 m^3/day [= 1,100.45 + (15.0 x 23.9)].

Wastewater quality generated in the South Mergong Industrial Area is estimated in Table D-11.

Table D-11 Estimated Wastewater Quality Generated in the South Mergong Industrial Area

Name of Factory or Industry	Wastewater (m^3/d)	B O D		S S	
		Concentration (mg/l)	Waste Load (kg/d)	Concentration (mg/l)	Waste Load (kg/d)
Dunlop Malaysia Industries, BHD	909.2	10 (*2)	9.09	50	45.46
Peninsular Paper Mills, SDN, BHD	79.0	100 (*2)	7.90	300	23.70
Kedah Stramit Industries SDN, BHD	0.25	10 (*2)	0.00	100	0.03
Slangher House	112.0		368.9 (*1)		284.9 (*1)
S. Mergon Ind. Area (excluding above four industries)	358.55	58	20.78	94	33.70
Total	1,459.0	(Av) 279	406.67	(Av) 266	387.79

Note: (1) (*1) Wastewater quantity and quality generated from the factory by slanghering cows and sheep are estimated by the following criteria and based on the designed processing capacity of 46.7 heads for cow, 20 heads for sheep per day.

Animal Name	Wastewater (m^3/head)	Waste Load (kg)	
		BOD	SS
Cow	2.1	7.3	5.8
Sheep	0.7	1.4	0.7

(2) (*2) adopted standard data applied in Japan.

4.3 Kuala Kedah Industrial Area

Data were collected for the three existing fishery industries in the Kuala Kedah Industrial Area as shown in Table D-12.

Table D-12 Data Obtained for the Existing Three Fishery Industries

Kind of Industry	Land Area (ha)	Wastewater	
		(m^3/day)	(m^3/day/ha)
Fish processing	0.6075	55	90.5
Fish meal	0.4050	68	167.9
Fish powder	0.5400	50	92.6
Total	1.5525	173	111.4*

Note: * net area

The wastewater quality in the drainage channel, wherein the wastewaters generated from the above three factories have been discharging, is taken at 10:25 p.m. on 25th of June, 1979 and analysed as shown in Table D-13.

Table D-13 Wastewater Quality of the Existing Three Fisher Factories

Water Temperature (°C)	pH	DO	BOD (mg/l)	SS (mg/l)
32.3	7.4	0	2,350	324

5. Schools

Four representative schools were selected for estimating per capita water consumption rate, based on the JKR's metre reading record of these schools for the past one year as shown in Table D-14 and Figure D-1.

Table D-14 Data Obtained for Representative Schools

Name of School	No. of Students (Person)	Water Consumed	
		(l/day)	(l/cap./day)
Kompleks II, Alor Malai	763	7,355	9.6
Vokesyenal Alor Setar	545	15,138	27.8
Datulaman	1,162	4,260	3.7
Publik Alor Setar	210	1,905	9.1
Total	2,757	28,658	10.4

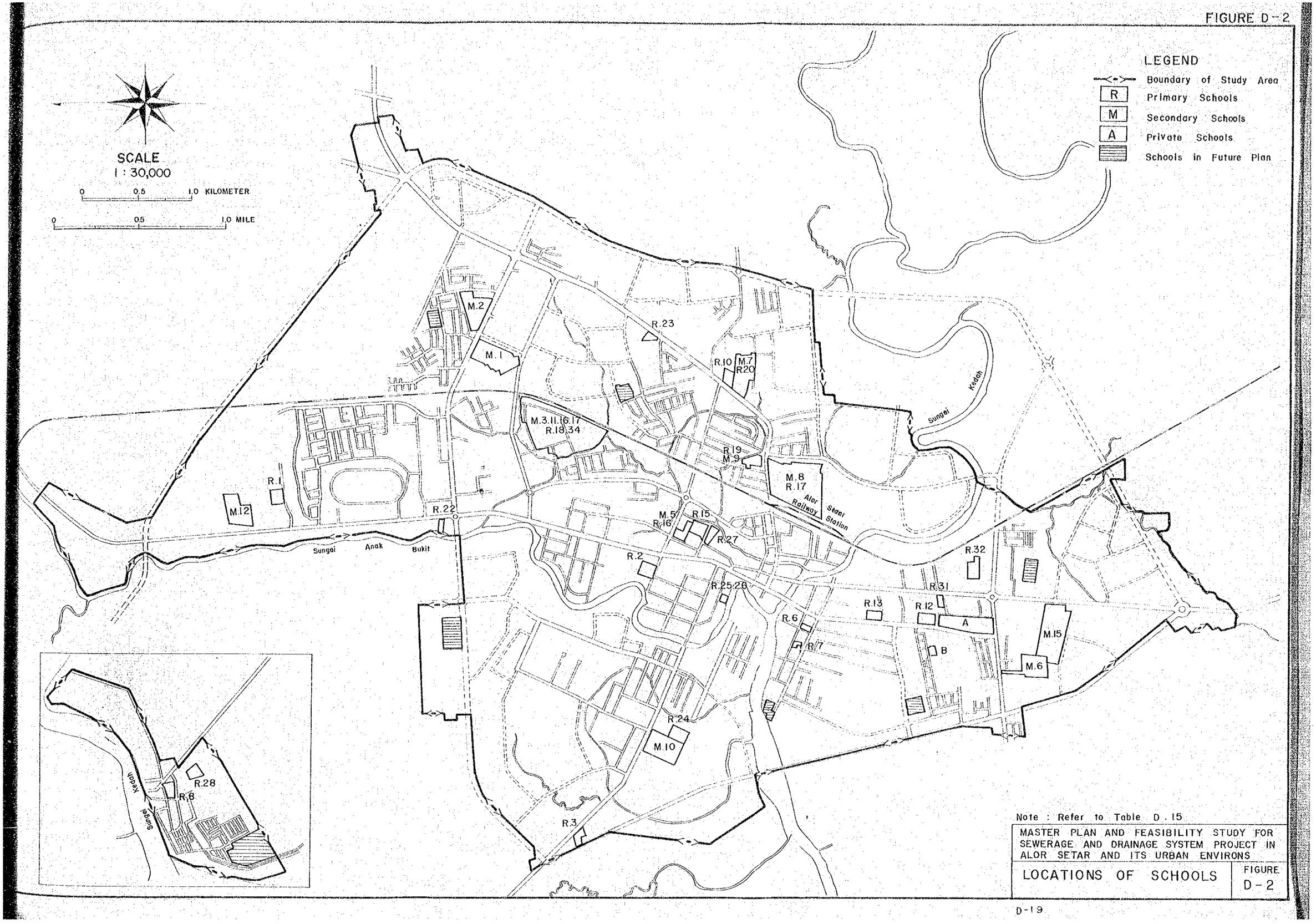
Considering seasonal variation of water consumption rate, per capita water consumption rate is set to be 11.5 litres per day.

Number of students for the year 2000 are estimated to be 90,400 as shown in Table D-15 based on the present number of students of 39,660. The total 2000-year available students are estimated by assuming that number of students will be increased in proportion to the increase of population till 2000 in the Study Area.

Table D-15 Estimated Numbers of Student in the Study Area

Sewerage Sub-zone	Name of School	No. of Student in 1979	No. of Student in 2000
A-1	SMK Kompleks II, Alor Malai	763	1,566
	SMJK Sultanah Asma II	910	1,868
	SM Vokesyenal, Alor Setar	545	1,119
	SM Darulaman	1,162	2,385
	SRK Haji Mohd, Shariff	771	1,582
	SRJK(C) Pumpong	288	591
	SRJK(T) Publik, Alor Setar	210	431
	SMK Dato Syed Omar	1,523	3,126
	New schools in the future plan		2,000
	Sub-total	6,172	14,668
A-2	SM Tunku Abdul Malik	1,543	3,167
	SK Sri Amar di Raja	536	1,100
	New Schools in the future plan		1,000
	Sub-total	2,079	5,267
B-1	SMJK St. Nicholas Convent	978	2,007
	SK Kenent	376	772
	SRK Tunku Abdul Halim	1,413	2,900
	SRK St. Nicholas Convent	1,427	2,929
	SRJK(C) Keat Hwa (H)	1,706	3,501
	SRJK(C) Keat Hwa (K)	1,673	3,434
	SRJK(C) Keat Hwa (S)	1,424	2,923
	SMJK St. Michael	792	1,626
	SRK St. Michael	245	503
	SMJK Kolej Sultan Abdul Hamid	1,747	3,586
	SRK Iskandar	1,743	3,577
	Sub-total	13,524	27,758

Sewerage Sub-zone	Name of School	No. of Student in 1979	No. of Student in 2,000
B-2	SMJK Sultanah Asma	1,550	3,181
	SK Junku Raudzoh, Derga	976	2,003
	SRK Sultanah Asma	1,413	2,900
	SRJK(C) Kee Chee, Derga	297	610
	New Schools in the future plan		1,000
	Sub-total	4,236	9,694
B-3	SMK Sultanah Bahiyah	1,165	2,391
C-2	SMJK Junku Abdul Rahman	1,534	3,148
	SK Mergong	569	1,168
	SRJK(C) Long Chuan, Mergong	398	817
	New Schools in the future plan		1,000
	Sub-total	2,501	6,133
D-1	Maktab Mahmud	815	1,673
	Maktab Mahmud Puteri	915	1,878
	SK Seberang Perak (P)	219	449
	SK Seberang Perak (L)	164	337
	SK Sungai Korok Baru	279	573
	SK Sungai Korok Lama	239	491
	SRJK(C) Sin Min, Sungai Korok	843	1,730
	SRJK(C) Peng Min Simpang Kuala	866	1,777
	New Schools in the future plan		1,000
	Sub-total	4,340	9,908
D-2	SNJK Keat Hwa	2,492	5,113
	SM Teknik, Alor Setar	1,157	2,375
	New Schools in the future plan		2,000
	Sub-total	3,649	9,488
E-1	SK Seberang Nyonya	1,355	2,781
	SRJK(C) Pej Shih, Kuala Kedah	639	1,312
	New Schools in the future plan	-	1,000
	Sub-total	1,994	5,093
Total		39,660	90,400



Note : Refer to Table D.15

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

LOCATIONS OF SCHOOLS | FIGURE D-2

6, Extraneous Water

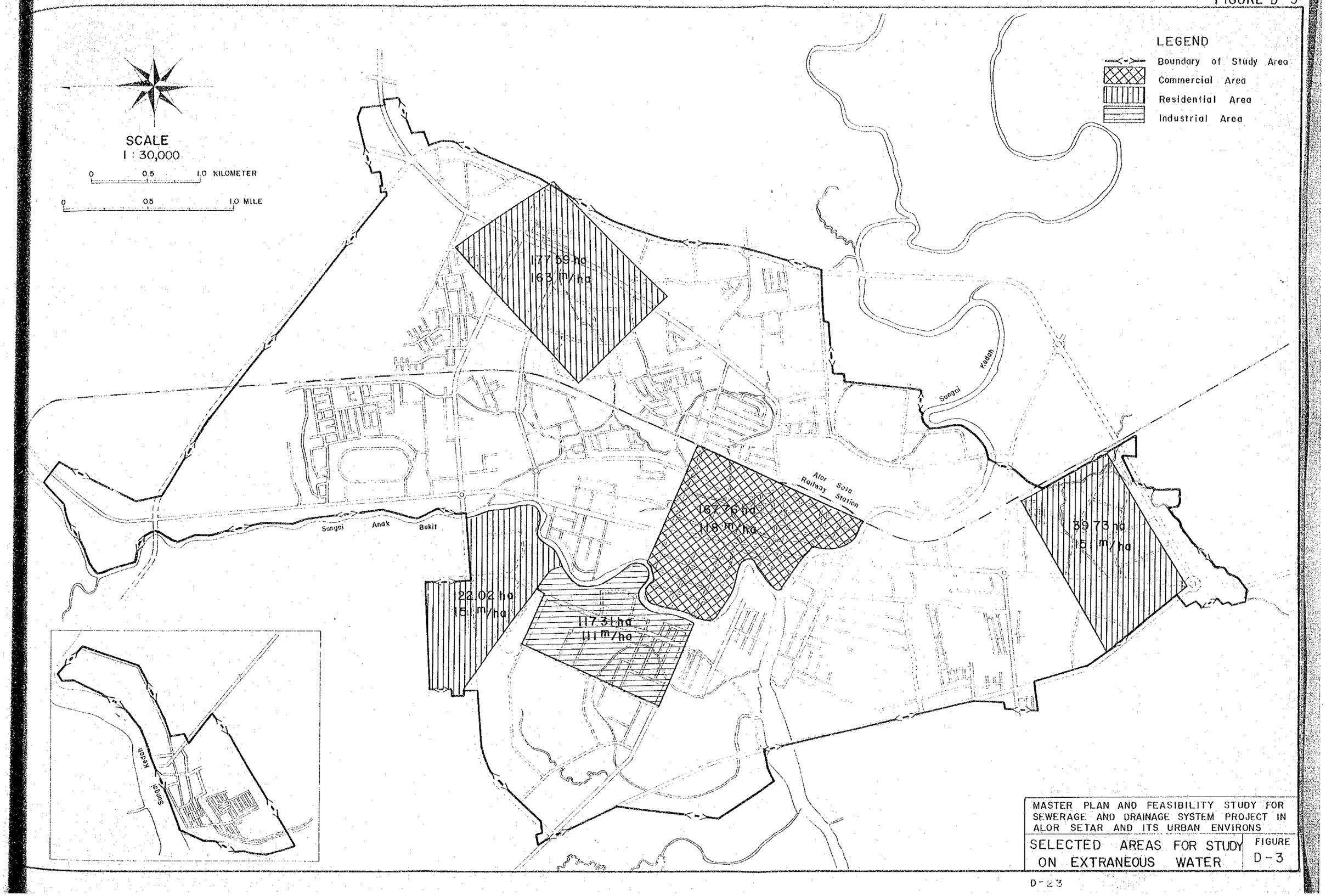
Although a sewerage system is intented to receive wastewater only, a certain amount of extraneous water is expected through incomplete pipe joints, cracks on sewers, and openings on manholes, etc., thus on infiltration allowance is necessary in designing sewer capacities. Since existing system is not available for estimating extraneous water within the Study Area, the allowances is assumed to be 0.045 m^3/day of sewer length based on similar city, Butterworth/Bukit Mertajam.

Typical areas representing residential, commercial and industrial areas are selected three places for residential, one place for commercial and industrial area respectively as shown in Figure D-3, to estimate average sewer length in unit of area.

Thus infiltration rates by land use is calculated as shown Table D-16.

Table D-16 Infiltration Allowances by Land Use

Land Use	Pipe Length* (m/ha)	Allowance (m^3/day/m)
Residential	151 ~ 163	6.3
Commercial	118	4.5
Industrial	111	4.5



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

SELECTED AREAS FOR STUDY ON EXTRANEOUS WATER

FIGURE D-3

7. Wastewater Quantities and Qualities Generated from Sewerage Zones and Sub-Zones in 1979 and 2000

Wastewater quantities generated from Sewerage Zones and Sub-Zones are calculated for the years 1979 and 2000 as shown in Tables D-17-1 and D-18-1, based on the relevant design values set out in Section 3 (Population Distributed into Sewerage Zones and Sub-Zones) and Section 4 (Wastewater Quantities and Qualities) in Chapter 5 of the main report and their relevant Appendices C and D.

Similarly, waste loads (BOD, SS) generated from Sewerage Zones and Sub-Zones are calculated in 1979 and 2000 as shown in Tables D-17-2, D-17-3, D-18-2 and D-18-3.

Table D-17-1

Wastewaters Generated from Sewerage Sub-Zones (1979)

Source of Wastewater / Sewerage Sub-Zones	Residential Area	Commercial Area	Institutional Area	School	Others	Industrial Area			Extraneous Water	Total (m^3/d)
						N. Mergong	S. Mergong	K. Kedah		
	m^3/cap	m^3/cap	m^3/cap	m^3/cap	m^3	m^3/ha	m^3/ha	m^3/ha	m^3/ha	
	0.17	0.34	0.023	0.0115		19.2	33.9	86.6	4.5, 6.3	
A - 1	15,112	-	-	6,172	-	-	-	-	385.0	
	2,569	-	-	71	418	-	-	-	2,426.0	5,484
A - 2	3,666	-	-	2,079	-	-	-	-	437.0	
	623	-	-	24	-	-	-	-	275.3	3,400
Sub-total	18,778	-	-	8,251	-	-	-	-	822.0	
	3,192	-	-	95	418	-	-	-	5,179.0	8,884
B - 1	24,629	21,000	3,000	13,524	-	-	-	-	343.0+116.0	
	4,187	7,140	690	155	8	-	-	-	2,683.0	14,863
B - 2	11,407	-	-	4,236	-	-	-	-	410.0	
	1,939	-	-	49	-	-	-	-	2,583.0	4,571
B - 3	1,243	-	-	1,165	-	-	-	-	102.0	
	211	-	-	13	-	-	-	-	643.0	867
Sub-total	37,279	21,000	3,000	18,925	-	-	-	-	971.0	
	6,387	7,140	690	217	8	-	-	-	5,909.0	20,301
C - 1	5,255	-	-	-	-	60.0	-	-	67.9+119.1	
	893	-	-	-	-	1,152	-	-	964.0	3,009
C - 2	2,897	-	-	2,501	-	-	-	-	357.1+69.9	
	492	-	-	29	-	-	-	-	2,564.0	3,085
Sub-total	8,152	-	-	2,501	-	60.0	-	-	614.0	
	1,385	-	-	29	-	1,152	-	-	3,528.0	6,094
D - 1	28,883	6,142	-	4,340	-	-	-	-	34.8 +40.0	
	4,910	2,088	-	50	-	-	-	-	2,372.0	9,420
D - 2	7,689	-	-	3,649	-	-	-	-	270.0	
	1,307	-	-	42	-	-	-	-	1,701.0	3,050
Sub-total	36,572	6,142	-	7,989	-	-	-	-	658.0	
	6,217	2,088	-	92	-	-	-	-	4,073.0	12,470
E	6,733	2,372	-	1,994	-	-	-	2.0	89.0 + 36.0	
	1,144	806	-	23	-	-	-	173	723.0	2,869
Sub-total	6,733	2,372	-	1,994	-	-	-	2.0	125.0	
	1,144	806	-	23	-	-	-	173	723.0	2,869
T o t a l	107,514	29,514	3,000	39,660	-	60.0	-	2.0	2809.0+381.0	
	18,275	10,034	690	456	426	1,152	-	173	19,412.0	50,618

Note: Figures in upper rows is sewerage Sub-Zones(15,112, 6,172 and 385 for residential, school and extraneous water columns respectively in case of Sewerage Sub-Zone A-1) refer to persons or ha, and similary figures in lower rows(2,569, 71, 418 and 2,426 for wastewater sources of residential, school, others and extraneous water columns respectively in case of the same Sub-Zone) refer to m^3/day.

Table D-17-2

Wastewater Loads (BOD) Generated from Sewerage Sub-Zones (1979)

Source of Wastewater / Sewerage Sub-Zones	Residential Area	Commercial Area	Institutional Area	School	Others	Industrial Area			Total	Av. Concentration (mg/ℓ)
						N. Mergong	S. Mergong	K. Kedah		
	mg/ℓ 200	mg/ℓ 200	mg/ℓ 200	mg/ℓ 200	mg/ℓ 200	mg/ℓ 60	m^3	mg/ℓ 2000		
A - 1	2,569.0	-	-	71.0	418.0	-	-	-	5,485.0	
	513.8	-	-	14.2	83.6	-	-	-	611.6	112
A - 2	623.0	-	-	24.0	-	-	-	-	3,400.0	
	124.6	-	-	4.8	-	-	-	-	129.4	38
Sub-total	3,192.0	-	-	95.0	418.0	-	-	-	8,884.0	
	638.4	-	-	19.0	83.6	-	-	-	741.0	83
B - 1	4,187.0	7,140.0	690.0	155.0	8.0	-	-	-	14,863.0	
	837.4	1,428.0	138.0	31.0	1.6	-	-	-	2,436.0	164
B - 2	1,939.0	-	-	49.0	-	-	-	-	4,571.0	
	387.8	-	-	9.8	-	-	-	-	397.0	88
B - 3	211.0	-	-	13.0	-	-	-	-	867.0	
	42.2	-	-	2.6	-	-	-	-	44.8	52
Sub-total	6,337.0	7,140.0	690.0	217.0	8.0	-	-	-	20,301.0	
	1,267.4	1,428.0	138.0	43.4	1.6	-	-	-	2,878.4	142
C - 1	893.0	-	-	-	-	1,152.0	-	-	3,009.0	
	178.6	-	-	-	-	69.1	-	-	247.7	82
C - 2	492.0	-	-	29.0	-	-	-	-	3,085.0	
	98.4	-	-	5.8	-	-	-	-	104.2	34
Sub-total	1,385.0	-	-	29.0	-	1,152.0	-	-	6,094.0	
	277.0	-	-	5.8	-	69.1	-	-	351.9	58
D - 1	4,910.0	2,088.0	-	50.0	-	-	-	-	9,420.0	
	982.0	417.6	-	10.0	-	-	-	-	1,409.6	150
D - 2	1,307.0	-	-	42.0	-	-	-	-	3,050.0	
	261.4	-	-	8.4	-	-	-	-	269.8	88
Sub-total	6,217.0	2,088.0	-	92.0	-	-	-	-	12,470.0	
	1,243.4	417.6	-	18.4	-	-	-	-	1,679.4	135
E	1,144.0	806.0	-	23.0	-	-	-	173.0	2,869.0	
	228.8	161.2	-	4.6	-	-	-	346.0	740.6	258
Sub-total	1,144.0	806.0	-	23.0	-	-	-	173.0	2,869.0	
	228.8	161.2	-	4.6	-	-	-	346.0	740.6	258
T o t a l	18,275.0	10,034.0	690.0	456.0	426.0	1,152.0	-	173.0	50,618.0	
	3,655.0	2,006.8	138.0	91.2	85.2	69.1	-	346.0	6,391.3	126

Note: Figures in upper rows in sewerage Sub-Zones (2,569, 71, 418 and 5,484 for residential, school, others and extraneous water columns respectively in case of Sewerage Sub-Zone A-1) refer to m^3/day, and similary figures in lower rows (513.8, 14.2, 83.6 and 611.6 for residential, school, others and extraneous water columns respectively in case of the same Sub-Zone) refer to Kg/day.

Table D-17-3

Wastewater Loads (SS) Generated from Sewerage Sub-Zone (1979)

Source of Wastewater / Sewerage Sub-Zones	Residential Area	Commercial Area	Institutional Area	School	Others	Industrial Area			Total	Av. Concentration (mg/ℓ)
						N. Mergong	S. Mergong	K. Kedah		
	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	m^3	mg/ℓ		
	200	200	200	200	200	100	-	500		
A - 1	2,569.0	-	-	71.0	418.0	-	-	-	5,484.0	
	513.8	-	-	14.2	83.6	-	-	-	611.6	112
A - 2	623.0	-	-	24.0	-		-	-	3,400.0	
	124.6	-	-	4.8	-	-	-	-	129.4	38
Sub-total	3,192.0	-	-	95.0	418.0	-	-	-	8,884.0	
	638.4	-	-	19.0	83.6	-	-	-	741.0	83
B - 1	4,187.0	7,140.0	690.0	155.0	8.0	-	-	-	14,863.0	
	837.4	1,428.0	138.0	31.0	1.6	-	-	-	2,436.0	164
B - 2	1,939.0	-	-	49.0	-	-	-	-	4,571.0	
	387.8	-	-	9.8	-	-	-	-	397.6	88
B - 3	211.0	-	-	13.0	-	-	-	-	867.0	
	42.2	-	-	2.6	-	-	-	-	44.8	52
Sub-total	6,337.0	7,140.0	690.0	217.0	8.0	-	-	-	20,301.0	
	1,267.4	1,428.0	138.0	43.4	1.6	-	-	-	2,878.4	142
C - 1	893.0	-	-	-	-	1,152.0	-	-	3,009.0	
	178.6	-	-	-	-	115.2	-	-	293.8	98
C - 2	492.0	-	-	29.0	-	-	-	-	3,085.0	
	98.4	-	-	5.8	-	-	-	-	104.2	35
Sub-total	1,385.0	-	-	29.0	-	1,152.0	-	-	6,094.0	
	277.0	-	-	5.8	-	115.2	-	-	398.0	65
D - 1	4,910.0	2,088,0	-	50.0	-	-	-	-	9,420.0	
	982.0	417.6	-	10.0	-	-	-	-	1,409.6	150
D - 2	1,307.0	-	-	42.0	-	-	-	-	3,050.0	
	261.4	-	-	8.4	-	-	-	-	269.8	88
Sub-total	6,217.0	2,088.0	-	92.0	-	-	-	-	12,470.0	
	1,243.4	417.6	-	18.4	-	-	-	-	1,679.4	135
E	1,144.0	806.0	-	23.0	-	-	-	173.0	2,869.0	
	228.8	161.2	-	4.6	-	-	-	86.5	481.1	168
Sub-total	1,144.0	806.0	-	23.0	-	-	-	173.0	2,869.0	
	228.8	161.2	-	4.6	-	-	-	86.5	481.1	168
T o t a l	18,275.0	10,034.0	690.0	456.0	426.0	1,152.0	-	173.0	50,618.0	
	3,655.9	2,006.8	138.0	91.2	85.2	115.2	-	86.5	6,177.9	122

Note: Figures in upper rows in sewerage Sub-Zones (2,569, 71, 418 and 5,484 for residential, school, others and extraneous water columns respectively in case of Sewerage Sub-Zone A-1) refer to m^3/day, and similary figures in lower rows (513.8, 14.2, 83.6 and 611.6 for residential, school, others and extraneous water columns respectively in case of the same Sub-Zone) refer to Kg/day.

Table D-18-1

Wastewaters Generated from Sewerage Sub-Zones (2000)

Source of Wastewater / Sewerage Sub-Zones	Residential Area	Commercial Area	Institutional Area	School	Others	Industrial Area			Extraneous Water	Total
						N. Mergong	S. Mergong	K. Kedah		
	m^3/cap 0.23	m^3/cap 0.46	m^3/cap 0.023	m^3/cap 0.0115	m^3	m^3/ha 19.2	m^3/ha 33.9	m^3/ha 86.6	m^3/ha 4.5, 6.3	(m^3/d)
A - 1	29,674	-	-	14,668	-	-	-	-	385.0	
	6,825	-	-	169	598	-	-	-	2,426.0	10,018
A - 2	37,980	-	-	5,267	-	-	-	-	437.0	
	8,735	-	-	61	-	-	-	-	2,753.0	11,549
Sub-total	67,654	-	-	19,935	-	-	-	-	822.0	
	15,560	-	-	230	598	-	-	-	5,179.0	21,567
B - 1	31,010	23,200	12,000	27,758	-	-	-	-	343.0+116.0	
	7,132	10,672	276	319	12	-	-	-	2,683.0	21,094
B - 2	40,738	-	-	9,694	-	-	-	-	410.0	
	9,370	-	-	112	-	-	-	-	2,583.0	12,065
B - 3	11,148	-	-	2,391	-	-	-	-	102.0	
	2,564	-	-	27	-	-	-	-	643.0	3,234
Sub-total	82,896	23,200	12,000	39,843	-	-	-	-	971.0	
	19,066	10,672	276	458	12	-	-	-	5,909.0	36,393
C - 1	9,548	-	-	-	-	119.1	-	-	67.9+119.1	
	2,196	-	-	-	-	2,287.0	-	-	964.0	5,447
C - 2	30,994	-	-	6,133	-	26.9	43.0	-	357.1+69.9	
	7,129	-	-	71	-	516.0	1,458.0	-	2,564.0	11,738
Sub-total	40,542	-	-	6,133	-	146.0	43.0	-	614.0	
	9,325	-	-	71	-	2,803.0	1,458.0	-	3,528.0	17,185
D - 1	38,520	8,000	-	9,908	-	-	-	-	348.0+ 40.0	
	8,860	3,680	-	114	-	-	-	-	2,372.0	15,026
D - 2	29,952	-	-	9,488	-	-	-	-	270.0	
	6,889	-	-	109	-	-	-	-	1,701.0	8,699
Sub-total	68,472	8,000	-	19,396	-	-	-	-	658.0	
	15,749	3,680	-	223	-	-	-	-	407.3	23,725
E	9,336	3,600	-	5,093	-	-	-	18.0	89.0+ 36.0	
	2,147	1,656	-	59	-	-	-	1,559.0	723.0	6,144
Sub-total	9,336	3,600	-	5,093	-	-	-	18.0	125.0	
	2,147	1,656	-	59	-	-	-	1,559.0	723.0	6,144
T o t a l	268,900	34,800	12,000	90,400	-	146.0	43.0	18.0	3,190.0	
	61,847	16,008	276	1,041	610	2,803.0	1,458.0	1,559.0	19,412.0	105,014

Note: Figures in upper rows in sewerage Sub-Zones (29,674, 14,668 and 385 for residential, school and extraneous water columns respectively in case of Sewerage Sub-Zone A-1), refer to persons or ha, and similary figures in lower rows (6,825, 169, 598 and 2,426 for residental, school, others and extraneous water columns respectively in case of the same Sub-Zone) refer to m^3/day.

Table D-18-2

Wastewater Loads (BOD) Generated from Sewerage Sub-Zones (2000)

Source of Wastewater / Sewerage Sub-Zones	Residential Area	Commercial Area	Institutional Area	School	Others	Industrial Area			Total	Av. Concentration (mg/ℓ)
						N. Mergong	S. Mergong	K. Kedah		
	mg/ℓ 200	mg/ℓ 200	mg/ℓ 200	mg/ℓ 200	mg/ℓ 200	mg/ℓ 60	mg/ℓ 280	mg/ℓ 2000		
A - 1	6,825.0	-	-	169.0	598.0	-	-	-	10,018.0	
	1,365.0	-	-	33.8	119.6	-	-	-	1,518.4	152
A - 2	8,735.0	-	-	61.0	-	-	-	-	11,549.0	
	1,747.0	-	-	12.2	-	-	-	-	1,759.2	152
Sub-total	15,560.0	-	-	230.0	598.0	-	-	-	21,567.2	
	3,112.0	-	-	46.0	119.6	-	-	-	3,277.6	152
B - 1	7,132.0	10,672.0	276.0	319.0	12.0	-	-	-	21,094.0	
	1,462.4	2,134.4	55.2	63.8	2.4	-	-	-	3,682.2	175
B - 2	9,370.0	-	-	11.2	-	-	-	-	12,065.0	
	1,874.0	-	-	22.4	-	-	-	-	1,896.4	157
B - 3	2,564.0	-	-	27.0	-	-	-	-	3,234.0	
	512.8	-	-	5.4	-	-	-	-	518.2	160
Sub-total	19,066.0	10,672.0	276.0	458.0	12.0	-	-	-	36,393.0	
	3,813.2	2,134.4	55.2	91.6	2.4	-	-	-	6,096.8	168
C - 1	2,196.0	-	-	-	-	2,287.0	-	-	5,447.0	
	439.2	-	-	-	-	137.2	-	-	576.4	106
C - 2	7,129.0	-	-	71.0	-	516.0	1,458.0	-	11,738.0	
	1,425.8	-	-	14.2	-	31.0	408.2	-	1,879.2	160
Sub-total	9,325.0	-	-	71.0	-	2,803.0	1,458.0	-	17,185.0	
	1,865.0	-	-	14.2	-	168.2	408.2	-	2,455.6	143
D - 1	8,860.0	3,680.0	-	114.0	-	-	-	-	15,026.0	
	1,772.0	736.0	-	22.8	-	-	-	-	2,530.8	168
D - 2	6,889.0	-	-	109.0	-	-	-	-	8,699.0	
	1,377.8	-	-	21.8	-	-	-	-	1,399.6	161
Sub-total	15,749.0	3,680.0	-	223.0	-		-	-	23,725.0	
	3,149.8	736.0	-	44.6	-	-	-	-	3,930.4	166
E	2,147.0	1,656.0	-	59.0	-	-	-	1,559.0	6,144.0	
	429.4	331.2	-	11.8	-	-	-	3,118.0	3,890.4	633
Sub-total	2,147.0	1,656.0	-	59.0	-	-	-	1,559.0	6,144.0	
	429.4	331.2	-	11.8	-	-	-	3,118.0	3,890.4	633
T o t a l	61,847.0	16,008.0	276.0	1,041.0	610.0	2,803.0	1,458.0	1,559.0	105,014.0	
	12,369.4	3,201.6	55.2	208.2	122.0	168.2	408.2	3,118.0	19,650.8	187

Notice: Figures in upper rows in sewerage sub-Zones (6,825, 169, 598 and 10,018 for residential, school, others and extraneous water columns respectively in case of Sewerage Sub-Zone A-1) refer to m3/day, and similary figures in lower rows (1,365.0, 33.8 119.6 and 1,518.4 for residential, school, others and extraneous water columns respectively in case of the same Sub-Zone) refer to Kg/day.

Table D-18-3

Wastewater Loads (SS) Generated from Sewerage Sub-Zone (2000)

Source of Wastewater / Sewerage Sub-Zones	Residential Area	Commercial Area	Institutional Area	School	Others	Industrial Area			Extraneous Water	Av. Concentration (mg/ℓ)
						N. Mergong	S. Mergong	K. Kedah		
	200 mg/ℓ	200 mg/ℓ	200 mg/ℓ	200 mg/ℓ	200 mg/ℓ	100 mg/ℓ	270 mg/ℓ	500 mg/ℓ		
A - 1	6,825.0	-	-	169.0	598.0	-	-	-	10,018.0	
	1,365.0	-	-	33.8	119.6	-	-	-	1,518.4	152
A - 2	8,735.0	-	-	61.0	-	-	-	-	11,549.0	
	1,747.0	-	-	12.2	-	-	-	-	1,759.2	152
Sub-total	15,560.0	-	-	230.0	598.0	-	-	-	21,567.0	
	3,112.0	-	-	46.0	119.6	-	-	-	3,277.6	152
B - 1	7,132.0	10,672.0	276.0	319.0	12.0	-	-	-	21,094.0	
	1,426.4	2,134.4	55.2	63.8	2.4	-	-	-	3,682.2	175
B - 2	2,564.0	-	-	27.0	-	-	-	-	3,234.0	
	512.8	-	-	5.4	-	-	-	-	518.2	160
B - 3	9,370.0	-	-	112.0	-	-	-	-	12,065.0	
	1,874.0	-	-	22.4	-	-	-	-	1,896.4	157
Sub-total	19,066.0	10,672.0	276.0	458.0	12.0	-	-	-	36,393.0	
	3,813.2	2,134.4	55.2	91.6	2.4	-	-	-	6,096.8	168
C - 1	2,196.0	-	-	-	-	2,287.0	-	-	5,447.0	
	439.2	-	-	-	-	228.7	-	-	667.9	123
C - 2	7,129.0	-	-	71.0	-	516.0	1,458.0	-	11,738.0	
	1,425.8	-	-	14.2	-	51.6	393.7	-	1,885.3	161
Sub-total	9,325.0	-	-	71.0	-	2,803.0	1,458.0	-	17,185.0	
	1,865.0	-	-	14.2	-	280.3	393.7	-	2,553.2	149
D - 1	8,860.0	3,680.0	-	114.0	-	-	-	-	15,026.0	
	1,772.0	736.0	-	22.8	-	-	-	-	2,530.8	168
D - 2	6,889.0	-	-	109.0	-	-	-	-	8,699.0	
	1,377.8	-	-	21.8	-	-	-	-	1,399.6	161
Sub-total	15,749.0	368.0	-	223.0	-	-	-	-	23,725.0	
	3,149.8	736.0	-	44.6	-	-	-	-	3,930.4	166
E	2,147.0	1,656.0	-	59.0	-	-	-	1,559.0	6,144.0	
	429.4	331.2	-	11.8	-	-	-	779.5	1,551.9	253
Sub-total	2,147.0	1,656.0	-	59.0	-	-	-	1,559.0	6,144.0	
	429.4	331.2	-	11.8	-	-	-	779.5	1,551.9	253
T o t a l	61,847.0	16,008.0	276.0	1,041.0	610.0	2,803.0	1,458.0	1,559.0	105,014.0	
	12,369.4	3,201.6	55.2	208.2	122.0	280.3	393.7	779.5	17,409.9	166

Note: Figures in upper rows in sewerage Sub-Zones (6,825.0, 169.0, 598 and 10,018.0 for residential, school, others and extraneous water columns respectively in case of Sewerage Sub-Zone A-1) refer to m^3/day, and similary figures in lower rows (1,365.0, 33.8, 119.6 and 1,518.4 for residential, school, others and extraneous water columns respectively in case of the same Sub-Zone) refer to Kg/day.

APPENDIX E

ALTERNATIVE SEWERAGE SYSTEM CONSIDERED

1. Conveyance Network

Initially, for several reasons as described in Chapter 5. Sewerage Master Plan Report, the entire Study Area was divided into five sewerage zones. Then, several cases of conveyance networks were studied on a preliminary basis, considering topographical and economic aspects both for present and future conditions.

The conveyance networks should be established in each sewerage zone independently, to avoid high initial investment due to construction of long conveyance system to collect sewage of wide area, and to be flexible for future development program.

2. Sewage Treatment and Disposal System

2.1 General

Sewage treatment facility improves raw waste water into an allowable final effluent. It is, therefore, fundamental first to estimate the characteristics of the raw waste water and the required degree of the effluent or the required treatment, before proceeding to the design of treatment facilities.

In the design of treatment faiclities of the Study Area, it is necessary to determine the most desirable treatment system among the vrious methods, to meet the degree of the required effluent as set-out in Section 5, Chapter 5 of main text for economical analysis.

This section deals briefly with alternative methods of treatment system such as stabilization pond, aerated lagoon and oxidation ditch, and recommendation is made for the desirable treatment method from both the technical and economical viewpoint.

2.2 Alternative Methods of Treatment

2.2.1 Stabilization Pond

Stabilization pond has been successfully used in many countries, which is sometimes referred as "oxidation pond" or "lagoon".

They are recognized as a means of sewage treatment and have considerable advantages particularly as regards to the costs and maintenance requirements and the removal of faecal bacteria.

They are the most economical method of sewage treatment in hot climates where sufficient land is available and where the temperature is most favourable for their operation, and land is available in reasonable cost.

On the basis of operational condition, the stabilization ponds are classified into three types, namely, aerobic, faclutative and anaerobic pond. Among them, since aerobic type requires large land area and anaerobic type emits bad odour, facultative pond described below will be the most appropriate type in the Study Area.

a) Facultative Pond

Facultative pond is the system in which the upper layers of the pond are aerobic and the bottom layers are either devoid of dissolved oxygen or are anaerobic. At present most of the existing waste stabilization pond installations are of the facultative type.

The facultative pond is oxygenated principally by the photosynthetic activity of algae under the influence of solar radiation, although in the larger ponds surface aeration by the wind action contributes significantly to the total oxygen budget.

The dissolved oxygen concentration is greater during daylight period than at night. The measurement of oxidation-reduction potential will show the tendency towards either aerobic or anaerobic conditions.

For the facultative pond, temperature is of great importance because it affects the rate of biochemical degradation. The average, daily fluctuations, and yearly variations of temperature influence the biological, physical and chemical processes in the pond.

The practical design of a facultative pond depends on difference of local conditions, but a number of useful and rational design procedures are available. The most important factors on stabilization pond design are areal load of BOD and depth of the pond. On the basis of the Penang sewage treatment plant

operation, 300 kg-BOD/day/ha(*1) of surface area and 1.5m of pond depth is proposed for this study. This corresponds to 10 days of mean detention time.

b) Maturation Pond

The main purpose of maturation pond is to provide a high-quality effluent which is used as a second stage to facultative pond. The principal factor for the design of the maturation pond is detention time, but for efficient reduction of the faecal bacteria,it is essential that the pond be arranged in series with the preceding pond. The detention time in the maturation pond, as well as the number of ponds, is determined primarily by the degree of bacterial reduction required. In design of maturation pond the reduction of faecal coliform in a pond has been found to follow first order kinetics. The appropriate equation is as follows.

(*1) Ref. "Master Plan for Sewarage and Drainage System Project, Butterworth/Bukit Mertajam Metropolitan Area", by NSC

$$Ne = \frac{Ni}{1 + K_{b(t)}T}$$

$$K_{b(t)} = 2.6\ (1.19)^{t-20}$$

where

Ne	:	effluent coliform, cells/ml
Ni	:	influent coliforms, cells/ml
$K_{b(t)}$	:	dieoff coefficient of coliforms at t°C, 1/day
T	:	detention time, days

From the above mentioned equation, the estimated number of effluent coliform from facultative pond (Ne) is 4,500/ml, assuming

Ni = 4×10^5/ml, $K_{b(27)} = 8.8\ d^{-1}$, and T = 10 days.

This value (Ne = 4,500/ml) is unsatisfied on sanitary aspects, so that the facultative pond should be followed by a maturation pond (detention time is 3 days) for further reduction of coliforms.

That is

$$Ne = \frac{4 \times 10^5}{(1 + 8.8 \times 10)\quad (1 + 8.8 \times 3)} = 164/ml$$

This can be satisfied for environmental protection from coliform contamination by treatment plant effluent.

2.2.2. Aerated Lagoon

The aerated laggon is an activated sludge unit operated without sludge return. This is historically developed from stabilization pond.

Low cost mechanical aeration is the most important matter to be a useful engineering alternative in cases that waste loads increase, land is limited, and high-quality effluent is required. Commonly, floating aerator for surface aeration is used to supply the necessary oxygen and for mixing lagoon contents.

In common with all activated sludge systems, aerated lagoon is not particularly effective in removing faecal coliforms and syspended solids. Faecal coliform reduction is only 90-95 percent and further treatment, that is maturation pond may, therefore, be necessary.

For the design of aerated lagoon in this study, the detention time is assumed as 4 days and the depth of lagoon is assumed at 3.0 m.

Oxidation Ditch

The oxidation ditch is a modification of the activated sludge process, generally followed by sedimentation basin except for small size plant. The oxidation ditch is a long continuous channel usually oval in plan and 1.0 - 1.5 m deep. The ditch liquor is aerated by one or more brush or rotors placed across the channel.

At present, there are few oxidation ditches exist in the hot climate due to the fact that stabilization ponds are usually more favourable both in terms of cost and the removal of faecal coliform.

A design of oxidation ditch is purely empirical at the present time. According to the Mara report(*1), the depth is in the range of 1 - 2 m and the volume is dependent on the detention time which in turn is based on the sludge loading factor. This is the weight of BOD applied to the ditch liquor suspended solids per day.

Therefore, the sludge loading factor is given by following equation.

$$r = \frac{Li}{St}$$

where

r = sludge loading factor, 1/d

Li = influent BOD, mg/l

S = ditch liquor suspended solids, mg/l

t = detention time, days

Then, ditch volume is estimated as follow.

$$V = \frac{LiQ}{Sr}$$

Where

V = ditch volume, cu m

Q = flow rate, cu m/day

The design values of this study are taken as $r = 0.1\ d^{-1}$, S = 4,000 mg/l, t = 0.5 days, and depth is assumed at 1.5 m.

(*1) "Sewage Treatment in Hot Climate", by Duncan Mara

3.3 Comparison of Alternative Treatment and Dsiposal Systems

For the purpose of cost comparison of alternative treatment and disposal systems for the (1) stabilization pond, (2) aerated lagoon and (3) oxidation ditch, firstly each type of treatment facilities was designed for varying daily average flow rate of wastewater for 5,000, 10,000, 30,000 and 50,000 m^3 respectively.

The wastewater quality of each treatment was estimated with the influent BOD of 200 mg/l and that the expected BOD removal is of 75 percent of influent BOD.

The all types of treatment were analyzed as to costs accruing to alternatives considered. Each type of methods of treatment and disposal systems for alternative study are described below and illustrated in Figures E-1, E-2, E-3 and E-4.

1) Stabilization pond process shall consist of the facultative and maturation ponds in series.

2) Aerated lagoon process shall consist of the aerated lagoon and maturation pond in series.

3) Oxidation ditch process shall consist of oxidation ditch, sedimentation basin, and sludge drying bed.

The capital costs of the each selected alternative of sewage treatment plant on the flow varying rates from 5,000 m^3 to 50,000 m^3 (daily average flow) are estimated on the basis of cost functions developed for the purpose of Master Plan and also annual operation and maintenance costs for these facilities are estimated as discussed in Appendix G.

Table E-1 shows the estimation of construction, operation and maintenance costs of the treatment and disposal systems and land acquisition cost for the system. All costs are at 1979 price level in the Study Area, but no consideration is given to cost escalation for purpose of economic comparison among alternatives.

For comparison purpose, all costs are then expressed on an annual basis, using the following weighted average useful lives of facilities.

(a)	pond, basin	30 years
(b)	pump, aerator	7 years

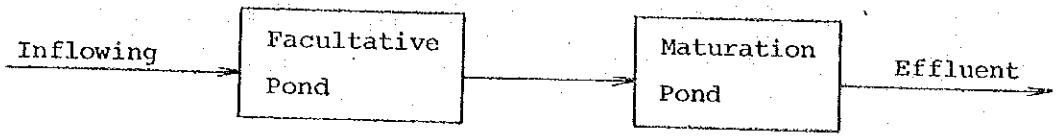
Overall useful life is estimated on the basis of the useful composite lives of facilities, 30 years for civil works and 7 years for machinery and other equipment. It is assumed that the fund is available at 10 percent interest rate and that annual depreciation payments into the sinking fund would grow the same rate.

Depreciated capital costs of the alternative systems are summarized in Table E-2, annual costs incurred by the interest in Table E-3 and total annual costs for the alternatives shown in Table E-4.

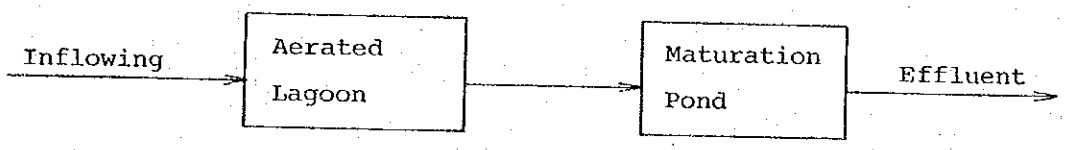
The results of cost analysis indicate that alternative (i) (stabilization pond process) is the most economical method for treatment and disposal system, in terms of total annual cost.

FIGURE E-1 Flow sheet

(1) Stabilization pond process



(2) Aerated lagoon process



(3) Oxidation ditch process

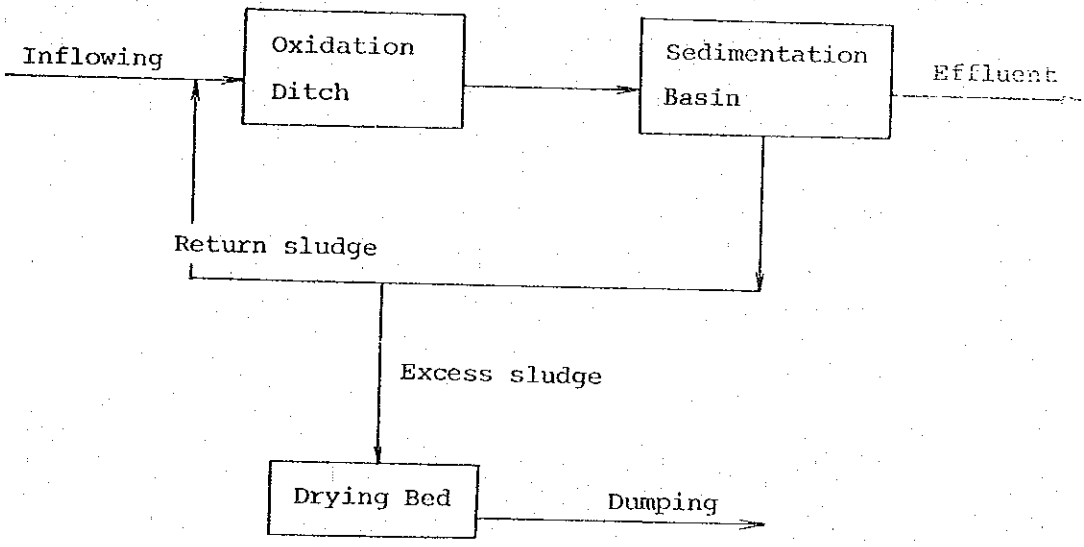


Table E-1 Cost Incurred by Alternative Treatment Systems

(1979 Price Level)

Alternative	Flow Rate (m^3/day) 5,000	10,000	30,000	50,000
1) Construction Costs (M$1,000)				
Alt. I				
Stabilization Pond Process	705	1,062	3,722	5,881
Alt. II				
Aerated Lagoon Process	852	1,579	3,629	5,672
Alt. III				
Oxidation Ditch Process	1,229	2,348	6,367	10,738
2) O & M Cost (M$1,000/year)				
Alt. I				
Stabilization Pond Process	21.65	25.59	54.01	77.06
Alt. II				
Aerated Lagoon Process	57.13	98.77	252.69	359.48
Alt. III				
Oxidation Ditch Process	109.98	203.42	561.18	918.30
3) Land Acquisition Cost (M$1,000)				
Alt. I	31.21	58.28	162.34	275.56
Alt. II	22.23	41.36	99.45	134.23
Alt. III	5.64	7.99	22.09	34.31

Note: Land acquisition costs are estimated by applying the average land value of M$4,700 per ha for the proposed locations of entire treatment facilities.

Table E-2

* Annually Depreciated Costs for Alternative Treatment Systems

(M$1,000)

Alternative	Flow Rate (m^3/day)			
	5,000	10,000	30,000	50,000
Alt. I				
Stabilization Pond Process	4.29	6.46	22.63	35.76
Alt. II				
Aerated Lagoon Process	9.63	17.84	41.01	55.73
Alt. III				
Oxidation Ditch Process	34.19	65.32	177.13	298.73

* Calculated by sinking fund method applying 10% interest rate.

Table E-3

* Annual Cost Incurred by Interest

(M$1,000)

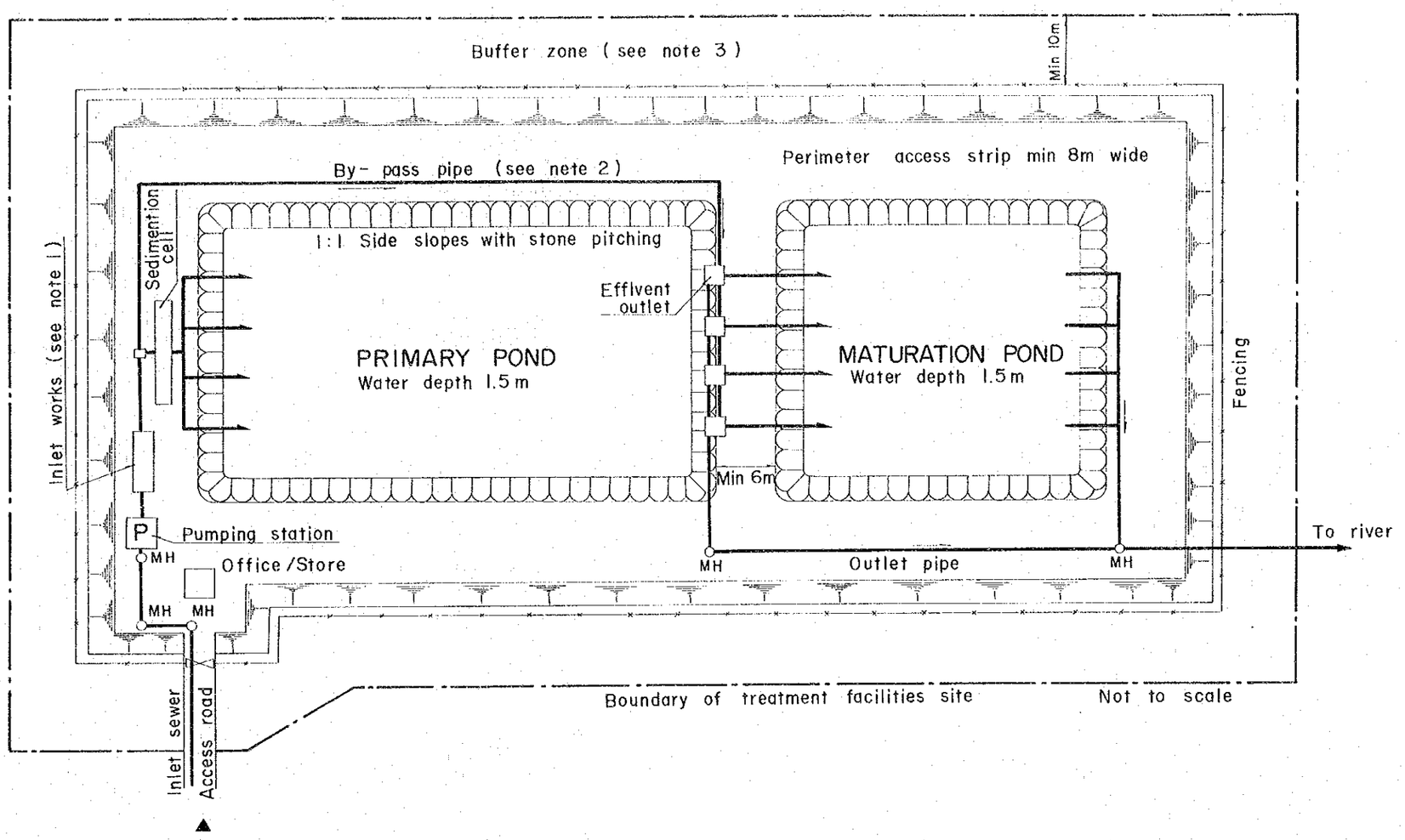
Alternative	Flow Rate (m3/day)			
	5,000	10,000	30,000	50,000
Alt. I	428.40	636.14	2260.30	3500.26
Alt. II	508.71	942.89	2169.59	3378.65
Alt. III	718.44	1370.95	3717.81	6268.41

Note: * based on construction costs and land acquisition cost for alternative treatment systems. It was assumed that construction for civil and architectural works, installation for electrical and mechanical works, and land acquisition would be implemented at first year of each 5 years by a half of total capital investment cost during 10 years.

Table E-4

Total Annual Cost for Treatment Systems by Alternatives

Alternative	(M$1,000)			
	5,000	10,000	30,000	50,000
Alt. I				
Stabilization Pond Process	454.34	668.19	2,336.94	3,613.08
Alt. II				
Aerated Lagoon Process	575.47	1,059.50	2,463.29	3,793.86
Alt. III				
Oxidation Ditch Process	862.61	1,639.69	4,456.12	7,485.44



Notes

(1) Inlet works
- Flume
- Flow recorder & recorder house

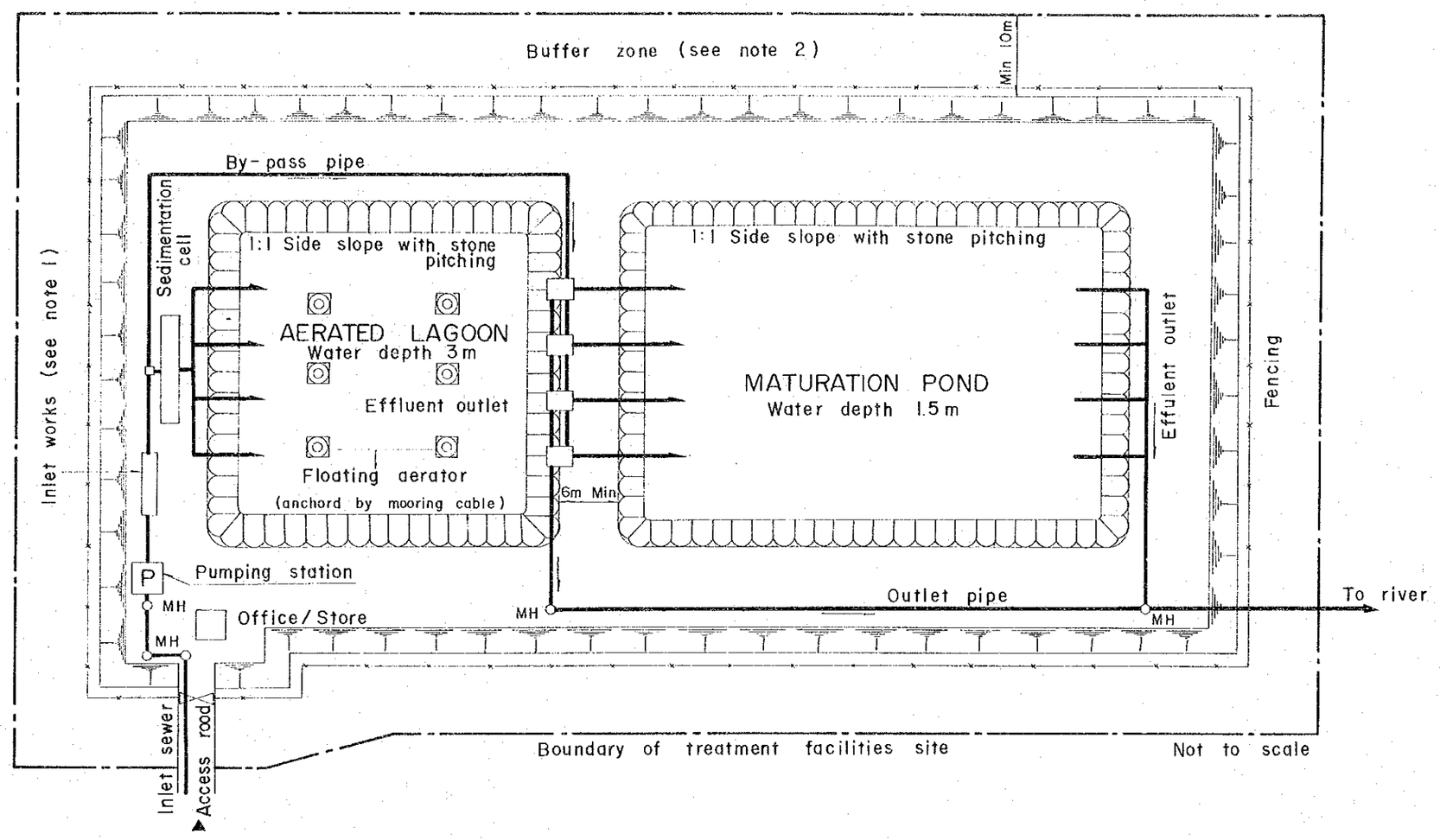
(2) By-pass pipe can be used for purpose of cleaning out primary pond and alternative operation of ponds in parallel.

(3) Buffer zone is not required if either existing river or road reserve is equal to or greater than 10m width

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

TYPICAL LAYOUT OF STABILIZATION POND PROCESS

FIGURE E - 2



Notes

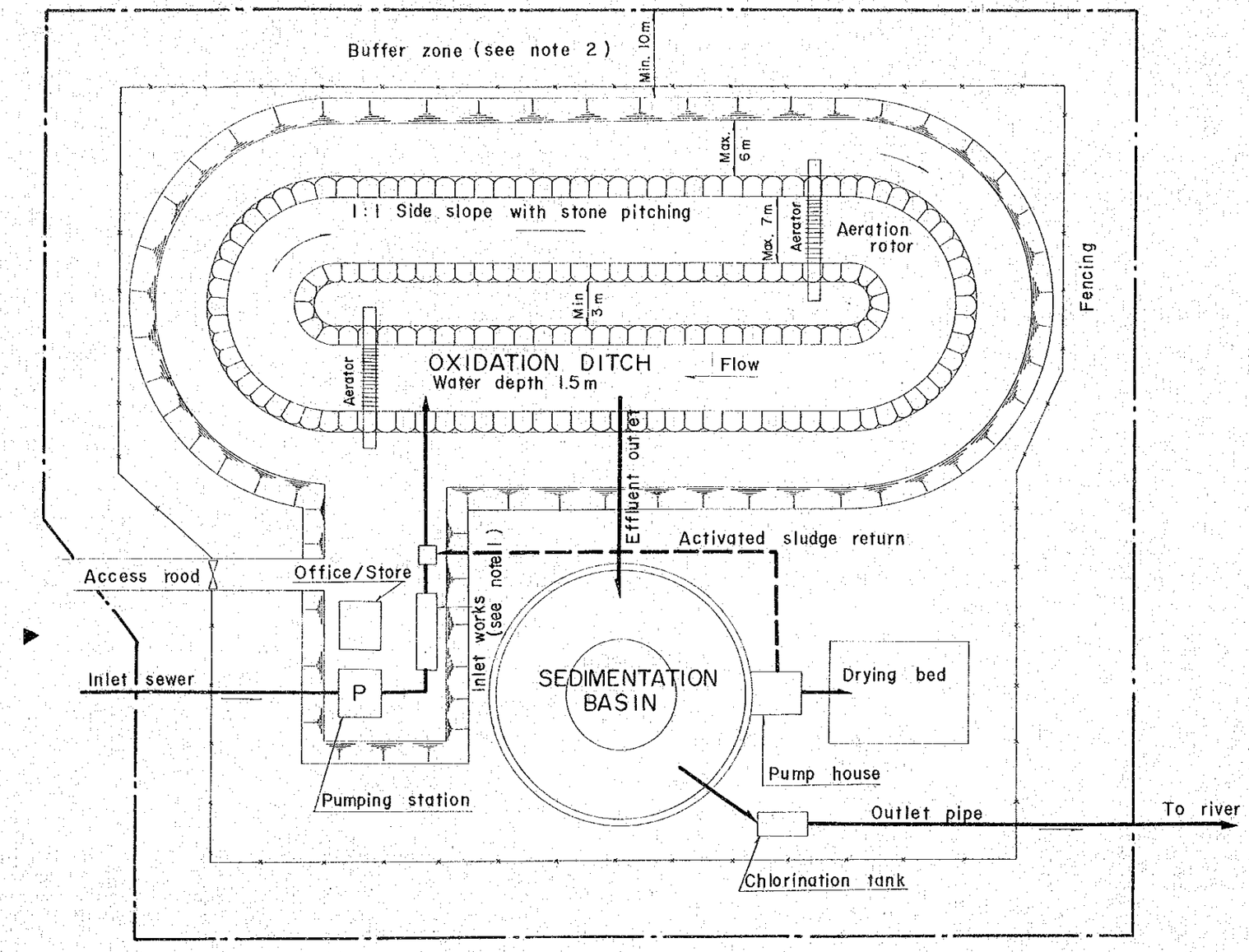
(1) Inlet works
- Flume
- Flow recorder & recorder house

(2) Buffer zone is not required if either existing river or road reserve is equal to or greater than 10m width

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

TYPICAL LAYOUT OF AERATED RAGOON PROCESS

FIGURE E-3



Notes

(1) Inlet works
- Grit channel
- Flume
- Flow recorder & recorder house

(2) Buffer zone is not required if either existing river or road reserve is equal to or greater than 10m width

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS	
TYPICAL LAYOUT OF OXIDATION DITCH PROCESS	FIGURE E-4