6.2 Water Quality

(1) Water Quality

The location and result of water quality analysis, which was carried out in the river and sea area near the candidate site in Pantai Acheh, is shown in Fig. 6-4, Table 6-5 and Table 6-6. The Proposed Interim National Water Quality Standards for Malaysia, which is used for the evaluation of water quality, is shown in Table 6-7.

Though this standard is prepared for fresh water, it will be applied as means of reference in the evaluation for sea water qualities in this report.

According to the result of water quality survey conducted in 1982 ~ 1983 shown in Table 6-6, water pollution concentrations at Station 3 in Sungai Pinang have 5 out of the 8 parameters measured which exceed the Standards Class IV of the proposed Interim Water Quality Standards. The 5 parameters are listed below:

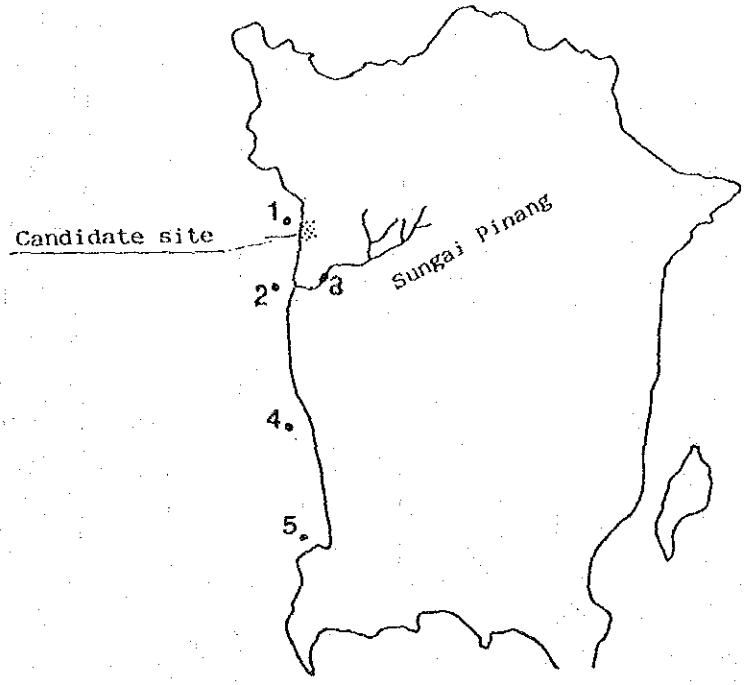
Parameters	Water Quality	Standards
BOD	53	12
COD	218	100
Total suspended solids	3654	300
F. Coliform	3.8×10^5	5.0×10^3
Total coliform	4.9×10^5	5.0×10^4

Water quality of Station 1 in Pantai Acheh, Station 2 in the sea near the mouth of Sungai Pinang, Station 4 in Bagan Air Itam and Station 5 in Pulau Betong is below the standard set in Class IV. The water quality survey done between 1987 and 1988, shows one datum of which the BOD is obtained. There has been no COD analysed.

Table 6-6 shows that almost all parameter indices are below the Class IV standards, except some indices from Station 1 and Station 2.

Judging from the DO and Fecal Coliform indices, it can be deduced that the water pollution has gradually increased since 1983.

Table 6-9 shows the result of the water analysis conducted in the Pantai Acheh area by the JICA Study Team. The levels of all items, excluding total suspended solid and total coliform, are below the proposed standards. In particular, the high concentration of total suspended solid is due to the shallow water depth of the sampling points (0.3 - 0.6 m) and the fine silty bottom mud.



ST1: Pantai Acheh
ST2: Sungai Pinang (Sea)
ST3: Sungai Pinang (River)
ST4: Bagan Air Itam
ST5: Pulau Betong

Fig. 6-4 Water Sampling Stations near Pantai Acheh

Table 6-6 Results of Water Quality Analysis from 5 Stations near Pantai Acheh

PARAMETERS (UNITS) \ ST.		1	2	3	4	5
Ammoniacal Nitrogen	mg/L	0.27	0.20	1.08	0.30	0.08
BOD	mg/L	2	2	53	1	1
COD	mg/L	34	77	218	25	35
DO	mg/L	5.7	5.5	5.3	5.7	5.9
pH		7.7	7.5	7.0	7.3	7.7
Colour	TCU	-	-	-	-	-
Elect. Cond.	umhos/cm	-	-	-	-	-
Floatables		-	-	-	-	-
Odour		-	-	-	-	-
Salinity	o/oo	-	-	-	-	-
Taste						
Total Diss. Solid	mg/L	-	-	-	-	-
Total Susp. Solid	mg/L	239	216	3654	370	195
Temperature	°C	-	-	-	-	-
Turbidity	NTU	-	-	-	-	-
F. Colif.	counts/ 100mL	2.1×10^{3}	2.9×10^{3}	3.8×10^{5}	7.1×10^{3}	4.8×10
Tot. Colif.	counts/ 100mL	-	-	4.9×10^{5}	-	-

Aug. 1982 ~ Jan. 1983

ST1: Pantai Acheh
ST2: Sungai Pinang (Sea)
ST3: Sungai Pinang (River)
ST4: Bagan Air Itam
ST5: Pulau Betong

Table 6-7 Results of Water Quality Analysis from Station 1 & 2

PARAMETERS	Date	5 Feb 87		17 Jun 87		24 Sept 87		17 Nov 87		9 Feb 88		9 Mar 88		6 Jun 88		21 Sept 88	
	ST. / (units)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Ammonical Nitrogen	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD	mg/L	-	-	-	-	-	-	-	-	-	-	7.5	-	-	-	-	-
COD	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DO	mg/L	5.2	3.2	4.4	3.5	3.8	4.5	3.8	4.0	-	4.6	-	4.0	-	4.0	-	-
pH		7.5	7.6	6.34	5.97	6.01	7.36	7.37	8.07	-	7.23	-	6.3	-	7.12	-	-
Colour	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elect. Cond.	umhos/cm	34000	18000	29000	9000	6000	1400	1500	180	-	1000	-	900	-	4000	-	150
Floatables		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Odour		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	‰	20	11	16	5	4	1	1	0	-	1	-	0	-	2	-	1
Taste		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Diss. Solid	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Susp. Solids	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	℃	36	34	31	29	32	30	30	28	-	27	-	30	-	25	-	30
Turbidity	NTU	88	>90	98	52	25	36	49	32	-	72	-	68	-	81	-	51
F. Colif.	counts/ 100mL	>1.8 $x10^4$	>1.8 $x10^4$	> 1.8 $x10^4$	1.6 $x10^4$	>3.0 $x10^3$	>3.0 $x10^3$	5.2 x10	>3.0 $x10^3$	-	>3.0 $x10^3$	>3.0 $x10^4$	>3.0 $x10^3$	>3.0 $x10^3$	8.0 $x10^2$	-	2.2 $x10^2$
Tot. Colif.	counts/	1.2 $x10^4$	>1.8 $x10^4$	1.8 $x10^4$	>1.8 $x10^4$	1.8 $x10^4$	1.6 $x10^4$	9.0 $x10^3$	>1.8 $x10^4$	-	1.6 $x10^4$	>1.8 $x10^4$	>1.8 $x10^4$	>1.8 $x10^4$	>1.8 $x10^4$	-	8.0 $x10^2$

PH: measurement on the site

ST.1; Sea of Pantai Acheh
ST.2; Sea near mouth of Sungai Pinang

Table 6-8 PROPOSED INTERIM NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA

PARAMETERS	(units)	CLASSES					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/L	0.1	0.3	0.3	0.9	2.7	>2.7
BOD	mg/L	1	3	3	6	12	>12
COD	mg/L	10	25	25	50	100	>100
DO	mg/L	7	5-7	5-7	3-5	<3	<1
pH		6.5-8.5	6-9	6-9	5-9	5-9	-
Colour	TCU	15	150	150	-	-	-
Elect. Cond.*	µmhos/cm	1000	1000	-	-	6000	-
Floatables		N	N	N	-	-	-
Odour		N	N	N	-	-	-
Salinity*	°/oo	0.5	1	-	-	2	-
Taste		N	N	N	-	-	-
Total Diss. Solid*	mg/L	500	1000	-	-	4000	-
Total Susp. Solids	mg/L	25	50	50	150	300	>300
Temperature	°C	-	Normal ±2	-	Normal ±2	-	-
Turbidity	NTU	5	50	50	-	-	-
F. Colif.**	counts/ 100mL	10	100	400	5000 (20000)[a]	5000 (20000)[a]	
Tot. Colif.	counts/ 100mL	100	5000	5000	50000	50000	>50000

N = No visible floatable materials/debris,
or No objectionable odour,
or No objectionable taste.

* = Related parameters, only one recommended for use

** = Geometric mean

a = Maximum not to be exceeded

CLASS	USES
I	Conservation of natural environment Water supply I -- practically no treatment necessary (except by disinfection or boiling only) Fishery I - very sensitive aquatic species
IIA	Water supply II - conventional treatment required Fishery II - sensitive aquatic species
IIB	Recreational use with body contact
III	Water supply III - extensive treatment required Fishery III - common, of economic value, and tolerant species Livestock drinking
IV	Irrigation
V	None of the above

CONTINUED

PARAMETERS	(units)	CLASSES I	IIA/IIB	III#		IV	V
Al	mg/L		-	-	(0.06)	0.5	
As	mg/L		0.05	0.4	(0.05)	0.1	
Ba	mg/L		1	-		-	
Cd	mg/L		0.01	0.01*	(0.001)	0.01	
Cr(VI)	mg/L		0.05	1.4	(0.05)	0.1	
Cr(III)	mg/L		-	2.5		-	
Cu	mg/L		1	-		0.2	
Hardness	mg/L		250	-		-	
Ca	mg/L		-	-		-	
Mg	mg/L		-	-		-	
Na	mg/L		-	-		3 SAR	
K	mg/L		-	-		-	
Fe	mg/L		0.3	1		1 (leaf) 5 (others)	
Pb	mg/L		0.05	0.02*	(0.01)	5	
Mn	mg/L		0.1	0.1		0.2	
Hg	mg/L		0.001	0.004	(0.0001)	0.002	
Ni	mg/L		0.05	0.9*		0.2	
Se	mg/L		0.01	0.25	(0.04)	0.02	
Ag	mg/L		0.05	0.0002		-	
Sn	mg/L		-	0.004		-	
U	mg/L		-	-		-	
Zn	mg/L		5	0.4*		2	
B	mg/L		1	-	(3.4)	0.8	
Cl	mg/L		200	-		80	
Cl_2	mg/L		-	-	(0.02)	-	
CN	mg/L		0.02	0.06	(0.02)	-	
F	mg/L		1.5	10		1	
NO_2	mg/L		0.4	0.4	(0.03)	-	
NO_3	mg/L		7	-		5	
P	mg/L		0.2	0.1		-	
Si	mg/L		~50	-		-	
SO_4	mg/L		250	-		-	
S	mg/L		0.05	-	(0.001)	-	
CO_2	mg/L		-	-		-	
Gross-α	Bq/L		0.1	-		-	
Gross-β	Bq/L		1	-		-	
Ra-226	Bq/L		<0.1	-		-	
Sr-90	Bq/L		<1	-		-	

NATURAL LEVELS (I)

IV LEVELS ABOVE (V)

* = At hardness 50 mg/L $CaCO_3$

\# = Maximum (unbracketed) and 24-hr average (bracketed) concentrations

CONTINUED

PARAMETERS	(units)	CLASSES I	IIA/IIB	III#		IV	V
CCE	µg/L	↑	500	-		-	-
MBAS/BAS	µg/L	N	500	5000	(200)	-	-
O&G (mineral)	µg/L	A	40;N	N		-	-
O&G(emulsified edible)	µg/L	T	7000;N	N		-	-
PCB	µg/L	L	0.1	6	(0.05)	-	-
Phenol	µg/L	E	10	-		-	-
		V					
Aldrin/ Dieldrin	µg/L	E	0.02	0.2	(0.01)	-	-
		L					
BHC	µg/L	S	2	9	(0.1)	-	-
Chlordane	µg/L		0.08	2	(0.02)	-	-
t-DDT	µg/L	O	0.1	1	(0.01)	-	-
Endosulfan	µg/L	R	10	-		-	-
Heptachlor/ Epoxide	µg/L		0.05	0.9	(0.06)	-	-
		A					
Lindane	µg/L	B	2	3	(0.4)	-	-
		S					
2,4-D	µg/L	E	70	450		-	-
2,4,5-T	µg/L	N	10	160		-	-
2,4,5-TP	µg/L	T	4	850		-	-
Paraquat	µg/L	↓	10	1800		-	-

N = Free from visible film, sheen, discoloration and deposits
\# = Maximum (unbracketed) and 24-hr average (bracketed) concentration

Table 6-9 Results of Water Quality Analysis near Station 1

PARAMETERS	UNITS	23 Nov. 88	3 Dec. 88
Ammoniacal Nitrogen	mg/L	-	-
BOD	mg/L	1.4	<1
COD	mg/L	23	22
DO	mg/L	4.3	6.3
pH		7.7	8.1
Colour	TCU	-	-
Elect. Cond.	umhos/cm	475 x 10	382 x 10
Floatables		-	-
Odour		-	-
Salinity	o/oo	-	-
Taste		-	-
Total Diss. Solid	mg/L	-	-
Total Susp. Solid	mg/L	747	1365
Temperature	^{o}C	30	23
Turbidity	NTU	-	-
F. Colif.	Counts/100mL	2.4 x 10	2.4 x 10
Tot. Colif.	Counts/100mL	6.4 x 10	4.9 x 10
Pb	mg/L	0.0042	0.0049
cd	mg/L	0.0029	0.0022
Hg	mg/L	N.D.	N.D.
Total - N	mg/L	3.0	3.2
Organo - P	mg/L	0.011	0.045

N.D.: Not Detectable

(by JICA Study Team)

(2) Soil

a. Geological profile

Soil investigation works have been carried out in the candidate site at Pantai Acheh by the JICA study team. Based on the works, a geological profile of PADS is made and illustrated in Fig. 6-5.

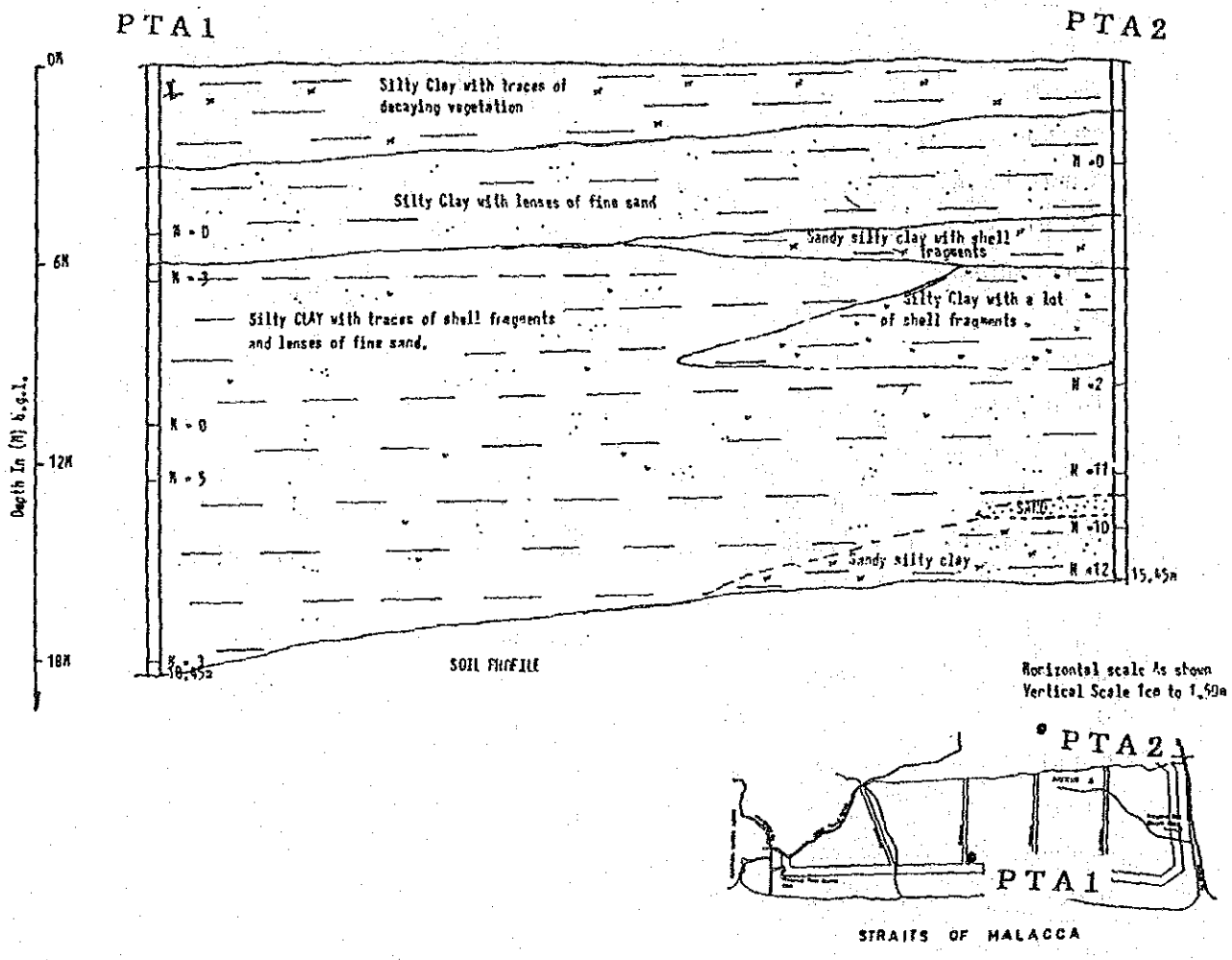


Fig. 6-5 Geological Profile of PADS

According to the geological profile, marine silty clay exists to a depth of 18 meters below ground level with fine sand and shell fragments partly.

b. Soil characteristics

Laboratory testing on selected soil samples has been performed to evaluate the engineering parameters of the subsoil encountered. Based on soil test, characteristics of marine clay are summarized as follows.

i.	Natural Moisture Contents	80 -100 %
ii.	Bulk density	1.5 - 1.6 ton/m^3
iii.	Specific Gravity	2.4 - 2.6
iv.	Atterberg Limit	
	- Plastic Limit	25 - 40 %
	- Liquid Limit	47 - 70 %
v.	Permeability Coefficient	10^{-6} - 10^{-7} cm/sec

6.3 Noise Hazards

There exists very close relationship between the traffic volume and noise level. For this reason, the traffic volume and traffic noise are discussed in the subsequent section.

(1) Traffic Volume

The main source of noise pollution in residential areas comes from vehicles.

The 12 hours traffic volumes relating to the study area are summarized in Figure 6-6 and Table 6-10. Figure 6-7 gives hourly traffic volumes at each points.

Table 6-10 Traffic Volumes relating to the study area

unit: vehicles/12hours

No	Cars (motor cycles)		Lorries①	①/②×100%	Total ②
1	1705	(1248)	123	6.7	1828
2	966	(620)	32	3.2	998
3	2239	(1554)	180	7.4	2419
4	827	(609)	130	13.6	957
5	2269	(1527)	202	8.2	2471
6	6857	(4390)	194	2.8	7051
7	5173	(3119)	167	3.1	5340

By JICA Study Team on December 20, 1988

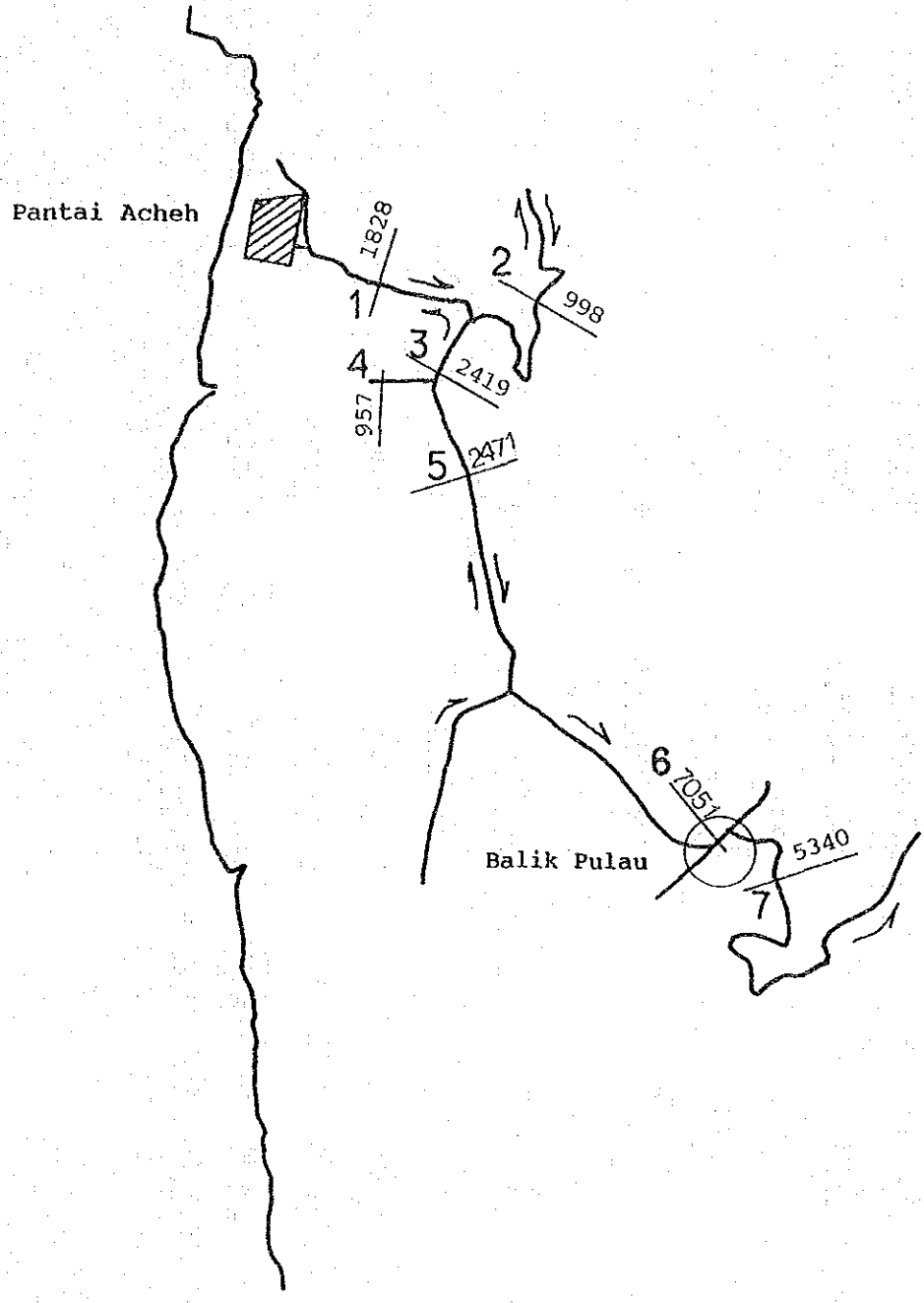


Fig. 6-6 12 Hours Traffic Volumes

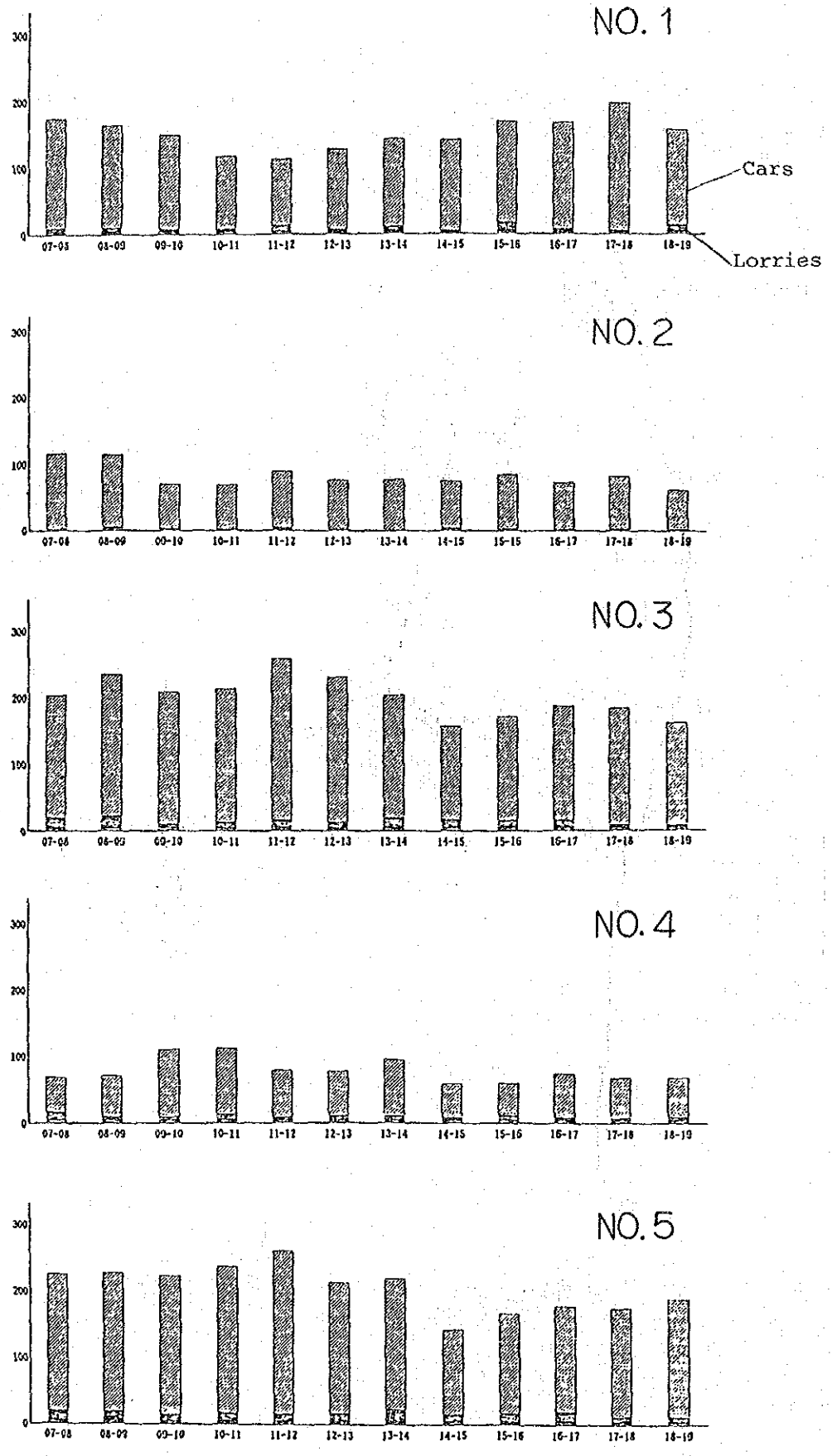
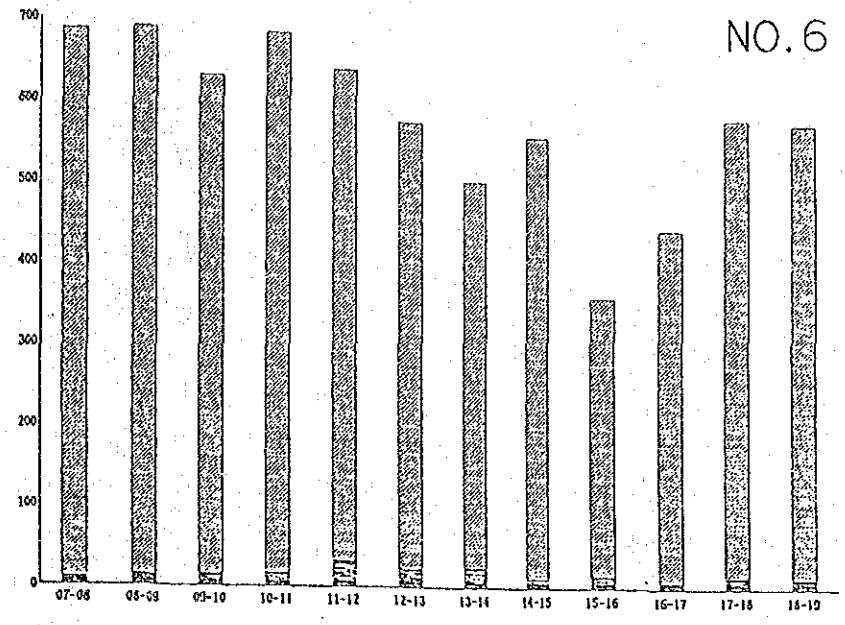


Fig. 6-7 Hourly Traffic Volumes at Each Point (1988)


NO.6
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500
400
300
200
100
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07-08
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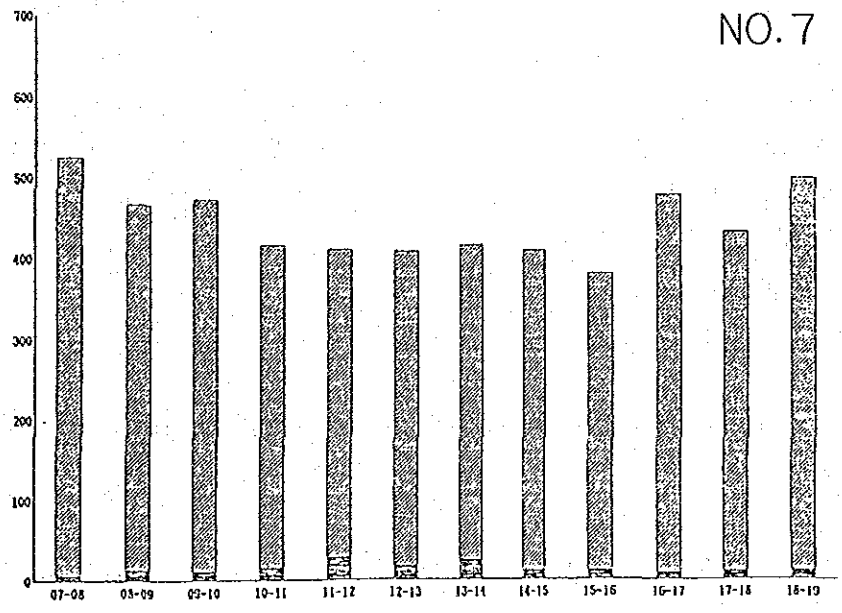
16-17
17-18
18-19


NO.7
700
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07-08
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09-10
10-11
11-12
12-13
13-14
14-15
15-16
16-17
17-18
18-19

(2) Traffic Noise

The main sources of noise pollution in Malaysia are from motor vehicles, industries, construction activities and aircrafts. Since 1981, several studies have been conducted by the Department of Environment at various important locations such as urban centres, residential areas surrounding airports to determine main sources of noise pollution and the respective noise exposure levels in these areas.

Motor vehicles were found to contribute significantly to the noise pollution problems in almost all urban centres and some residential areas. Noise levels were measured in all major city/towns in Malaysia. Table 6-II shows noise measurements conducted in 1981 and 1982, and between 1984 and 1986 in Penang. Measurements were conducted using the same procedures.

The World Health Organization (WHO) in its document entitled 'Environmental Health Criteria 12 - Noise' recommends that the community/urban daytime Leq value should not exceed 55 dBA beyond which annoyance would increase.

The results of the surveys clearly indicate that the ambient noise levels in Penang were generally higher than the WHO recommended value. The surveys also revealed that many residential quarters, schools and offices were located very close to the main roads having heavy traffic flows. As such these residents were likely to be exposed to noise levels not conducive to healthy living.

(3) Landuse

Residential areas around the candidate site and along the access roads are shown in Fig. 6-8.

The distance from the site to the nearest house is about 100 m. It should also be noted that on both sides of the access roads towards the candidate site are lined with houses.

The Construction of 224 units of terrace type houses b(low to medium cost) is propsed at the 13 acre site, bying just morth of the PADS. The project

is expected to be completed within three years, by the end of 1992.

Table 6-11 Noise Levels in Penang State

No. of Measuring Station	Average Noise Level - dBA (7 am - 7 pm)	Period
50	69.4	1981 - 1982
106	72.1	1984 - 1986

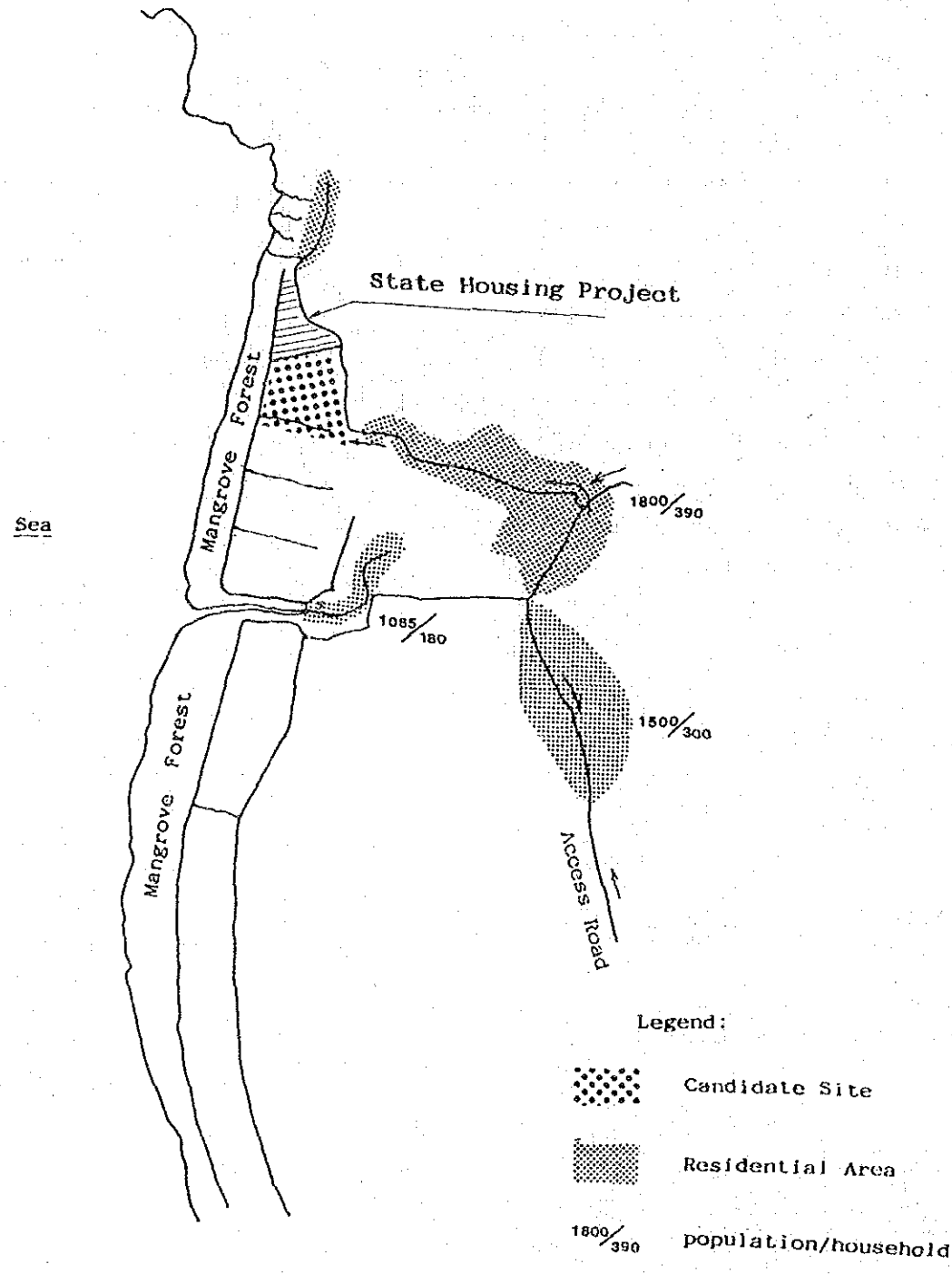


Fig.6-8 Residential Areas near Pantai Acheh

6.4 Vegetation and Animals

6.4.1 Vegetation

(1) Flora and vegetation

The candidate site is presently covered with mangrove forest. The trees are matured and are up to 100 feet in height as shown in the photograph. A strip of land has been cleared between the proposed site and the coastal strip of mangrove.

A bund has been built to separate the coastal strip of mangrove from the candidate site. There is also a drainage canal between the bund and the candidate site. The strip of mangrove is about 100 meters wide. The mangrove plants include Avicennia, Bruguiera and Rhizophora. The species in the drier areas appear to be mainly Avicennia. The drainage canals and bund are maintained by the DID.

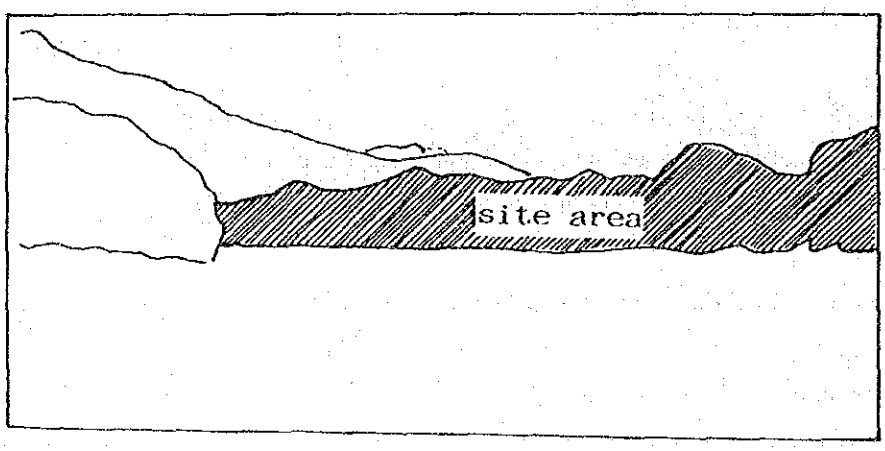
Ecology in detail has been studied by USM.

(2) The Value of Mangrove

Mangrove forests in Malaysia occur mainly along the west coast of Peninsular Malaysia, at the estuaries of the Sarawak, Rejang and Trusan-Lawas rivers of Sarawak and along the east coast of Sabah (Fig. 6-9).

The areal extent of these forests in Peninsular Malaysia, Sabah and Sarawak has been estimated to be about 120,000 ha, 284,000 ha, and 173,000 ha respectively about 351,000 ha occur as forest reserves. The values of the mangrove resource are many and of great importance to the socio-economy of the country.

The importance of the resource derives both from the direct products taken from the mangrove forests and from the amenities provided by the resource from within and beyond their boundaries.



Vegetation at Pantai Acheh Disposal Site

Products taken from the mangrove forests are mainly wood for charcoal, poles and firewood. In terms of economic value per hectare per annum of timber, the mangrove forests have been amongst the most valuable in the country. The leaves of the nipa palm, Nipa fruticans, are used for making roof thatches and cigarette wrappers while the inflorescences are tapped for nipa sugar for conversion to alcohol. In Sabah and Sarawak, mangrove timber is an important source of wood-chips for the manufacture of rayon.

Other natural products harvested from the mangroves ecosystem include many prawn species which are caught in the mangrove waterways or in adjacent coastal waters. Edible mud crabs and gastropods are common in the mangroves while cockles are abundant on mud flats. Together they provide an important commercial food source. Some prawn species may breed and complete their life cycles in the shallow coastal mangrove waters.
Under natural conditions, mangrove forests act as seaward barriers against coastal erosion and help to stabilise the coastline. Erosion often occurs following removal of mangroves by humans.

6.4.2 Animals

This has not been determined, but there appeared to be a large number of bird species.

The animal life in the mangroves include the usual crabs, shell fish and possibly some monkeys. There were indications of human activities within the mangrove which would mean that a certain amount of collection of shell fish and other invertebrates take place within these areas. There were also sounds of wood being chopped during our visit and some bundles of twigs were placed at the edge of the mangrove.

From other studies, it is known that the coastal mudflats of the mangroves off Pantai Acheh and Sungai Pinang is a source of cockle spats. These are collected and sold to aquaculture farmers in other parts of Penang, such as in Juru.

Details of all species habitating this area is available after USM has completed their investigation at this area.

6.5 Landscape

There is no recreational zone, which has excellent landscape to be preserved around the candidate site.

6.6 Historic and Religious Places

There are no historic or religious places and structures around the candidate site.

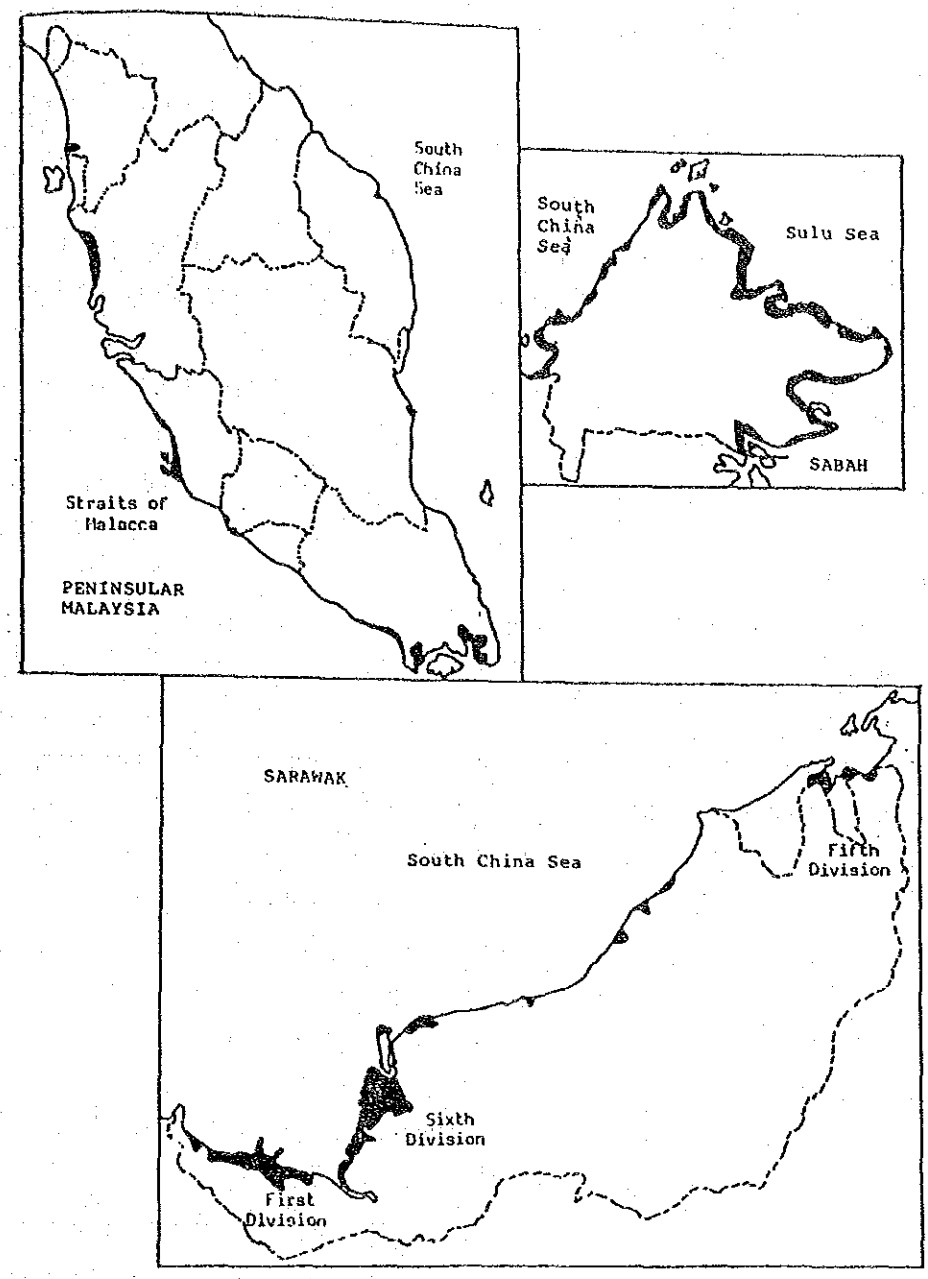


Fig. 6-9 Mangrove Forest in Malaysia

The following activities might have significant impacts on the environmental components as shown in Table 7-1.

Of these environmental components, vegetation and animals with mark * in the Table which are currently under field investigation, are not fully surveyed. For this reason, these items are examined.

Table 7-1 Project Activities and Environmental Components

Project Activities	Environmental Components
Site Clearing	* Vegetation and Animals
Earth-works	Noise against human life
	* Noise against animals
Landfill activities	Dust and Odor
	Water Pollution
	Noise against human life
	* Noise against animals
Transportation activities	Air pollution due to vehicle exhaust
	Noise from haulage vehicles
	Safety on public roads.

(1) Site Clearing

Before earthworks, in the site clearing, trees and bushes will be cut down and cleared throughout the site. Ecology of the site should be studied.

(2) Earthworks

Noise from vehicles during construction may cause some impact against human environment and on to the wildlife in the mangrove forest. Some species of birds were seen habitating in the mangrove forest during reconnaissance

survey. Further study should be executed in determining the possible extent of impact on these wildlife.

(3) Landfill

Since leachate from final disposal site is gathered and pumped up back to the site, it will not be discharged directly out of the site.

However, some leachate will permeate into the ground, and only some will be purified after passing through layers of sand and finally flow out into the sea. Therefore, there may be some impact against the ground water due to this.

Odour will be generated during landfill work, but it can be reduced by completely covering the waste with soil. Spontaneous combustion of waste would give off smoke and it is undesirable to the environment. However, it can be controlled by covering it with soil and timely sprinkling with water. Water trucks shall have to be prepared for sprinkling.

Suspended particulate matter and dust generated from solid waste and residue can also be mitigated by regular timely sprinkling of water and adequate covering soil.

There is a development possibility of tourist resort area to the north of the site and a traditional village center to the south of the site. Therefore, this disposal site will reserve about 50 meter wide green belts as buffer zones on the north and south areas respectively, and impact against landscape will be abated.

Noise from landfill equipment may give some impact against wildlife in the adjacent mangrove forest. However, to determine its extent, further detailed study is required.

(4) Transportation

SWM vehicles cause impact to three environmental components of air quality, noise and physical safety.

The traffic noise and traffic unsafety will not always be in direct proportion to the increase of traffic volume. However, the SWM vehicles may give some impacts on noise and traffic safety, because general traffic volume is not very much at present.

Chapter 8 Detailed Examination of Impact

Result of preliminary environmental evaluation provided the basis for detailed examination of the following environmental components.

(1) Air Quality
(2) Water Quality
(3) Noise
(4) Safety

8.1 Air Quality

(1) Dust and Odor

The western side of the candidate site faces the sea. The most predominant wind direction is NNE throughout the year. This wind blows from the land to the sea, and so dust and odor will have no adverse effect in daily life. The wind blowing from the sea to the land is within the range of NNW-SSW, but its frequency is not so high.

The proposed sanitary lanfill in which soil covering will be conducted every day can minimize the generation of odor.

The generation of dust can be controlled with the proposed plan in which water sprinkler trucks will stand ready for water sprinkling whenever necessary.

A 50 m wide green belt will be placed on the land side of the site. The distance between the site and the houses is approximately 600 m on the north side, 400 m on the east side, and 1000 m on the south side at the stage of the first phase project.

Adverse impact of dust and odor would not be significant even if the state housing project should start to the north side of the side.

(2) Air Pollution from Haulage Vehicles

The most serious pollutant derived from car exhaust gas in Penang is carbon monoxide (CO). The number of haulage vehicles is not so large in comparison with the general traffic volume, but it is necessary to evaluate the degree of the adverse effect of increasing haulage vehicles because the traffic volume on the access road to Pantai Acheh is not so large. Then, the method proposed by Management and Control of Air Pollution in Penang (Dr. Lim Poh Eng and Dr. Koh Hock Lye, USM) was adopted.

$$CO = (0.5 + 0.65\ Tt - 0.6\ W)/(1-a)$$

CO : Steady state or mean CO level (ppm)

Tt : (traffic count) x 10^{-3} (per hour)

W : Wind speed (km/hour) = 6.12

a : 0.39 - 0.64 (=0.64)

Result of the calculation is given in Figure 8-1. Concentrations of Carbon Monoxide are very low. The general traffic volume is calculated on the assumption of the annual increase rate of 5% in which the year of 1988 is the base year and the year of 1995 is the target year. Hourly haulage vehicles are assumed to be 50 vehicles.

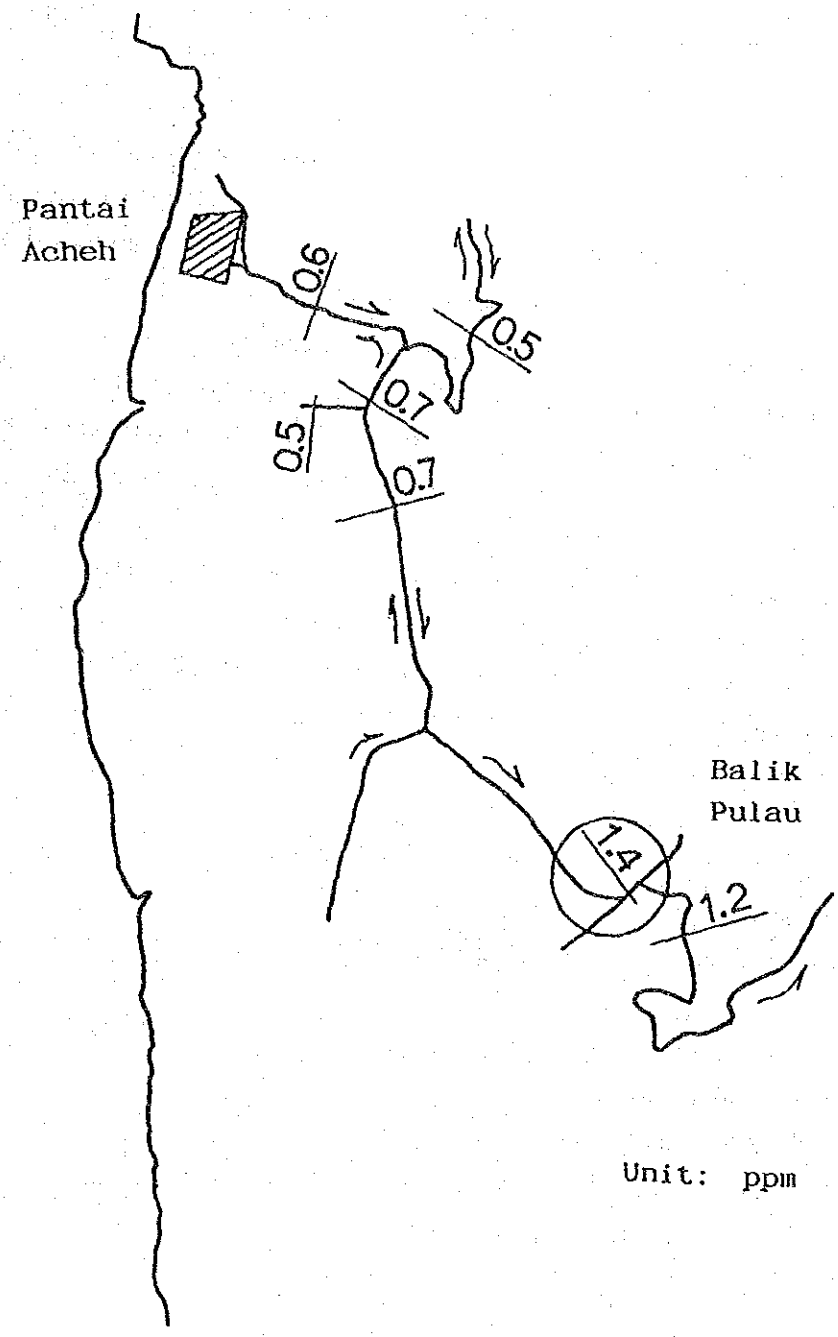


Fig. 8-1 Concentration of CO along access road (in 1995)

8.2 Water Quality

Control of leachate from the landfill is planned as follows (Refer to Supporting Report Vol.II P.75-P.97) :

Regulating and retention ponds are prepared as shown in Fig.4-1.

Leachate is discharged into the regulating pond and usually pumped up back to the disposal area by leachate cycling facilities. Leachate cycling facilitates self-purification by the wastes disposed of. Leachate is not usually discharged directly into the sea. In case of heavy rain, the sluice gate is to be opened and leachate diluted in the regulating pond is flown into the retention pond. Then, the leachate in the retention pond is pumped up and discharged into the sea area.
The leachate is pressured to send through pipes to the sea area where the water depth of approximately 0.5m can be assured even in low tide. The concentration distribution in this measure was assumed by using a simple prediction equation (Joseph - Sendner):

$$(S-S_1)(S_0-S_1) = \exp(Q/\pi d p (1/r_0 - 1/r)) \times (\exp(Q/\pi d p r_1) - \exp(Q/\pi d p r)) \div (\exp(Q/\pi d p r_1) - \exp(Q/\pi d p r_0))$$

where S : concentration at r = r
So : concentration at r = ro
S1 : concentration at r = r1
Q : water discharge per unit time (=0.01044 m^3/sec)
d : depth of mixing (=0.5 m) and
P : rate of diffusion (=0.01 m/sec)

The concentration at r = r1 (S = 0) is described from the following equation (Nitta, Japan) :

$$\text{Log}(\pi r_1^2/2) = 1.226 \log Q + 0.0855$$

where Q : discharge (= 902 m^3/day)
r_1 = 57 m

Thus, S = 3 ppm at r = 35m on the assumption of So = 800 ppm at r = ro. That is, when the effluent is discharged at 800 ppm BOD, the effluent is diluted to less than 3 ppm in the outer sea area of 35m radius centering around the discharge point. This low level is because of the extremely low volume of the effluent.

When the effluent is discharged at 1200 ppm COD, then it is diluted to less than 5 ppm in the outer area of 35m radius.

These levels are below the Class II (3 ppm) for BOD and Class I(10 ppm) for COD set by the Proposed Interim National Water Quality Standards for Malaysia.

In addition, when tidal current is taken into consideration, because this equation does not include this factor, diffusion will be further promoted.

Therefore, almost no adverse effect on aquatic flora and fauna is expected in the sea of Pantai Acheh.

Furthermore, there is more than 10 meter depth of marine clay layer which exists under the bottom of the PADS. The permeability coefficient of mariene clay is very low; i.e.10^{-6} to 10^{-7} cm/sec. This indicates that the possibility of ground water contamination by leachate is very little even without liner on the bottom.

8.3 Noise

(1) Noise during Construction Phase

Types of major construction works and machines which are expected to be major noise sources, and power levels of these noise sources are summarized in Table 8-1.

The levels of these noise sources are all round 100-110 dB(A).

A general equation to predict the effect of a point noise source is given by the following:

$$Lr = Lw + 10 \log (1/2\pi r^2)$$

where Lr; noise level at a point r meter distant from the noise source, and

Lw : power level of the noise source

The distance from the noise source to the site border including the 50m width of the buffer zone and the 25m width of the bund becomes approximately 75m.

$$L75 = 55 - 65 \text{ dB(A)}$$

In some cases the noise level may be higher than the WHO's standard of 55 dB(A), but no adverse effect in daily life is expected, because there is no houses near the site. Even if the state housing project should be carried out, noise level near the houses would be 50-60 dB(A), because the distance from the noise source to the houses would be more than 110 m. Any possible adverse effects on animals in the surroundings are expected to be negligible, because the construction period is not so long and points for construction works always move so that they will come back very soon after the completion of the construction.

Table 8-1 Construction Works and Power Level of noise sources

Type of Construction Work	Machines to be used	Noise level (power level) dB(A)
Clearing	Bulldozer	100 - 110
Levelling	Scraper	100 - 110
Bund construction	Drug line	100 - 110
	Back hoe	
Paving	Asphalt finisher	100 - 110
Concrete placing	Small mixer	100
Piling	Small piling machine	100

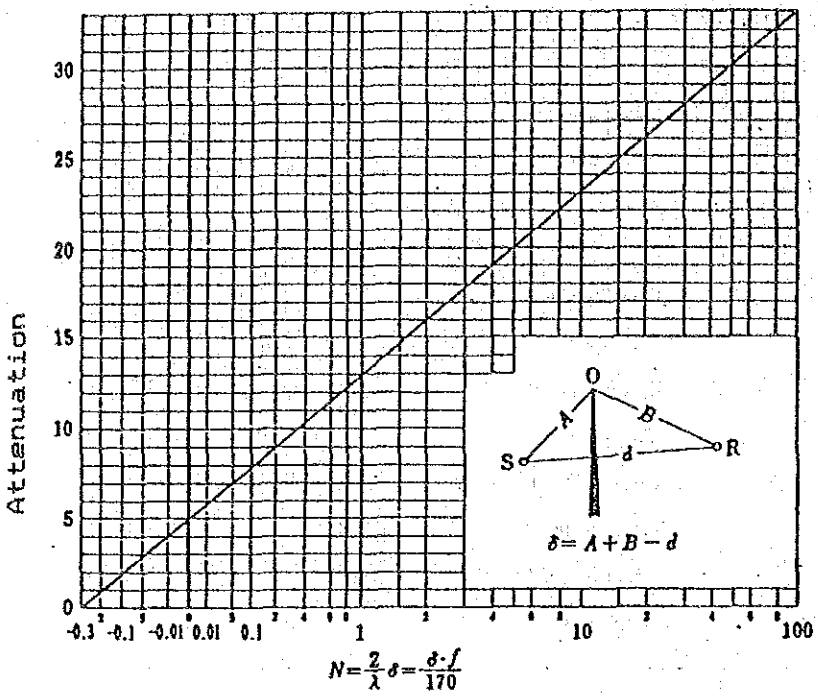
(2) Noise from Sanitary Landfill Equipment

Of sanitary landfill equipments, the major noise source is bulldozers. On the site, 1-2 bulldozers are planned to be operated regularly. One bulldozer generates noise of 55-65dB(A), similarly in the construction phase. However, more than 10 dB(A) of noise is expected to be attenuated as shown below because 5 meters high bund around the disposal area will arrest the noise and thus bulldozers being operated simultaneously can yield the energy shown below;

$$L = 10 \log \sum_{i=1}^{2} 10^{\frac{Li}{10}}$$

$$= 10 \log \left(10^{\frac{45}{10}} - \frac{55}{10} + 10^{\frac{45}{10}} - \frac{55}{10}\right)$$

$$= 48 - 58^{dB(A)}$$



N : Fresnel Number

λ : Wave length

f : frequency

Although this level may exceed the WHO's standard, no adverse effect in daily life is expected because of no private houses in the surroundings.

(3) Noise from Haulage Vehicles

The noise level from haulage vehicles can be estimated from the following prediction equation:

$$Leq. = Lm + \Delta Lstro + \Delta Lv + \Delta Lstg - \Delta Ls,l + \Delta Lk$$

$$Lm = 37.5 + 10 \log M(1 + 0.082\ P)$$

M : traffic density (vehicles/hour)

P : percentage of lorries

$\Delta Lstro = 0$ in case of not rough asphalt

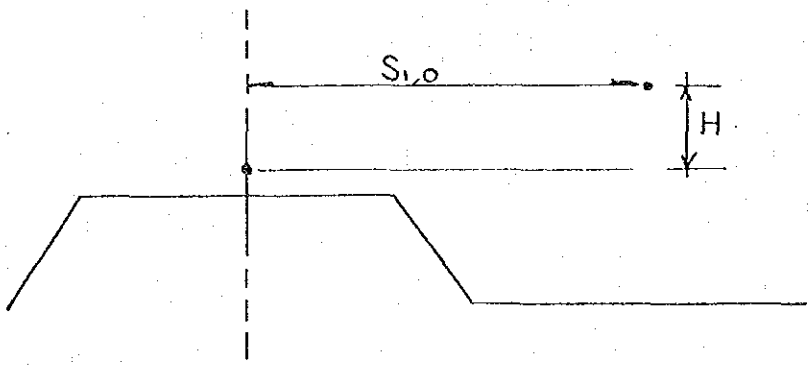
$$\Delta Lv = (23 - 3.5\sqrt{P} + 0.2P)\ (\log v - 2))$$

v : speed (km/hour)

$\Delta Lstq = 0$ in case of slope $\leq 5\%$

$$\Delta Ls,l = -13.8 + 3.5\ x + x\ /2$$

$$x = \log (S_{1,0}^2 + H^2)$$



ΔLk : Distance between receive point and junction

$\Delta Lk = 0$ in case of more than 100 m

The noise levels on roads around Pantai Acheh are shown in Table 8-2 at points shown in Figure 8-2. The traffic volume is increased at the annual rate of 5%, using the mean hourly traffic volume in 1988 as the base and that in 1995 as the target year. Noise levels exceed WHO's standard 55dB, but noise impact from waste transportation vehicles will be 3-9dB(A) increase in noise level. These noise level is low in comparison with the existing condition 72.1 dB(A) in Penang State. (Refer to P.30)

Table 8-2 Noise levels on roads

Unit : dB(A)

No.	'88	'95 1	'95+ Haulage Vehicles 2	L = 2 - 1
1	54	55	61	6
2	50	51	60	9
3	55	57	61	4
4	53	55	61	6
5	56	57	61	4
6	58	59	62	3
7	57	58	62	4

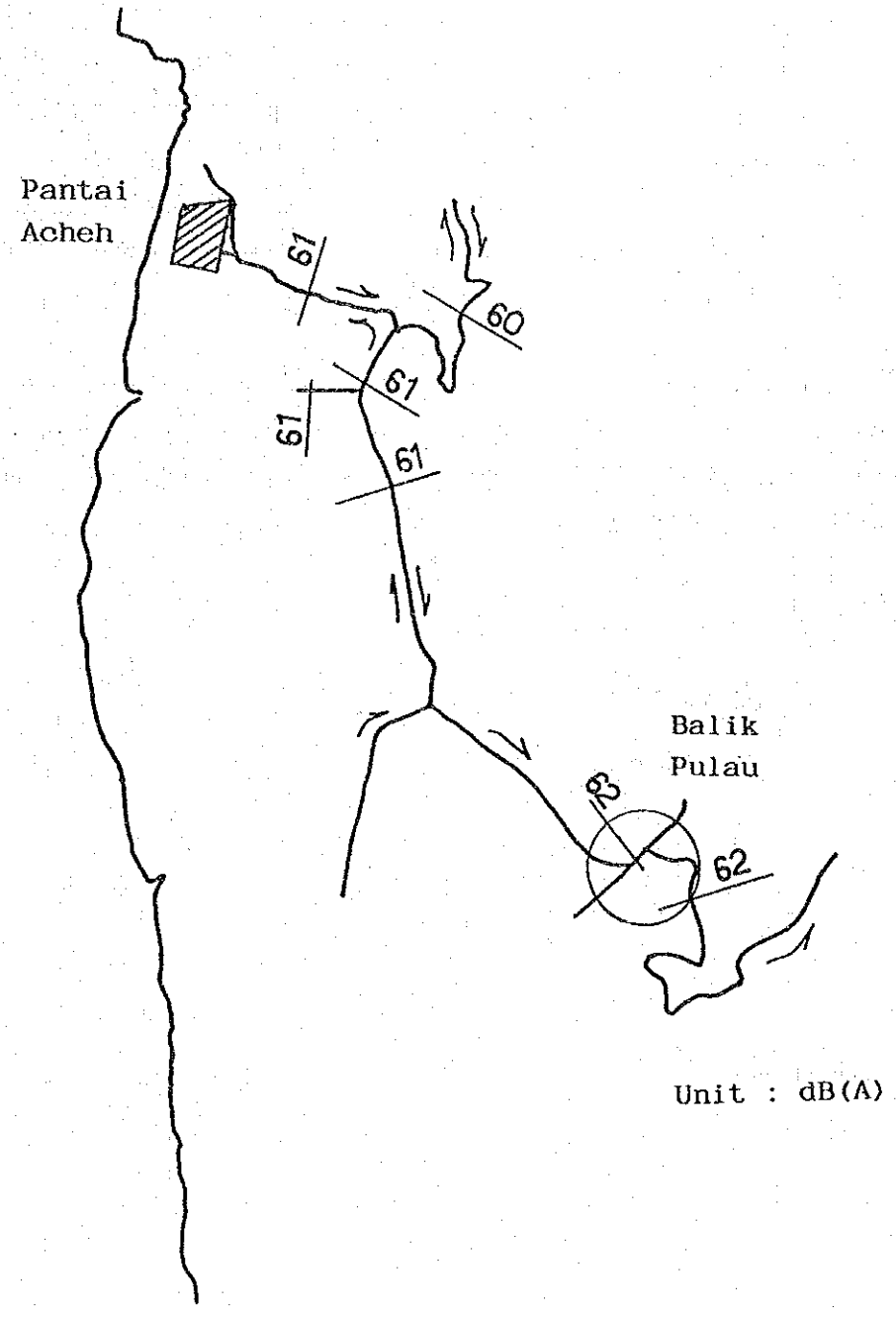


Fig. 8-2 Traffic Noise Levels along Access Road (in 1995)

8.4 Safety

The transportation route by haulage vehicles is given in Figure 8-3. As shown in this figure, the crossing in Sungai Pinang, and the road in the downtown and the north-west part of Balik Pulau, and the roads in Ayer Itam and Telok Kumbar are all narrow.

Along some parts of the roads, shops stretch and cars parking on the both sides make the road narrower.

Safe waste transportation to prevent any traffic accidents requires education of residents. At the same time, it is necessary to conduct rigid enforcement of regulations against traffic offenses and to teach haulage vehicles' drivers to reduce the speed at these neckpoints.

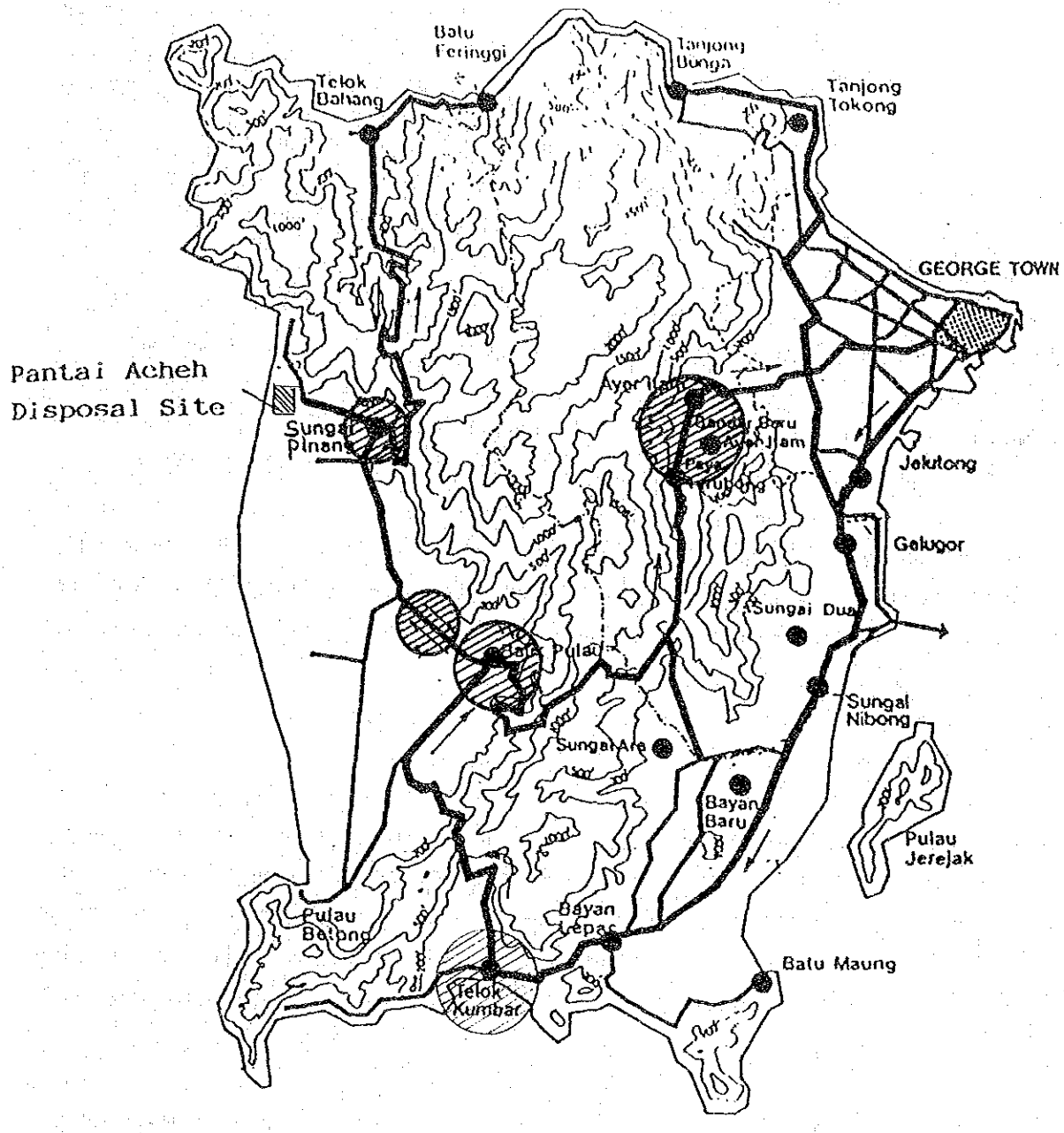


Fig.8—3 Haulage Route

Chapter 9 Mitigation and Abatement Measures

9.1 Construction Phases

In the first stage of sanitary landfill construction, bund which contain the sanitary landfill site and settling basin will be constructed. This step is to ensure that the muddy flow within the bund is collected and settled before discharging the clear water out of the bunded area. To further eradicate possibility of muddy flow discharge, the discharge is again collected and settled into another basin outside the bund before being discharged finally into the sea.

Existing tall trees will be left as intact as possible for the green belt, and this rule will be strictly observed during the construction phase.

In constructing the green belt, the bund will be built. At that time, full consideration will be given so that the mangrove forest to be left outside is not damaged by dropping soil for banking.

9.2 Operational Phase

Although sanitary landfill could be the better way of disposal, it is undeniable that nobody would want to have it in front or at the backyard of their houses. Based on this understanding, the buffer zone of green belt is prepared to isolate the site from common view of the public. Its other purposes are to blend the existence of the disposal site with the surroundings and mitigate odor dispersion from the disposal site to the surrounding areas.

The landfill operation area will be divided into several smaller work areas by bunds within the site. The division into smaller operation area would help to reduce the volume of leachate to be treated because of smaller area for higher rainfall infiltration.

After the first landfill sub-division is completed, a final layer of earth will be applied over the top. In addition to this, the area would be sloped and drains will be provided. With the existence of these measures,

the surface run-off infiltrating into the ground would be minimized. All surface run off would be drained directly out of the site as surface water. In the next sub-division, leachate would be abated in the same manner explained previously and the completed sub-division of landfill would be furnished with drains and cover material.

For the remaining areas to be used in the disposal site, water run-off will be discharged directly out of the site as general surface water.

Leachate is discharged into the regulating pond and usually pumped up back to the disposal area by leachate cycling facilities. Leachate cycling facilitates self-purification by the wastes disposed of. Leachate is not usually discharged directly into the sea. In case of heavy rain, the sluice gate is to be opened and leachate diluted in the regulating pond is flown into the retention pond. Then, the leachate in the retention pond is pumped up and discharged into the sea area.
The leachate will be pressured to send through pipes to the point where the water depth of approximately 0.5m can be assured even in low tide, so that aquatic organisms inhabiting in the coastal mangrove forests are not adversely affected. Therefore, it is expected that no adverse effect will reach the sea areas fifty meters away from the discharge point.

Odor, dust and spontaneous combustion can be controlled by covering with soil and timely sprinkling with water. Water trucks will b prepared for sprinkling.

Gas generation in a landfill area due to decomposition of waste cannot be eliminated, but impact can be mitigated because gas dispersion measures will be adopted in the site.

Education of haulage vehicles' drivers for safety promotion, enlightment of dwellers along the roads, and tight control over illegal parking will be conducted.

As for the collection vehicles route, the following mitigation and abatement measures are to be considered prior to the operation of the PADS,

i. Batu Feringgi Route

- Although the existing road is narrow and steep, it seems to be difficult to improve both vertical and horizontal alignments.
- The collection vehicle can pass through the route because heavy buses are already using the route for reguler services.
- Collection vehicles' drivers need to keep safe speed.
- In order to obtain traffic safety at the curves where visibility is bad, curve mirrors shall be installed there.
- As traffic volume of the collection vehicles is only several units per day, the impact on the traffic is very little.

ii. Georgetown → Bayan Lepas → Balik Pulau → PADS → Balik Pulau → Ayer Iteam → Georgetown Route.

- Pedestrian roads need to be constructed at the town areas which are the bottle neck of the existing route.
- Curve mirrors shall be installed at the dangerous curve.
- Traffic signals shall be installed at the main intersections.

In case that the above-mentioned mitigation and abatement measures are realized, the traffic impacts on the residents along the route by the haulage vehicles will be greatly mitigated and minimized.

Chapter 10 Residual Impact and Monitoring System

There seems to be no residual impacts because many mitigation and abatement measures are adopted. However, to enhance more safety, method such as monitoring systems are recommended.

In order to examine impacts on surrounding environment by landfill operation, the following monitoring systems are introduced in PADS operation.

a. Water monitoring system

The following monitors of water are proposed.

i. Groundwater monitoring by monitoring well
ii. Surface water monitoring at surrounding drain
iii. Leachate monitoring at the inlet of the regulation pond
iv. Effluent monitoring at effluent pump pit and effluent outlet.

The locations for above mentioned monitoring are illustrated in Fig. 10-1.

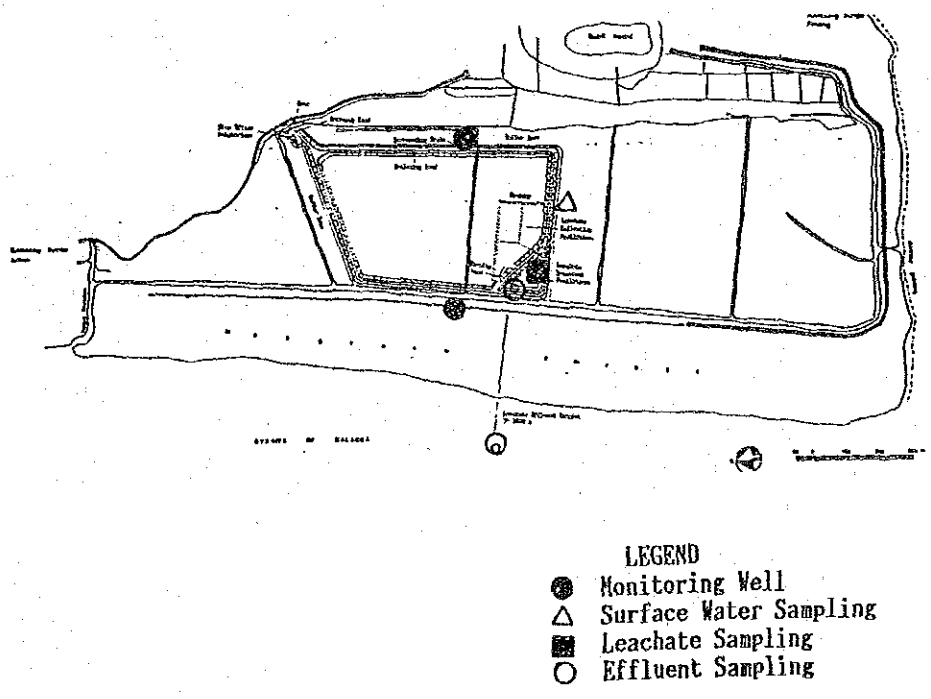


Fig. 10-1 Location of Water Monitoring Place

b. Waste Monitoring System

The following monitor of wastes are proposed.

i. Inspection of direct haul wastes by private sector including industrial wastes.

ii. Monitoring of littered wastes

iii. Patrol surrounding area of PADS for the prevention illegal dumping.

Chapter 11 Project evaluation and Summary of Conclusion

Table 11-1 summarizes the environmental evaluation. In the table, environmental aspects are discussed in comparison between "with project" and "without project".

Implementation of the project will result in acquisition of a sufficient capacity of landfill and sanitary landfill. Because implementation of some of the mitigation measures can minimize possible adverse impacts caused from the site, the city can be maintained clean with nearly no adverse effect.

On the other hand, the existing disposal site is very likely to have serious impacts on the surrounding environment, and further filling operation would lead to the shortage of filling capacity. If the same type of dumping is conducted after a new site is built, adverse effects on the surrounding environment will very possibly appear. Without a new site, wastes and garbage would fill the city, and clog the water channel, with resultant flooding at many places.

Table 11-1 Project Evaluation

Environmental Aspects	With Project	Without Project
I. Discharge & storage		
Aesthetic	In residential areas collection is made three times a week. Garbage will not be seen except on the designated day for collection, because one can put garbage only at a fixed time on a fixed day.	In residential areas, currently door to door collection and container collection are conducted Regular placement of containers and littery garbage around them damage seriously the aesthetics of the city.
Odor and waste water	The use of standard plastic bags can solve almost perfectly the problems of odor and waste water overflow.	Because currently plastic bags are not used, we can find odor and waste water outflow problems here and there.
Others	In Kampong area, collection service will be made with communal containers.	Kampong area where nearly no collection service is available is littered with garbage.
II. Transportation		
Odor, waste water, garbage flying, and working environment	All collection vehicles will be shifted to compactor vehicles and at the same time the maintenance system will	Current sideloaders and open trucks have no cap, and odor generation, waste water dropping and garbage flying have

be strengthened. Therefore, odor generation during transportation, dropping of waste water and garbage flying will disappear, and the working environment will be improved.

become serious problems. Loading of garbages to sideloaders and open trucks in the dusty air is not desirable for workers' health. With currently used compactor vehicles, which are poorly maintained and very old, the problems of odor generation and waste water dropping have become serious.

Continue/...(1)

Environmental Aspects	With Project	Without Project
Roadside environment (air pollutant)	Air pollutants derived from traffic of waste transportation vehicles will have a minor impact on the roadside environment.	Air pollutants from waste transportation vehicles do not have a serious impact on the roadside environment.
Roadside environment (noise)	The possible noise impact associated with traffic of waste transportation vehicles will be a 3-9dB(A) increase in noise level.	The noise impact associated with traffic of waste transportation vehicles can be seen slightly against houses along the road.
III. Final Disposal		
Impact on surface water quality	Because the leachate is not usually discharged directly into the sea, nearly no adverse effect is expected. Although the leachate is discharged in case of heavy rain, no adverse effect will reach the sea area fifty meters away from the discharge point.	Leachate flows directly into the sea area with resultant pollutant of sea water.

Impact on groundwater	Although no seepage control works are made, the possibility of groundwater contamination is very low because of clay layer with a relatively low permeability on the site bottom. In addition, no ground-water is utilized in the surroundings.	At the existing disposal site, leachate infiltrates into the underground with resultant possibility of groundwater contamination.
Noise, odor and dust problems	The distance from the site to surrounding private houses is long, and noise, odor and dust generated from the final disposal operation will have no adverse impact in daily life.	Private houses are located very near the existing disposal site, and the effects of noise, odor and dust are serious.

Continue/...(2)

Environmental Aspects	With Project	Without Project
Compatibility with landuse of adjacent area	Good	Not good, because private houses and factories are located in the neighbourhood.
Impact on fisheries	Because leachate from the site will not usually be discharged, nearly no adverse effect is expected.	Leachate from the site flows directly into the sea area. When the present dumping is kept, the possibility of contamination of fish and shellfish which are major products of fishery is fairly high.
Impact on terrestrial vegetation and wildlife	Cutting the mangrove forest in the existing bund will have no adverse impact on aquatic organisms in the sea area, but the reduction of habitats for birds and other animals may have an adverse effects.	No impact.
Impact on marine flora and fauna	Almost no adverse effect is expected on marine flora and fauna.	The adverse effect on marine flora and fauna.
Impact on natural	There is no aesthetic elements to be	Although there is no aesthetic elements to be

landscape	conserved. In addition, planning of planting for better natural landscape will hide disposal operation.	conserved, the current condition is very undesirable because one can directly overlook the site.
Impact on historical places or structures	No impact.	No impact.
Impact on religious places or structures	No impact.	No impact

Continue/...(3)

Environmental Aspects	With Project	Without Project
Impact on traffic safety	Drivers' special attention to traffic safety will be required in driving on access road extending from the temple town in Ayer Itam and the downtown of Balik Pulau to the Sungai Pinang area.	Special attention is needed in driving the access road, but there is no case in which waste transportation vehicles cause some safety problem.
Harmful insects and others	Perfect implementation of sanitary landfill will prevent any such problems.	The existing site is the food source for fly, mosquito, rat, and other harmful insects.

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II. Kuala Muda and Pulau Burong Disposal Site

Chapter 1 Title of Project

The title of the project is Kuala Muda and Pulan Burong Disposal Site Development Project (1991-1995)

Chapter 2 Project Initiator

The initiator of the project is Seberang Perai Municipality.

Chapter 3 Necessity of the project

The rapid pace of socio-economic development in Malaysia has brought about an increase in the generation of solid waste with increasing complexity. Solid waste collection and disposal has become a social and public health problem of great magnitude and this is evident in the numerous reports published in the mass media in the country. The Malaysian Government is firm in its policy of maintaining clean urban centres and for this purpose the National Cleanliness Campaign was launched throughout the country by the Honourable Prime Minister towards the end of 1983. However, in many areas this campaign failed to have any reasonable effect because of lack of cooperation from the public and most of all due to the inability of the Local Authorities throughout the country to sustain the campaign.

Under the Local Government Act 1976, Local Authorities are given responsibility of collecting and disposing solid waste in urban areas. However, almost all Local Authorities in Malaysia are facing acute difficulties in carrying out such responsibility. This difficulty mainly arises from the shortage of adequate funds, manpower problems, lack of disposal sites, absence of a good management system and the lack of expertise. Waste Management has been given very low priority in the past and the problems have been conveniently left to the Local Authorities to manage in the best way possible with their limited financial and manpower resources, without any form of technical aid or financial assistance from any other sources.

To overcome the problems stated earlier and to improve the situation in a systematic manner, the Ministry of Housing and Local Government has decided to prepare and implement a National Solid Waste Management Action Plan. A vital component of the National Action Plan is the preparation of Solid Waste Management Master Plan for each Local Authority in the country. Experience has shown that this is the most effective approach, technically as well as financially, to resolve solid waste management problems and plan for the needs in the years to come. However, this approach has not been practiced in Malaysia and not a single Solid Waste Management Master Plan has been prepared for any Local Authority in the country. As such, it is very important to carry out the first Solid Waste Management Master Plan

and Feasibility Study project successfully in a Local Authority so that the experience gained can be used to benefit other Local Authorities. At the same time such success will gain the confidence and support of the decision makers at all levels and thus provide a boost to the National Action Plan stated above.

MPPP is the oldest Local Authority in the country whereas MPSP is the largest in term of administration area. Both have important and fast growing development centres for industrial as well as commercial developments. These developments put a heavy strain on the solid waste management systems of both the Municipalities. Therefore both Municipalities must have a good and efficient solid waste management system. Furthermore Penang Island with its beautiful beaches is a major tourist attraction and is a vital link in the national tourist industry which is being actively promoted by the Government as an important source of revenue for the country. MPPP and MPSP are seperated only by a narrow strait. Therefore, it is absolutely vital to keep these two areas clean so as not to affect the efforts made in promoting the tourist industry. A seashore polluted by floating refuse will nullify the impact of the best tourist promotion drive.

To be concrete, there are various problems as follows:

a. Unsatisfactory measurements for environmental conservation

In the existing disposal sites, implementation of short-term improvement plans at Permatang Pauh Disposal Site provides partial consideration, but almost no measures for environmental conservation has been executed. Therefore, not only littering and release of leachate but also fire due to spontaneous ignition in result in some cases. This has become a serious problem.

b. Unsatisfactory plan to ensure disposal sites

Permatang Pauh Disposal Site where approximately 90% of the wastes generated in the MPSP Area has no space any more, and causes environmental problems in the neighboring residential areas and industrial areas. Thus,

ensurement of the next disposal site is urgently requested.

c. Unimproved organization

MPSP, where the organization in charge of cleaning is regionally separated, has no department for planning, management and operation of disposal sites. For this reason, filling, transportation of disposal sites can not be satisfactorily carried out.

d. Illegal dumping

In spite of the fact that MPSP does not levy disposal charge at present for prevention of illegal dumping, wastes have been illegally dumped here and there. In order to prevent illegal dumping, stricter application of penalty is necessary.

e. Poor understanding of final disposal

Solid waste management (SWM) can be made only when collection, cleaning, treatment and disposal function perfectly. The current major concern of MPSP's Councillor is collection and cleaning, and his basic idea is "just dumping is good enough" with rather poor understanding of the issue. This seems to be an underlying cause of the above-listed (a) through (d). Even when an incineration plant is built, final disposal is essential for solid waste management. The necessity of a firm organization/system for adequate disposal is not fully understood. Furthermore, very strict application of penal regulations and full participation of citizens are indispensable for prevention of illegal dumping.

In order to solve all these problems, promotion of this project is urgently required.

Chapter 4 Summary of Project

Landfill development and operation of Kuala Muda Disposal Site (KMDS) and Pulau Burung Disposal Site (PBDS) for the first phase project (1991-1995) is designed as to comply with third level of satisfy landfill. The basic conditions for the design of KMDS and PBDS are summarized as follows;

Items		KMDS & PBDS		Remarks
Area of Site (ha)		Lagoon 60 Inland 17.9	29.1	
Wastes to be disposed		Municipal wastes including road,drain and beach cleansing wastes and non-hazardous industrial wastes		
Disposal amounts in 1995		199ton/day	238ton/day	
Cummulative Disposal Volume (1000m3)	Phase I 1992-1996	560	664	Including cover soil
	Phase II & III 1997-2005	1,415	1,673	Including cover soil
Numbers of incoming vehicles		59 units/day	69 units/day	
Required Area for Phase I		17.9ha	16.7ha	
Level of Landfill		3	3	
Construction Plan		3 stages		1991,1996 and 2001

Based on the above mentioned conditions, the preliminary design of KMDS and PBDS developments for Phase I is made and illustrated in Fig.4-1 - 4-3. The proposed project investment components of final disposal in KMDS and PBDS are summarized below;

a. Main facilities

i. Enclosing structure
- Enclosing bund
- Divider

ii. Drainage system
- Surrounding drain
- On-site drain (surface water)
- On-site drain (underground springs)
- Drain for reclaimed area

iii. Access
- Approach road
- On-site road

b. Environment protection facilities

- Buffer zone
- Litter control facilities
- Gas removal facilities
- Leachate collection facilities
- Leachate cycling facilities
- Leachate outlet
- Monitoring facilities

c. Buildings and accessories

- Site office
- Weigh bridge
- Garage and storage building

- Safety facilities
- Fire Prevention facilities
- Car wash
- Utilities

d. Equipment

i. Landfill equipment
- Bulldozer
- Hydraulic excavation

ii. Others
- Water sprinkler truck
- Inspection vehicle

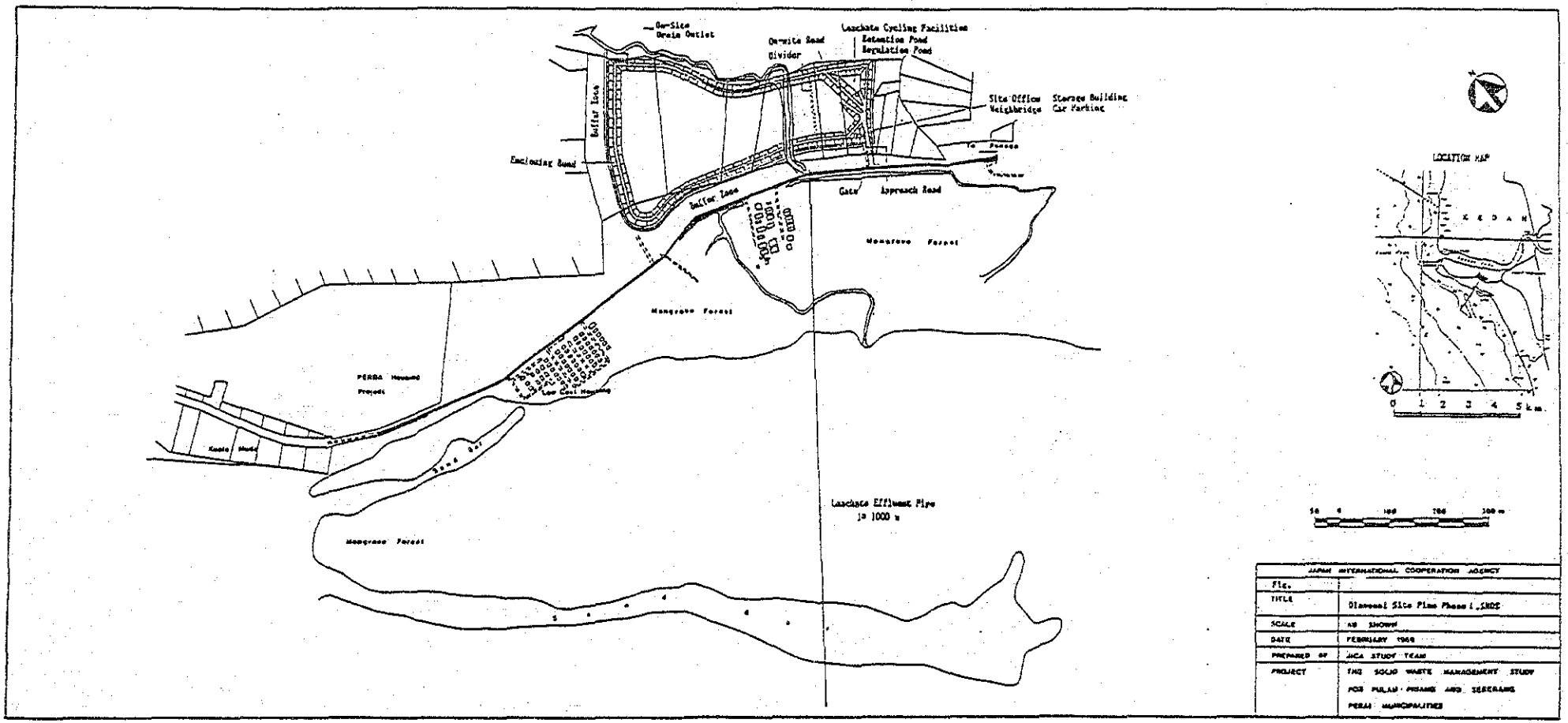


Fig. 4-1 Preliminary Design of KMDS Development for Phase I

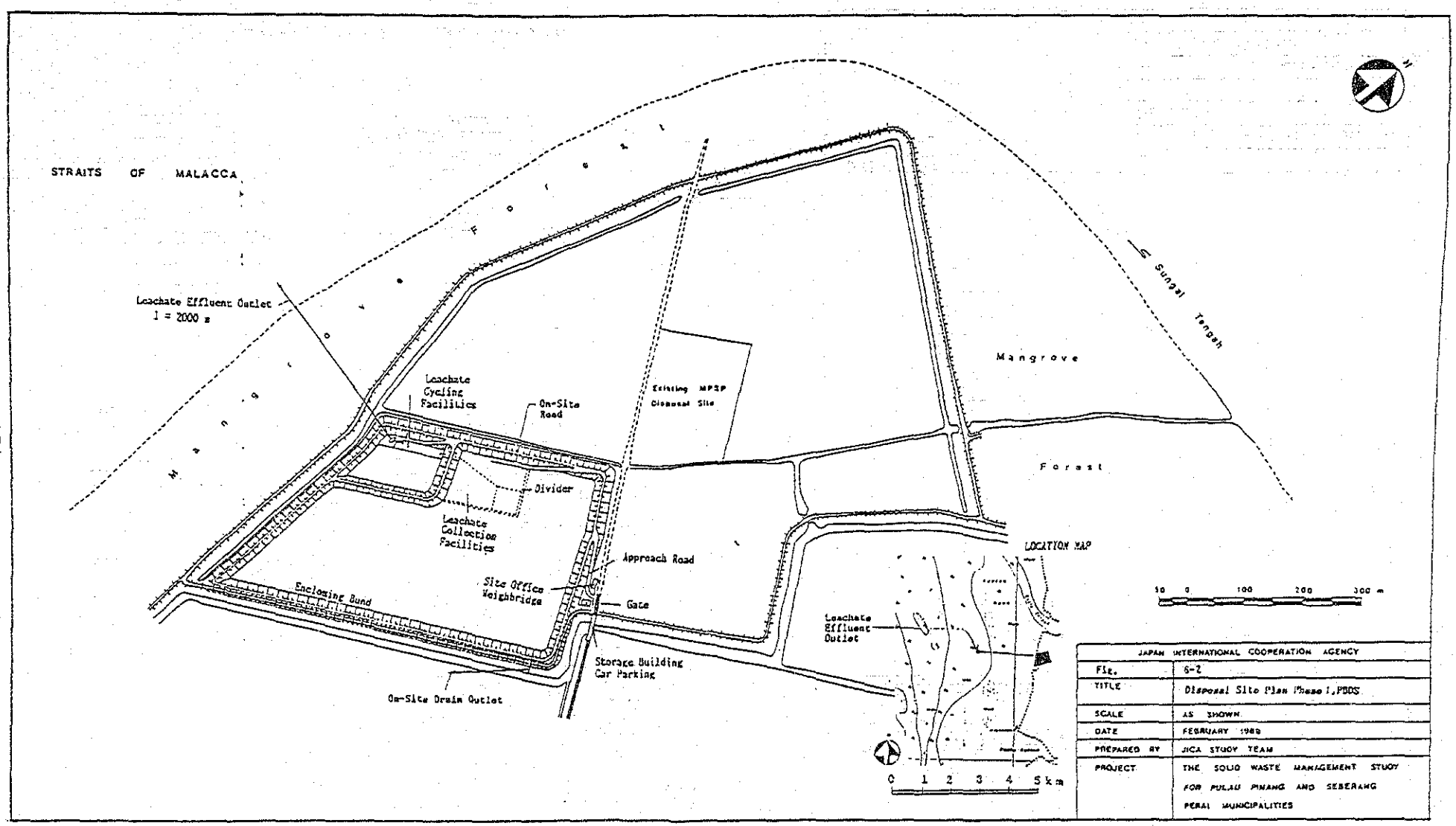
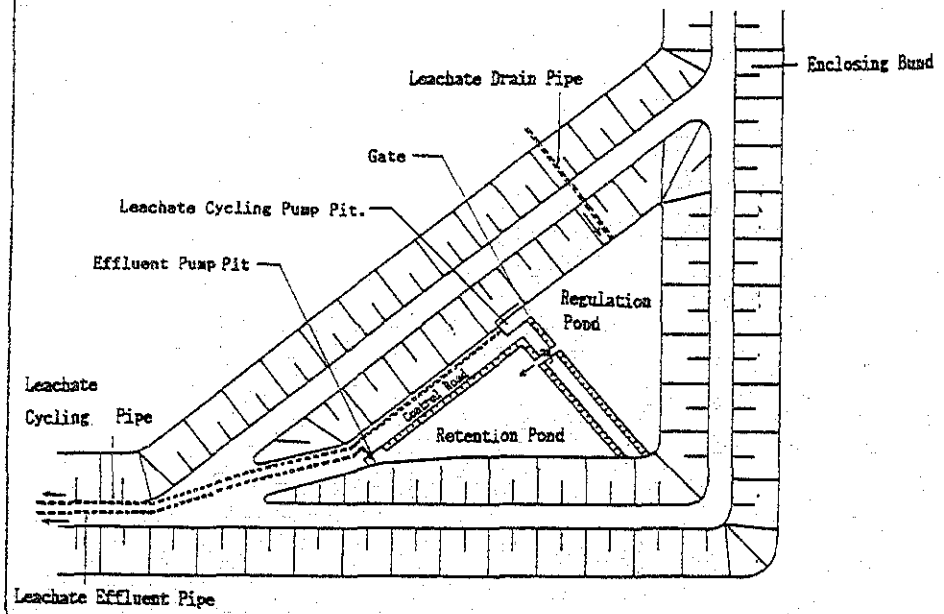
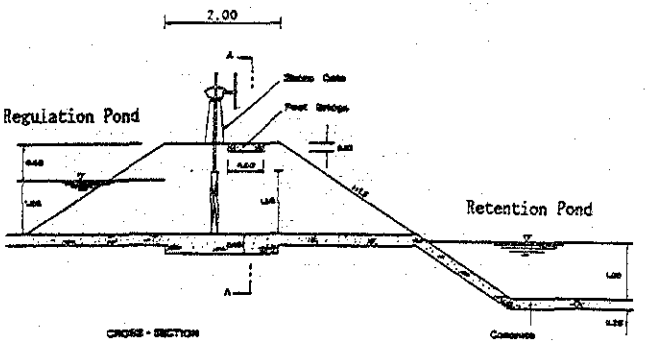


Fig. 4-2 Preliminary Design of PBDS Development for Phase I



Detail of Gate



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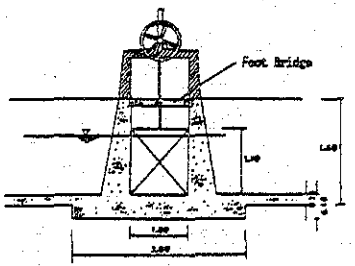
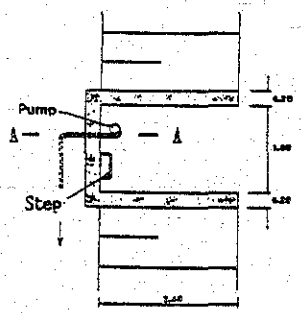


Front Elevation



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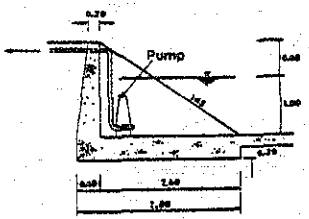
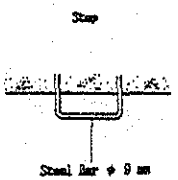




Leachate Cycling And Effluent Pump Pit

LEGEND	Fig. 4 - 3
	Detail Of Leachate Cycling Facilities
	For KMDS And PBDS
	:
	Source : JICA Study Team
	Scale : As Shown
	Date of Drawings :

THE SOLID WASTE MANAGEMENT STUDY FOR PULAU PINANG AND SEBERANG PERAI

Chapter 5 Project Options

There are 9 potential sites selected by the site selection committee. These options of project sites are Kuala Muda, Kampong Selamat, Mak Mandin, Prai Barrage, Prai Industrial Complex, Bukit Minyak, Gajah Mati, Pulau Burong and Bukit Tambun and their respective locations are shown in Fig. 5-1.

To determine the possible impacts that the project may cause on to the existing environment, evaluation on environmental acceptability consists of factors that protect major public and environmental interests from possible hazards induced to the surroundings by the project.

The extent of impact on each evaluation item is ranked and an overall environmental acceptability on each potential site is evaluated.

The evaluation on environmental acceptability of each project site is summarized in Table 5-1. Principally, Kampong Selamat, Prai Barrage and Prai Industrial Complex are found to be unsuitable as final disposal sites. Upon evaluation on political, social, legal and technical aspects in addition to the environmental aspect, Kuala Muda and Pulau Burong are finally selected.

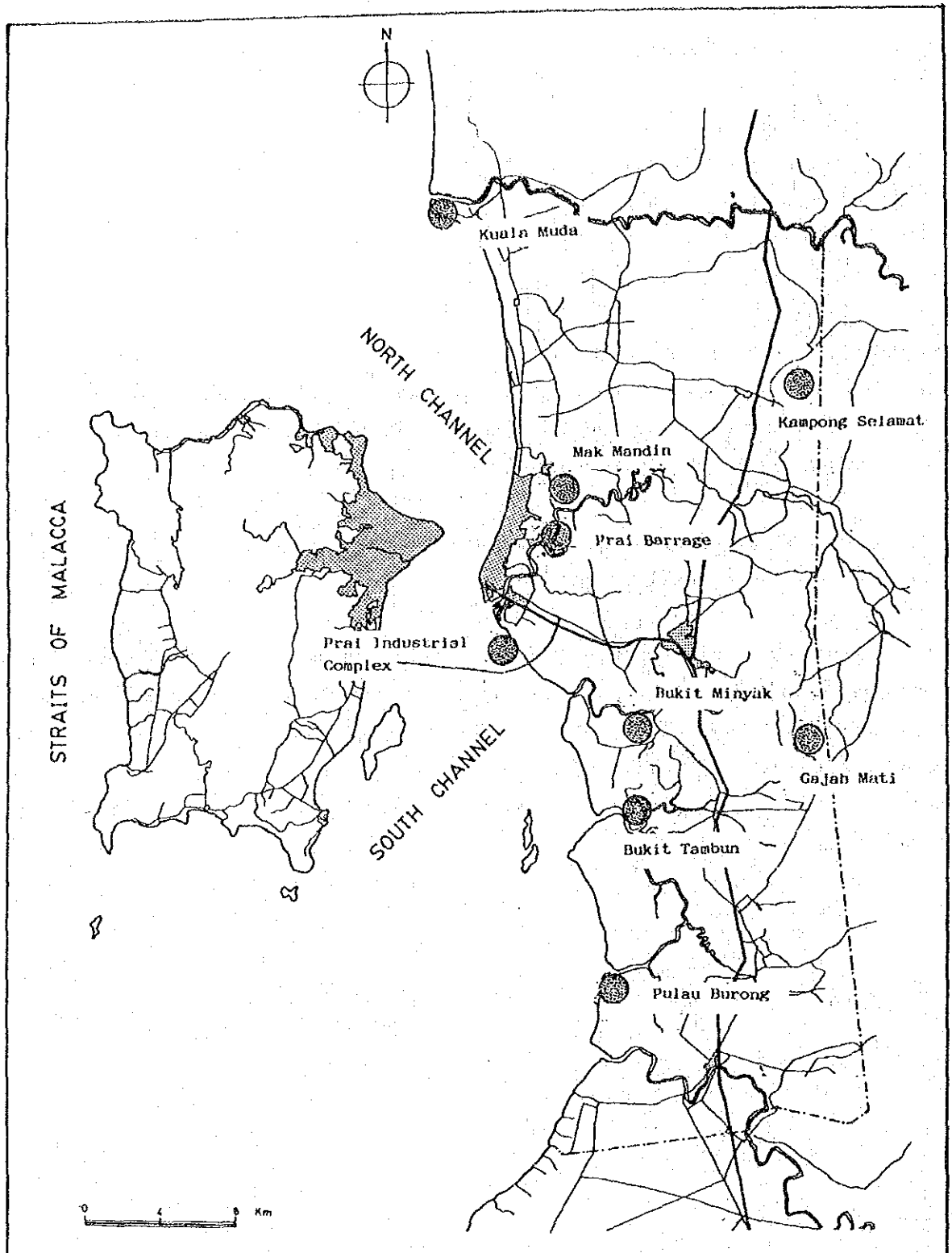


Fig. 5-1 Location of Potential Sites

Source : JICA Study Team

Table 5-1 Evaluation of Potential Site for Final Disposal on Environmental Acceptability

Evaluation Items	Kuala Muda	Kampong Selamat	Mak Mandin	Prai Barrage	Prai Industrial Complex	Bukit Minyak	Gajah Mati	Pulau Burung	Bukit Tambun
Overall Environmental Acceptability	Δ	×	Δ	×	×	Δ	Δ	Δ	Δ
a. Possibility of drinking water pollution	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
b. Impact by surface water pollution	Low	High	Fair	Fair	Low	Fair	High	Low	Low
c. Impact of flooding	Low	Very high	Low	Fair	Low	Fair	Nil	Nil	Low
d. Impact by groundwater pollution	Low	High	Fair	Fair	Low	Fair	High	Low	Low
e. Distance from airport and other public facilities	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate
f. Distance from densely populated area	Adequate if buffer zone were prepared	Adequate	Adequate if buffer zone were prepared	Adequate if buffer zone were prepared	Adequate	Adequate	Adequate	Adequate	Adequate
g. Possibility of dust, noise and odour hazards	Fair	Low	Fair	Fair	Low	Fair	Nil	Nil	Nil
h. Compatibility with land use of adjacent area	Fair	Good	Fair	Fair	Good	Fair	Fair	Good	Good
i. Slope stability	Good	Good	Good	Good	Good	Good	Further study	Good	Good
j. Impact on inshore or river fishery	Fair	Low	Fair	High	Fair	Low	Low	Further study	Further study
k. Impact on terrestrial vegetation and wildlife	Further study	Low	Low	High	High	Fair	Fair	Further study	Further study
l. Impact on Aquatic/Marine flora and fauna	Further study	Low	Low	High	High	Low	Nil	Further study	Low
m. Impact on natural landscape	Fair	Low	Low	High	Very high	Low	Low	Low	Low
n. Impact on historic places or structures	Low	Low	Low	Low	Low	Low	Low	Low	Low
o. Impact on religious places or structures	Low	Low	Low	Low	Low	Low	Low	Low	Low

Note:

For items a, b, c, d, g, j, k, l, m, n & o
: Very high, High, Fair, Low and Nil.

For items h & i
: Good, Fair and Poor.

For items e & f
: Adequate and Inadequate.

Δ means that there are some considerations or further study required for the clearance of some evaluation items.

× means that there is a critical barrier which cannot be cleared or there are some unsuitable points for a candidate site at this stage.

Chapter 6. The Existing Environment

Although it is best to consider and study the existing environment thoroughly, it should be recognized that such detail investigation within the limited time and financial constraints is not possible. For the purpose related to solid waste management environmental impact evaluation, the existing environmental study is divided into the following components:

(1) Air quality
(2) Water and soil quality
(3) Noise hazard
(4) Vegetation and Animals
(5) Landscape
(6) Historic and religious places

The existing conditions of these components shall be the baseline in measuring the extent of impacts of SWM in the project area.

6.1 Air Quality

With the project implementation, the air quality may be affected by pollutants from dust, emission from haulage vehicles and odor. Although there may be other air quality components that may be considered, their impacts are negligible and thus can be omitted.

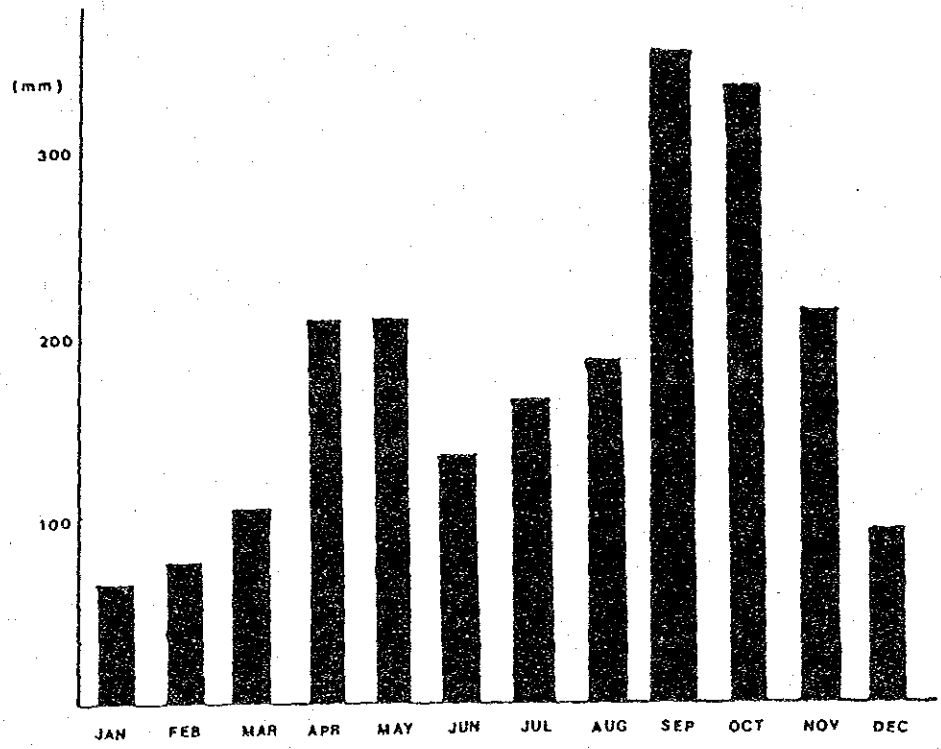
In view of these possible impacts to air quality, factors which would reduce the impacts are studied. Basically, air pollution caused by dust, exhaust gas and odor are reduced with the presence of favourable meteorological conditions such as winds and rainfall (precipitation). Based on this understanding, the impacts to existing air quality are discussed.

(1) Rainfall

The mean annual rainfall observed over a 16 year period (between 1969 and 1985) is 2,158.1 mm at Butterworth. The mean monthly rainfall distribution during this 16 year period is shown in Fig. 6-1. It is seen that in

September and October, the rainfall intensity exceeds 300 mm. On the other hand, during the months of January, February and December, less than 100 mm of rain is precipitated. Otherwise, Seberang Perai has been experiencing ten months which have more than 10 raindays in each month and a total of six months which have 15 days or more of raindays.

Hence, based on the intensity and number of raindays, it can be deduced that the degree or extent of suspended particulates and other pollutants can be mitigated naturally. Indirectly, frequently, the result of raindays may help keep air pollutants within the satisfactory levels.



No. of Rainday												
1969 - 1985 Mean:	6	9	11	16	18	13	14	15	21	22	19	12
Highest:	15	17	18	22	22	18	19	23	24	27	28	21

Annual Mean: 2,158.1 mm

* Source: Butterworth

Fig. 6-1 Mean Monthly Rainfall (1969 - 1985)

(2) Wind

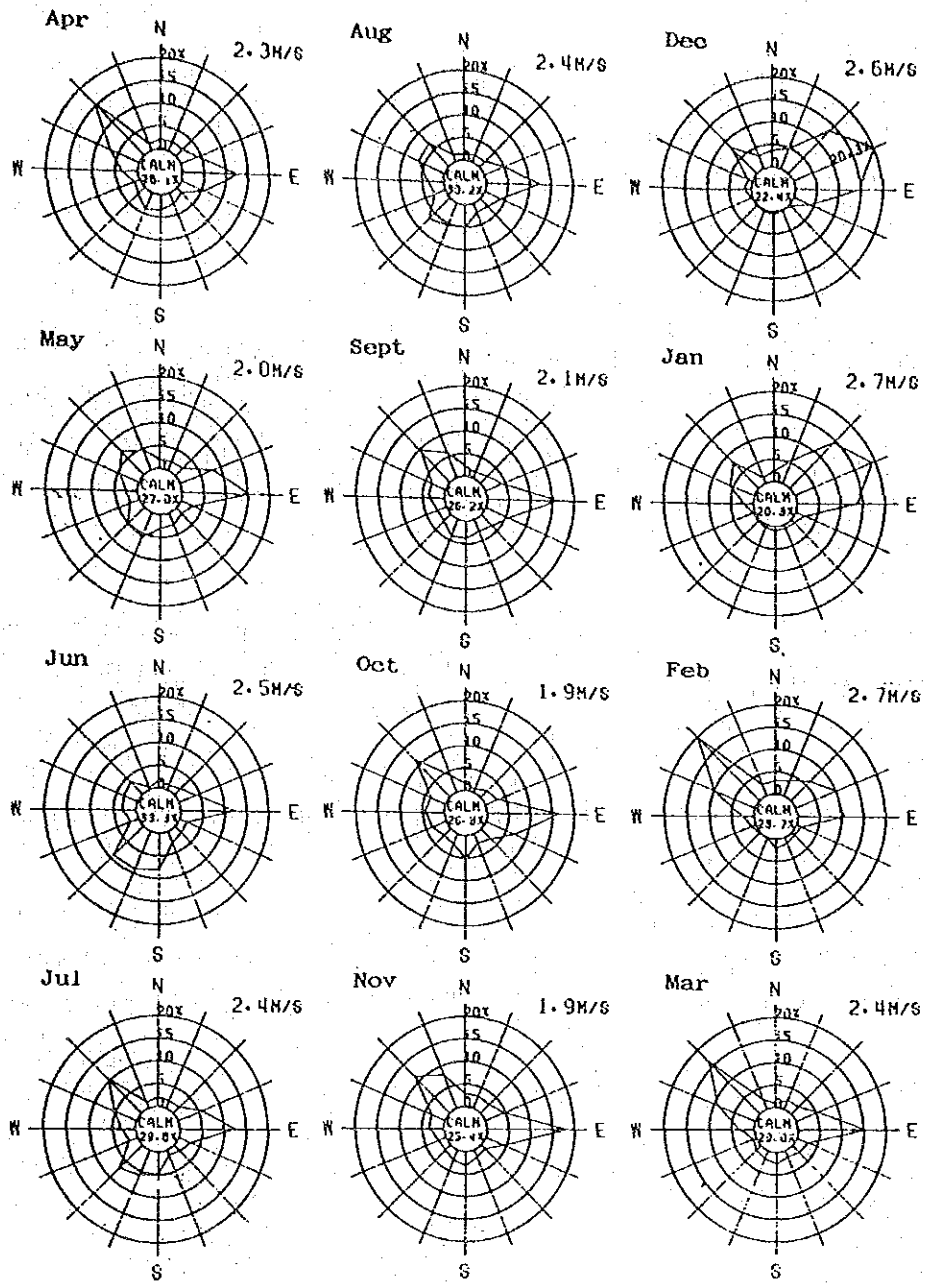
The monthly wind rose and monthly mean wind velocities in 1987 are shown in Fig.6-2.

Between December and January, the East North-East wind dominates the study area. From February to April, the orientation changes from North-West to East.

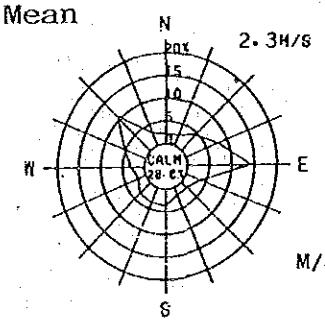
The mean wind velocities between December and February are higher than any other months. The wind velocities between December and February ranges between 2.6 m/s to 2.7 m/s.

Between May and November, although East wind is dominant, it is often complimented by the North-West wind.

The annual mean wind velocity is 2.2 m/s with the various dominant wind directions of East and North-West.



Annual Mean



M/S: meter per second (mean wind velocity)

Fig. 6-2 Wind Rose and Mean Wind Velocity in Butterworth

(3) Dust

In Draft Laporan Teknikal of Pelan Struktur Seberang Perai, it is reported that concentrations of dust from many monitoring stations in Seberang Perai range between 25 to 1000 mg/m^2/day. This value can be converted into 1.9 to 76.5 tons/$mile^2$/month.

For reference purposes, the data of suspended particulate matter and dustfall survey carried out at Permatang Pauh, between 1st September through 30 November in 1988 is adopted. The result is shown in Table 6-1 and Table 6-2, and the location map of sampling stations is shown in Fig. 6-3.

As to the study result of suspended particulates, the only point where the level exceeds the standard 0.10 mg/m^3 for industrial zone is on the dump site.

It would be interesting to note that although open dumping has been carried out and sometimes spontaneous fires have frequently occured in the existing disposal site, volume of dust around the site does not exceed the 30 tons/$mile^2$/month, proposed Malaysian Air Quality Standards. In October the result at every station exceeds the 10 tons/$mile^2$ /month for residential zone.

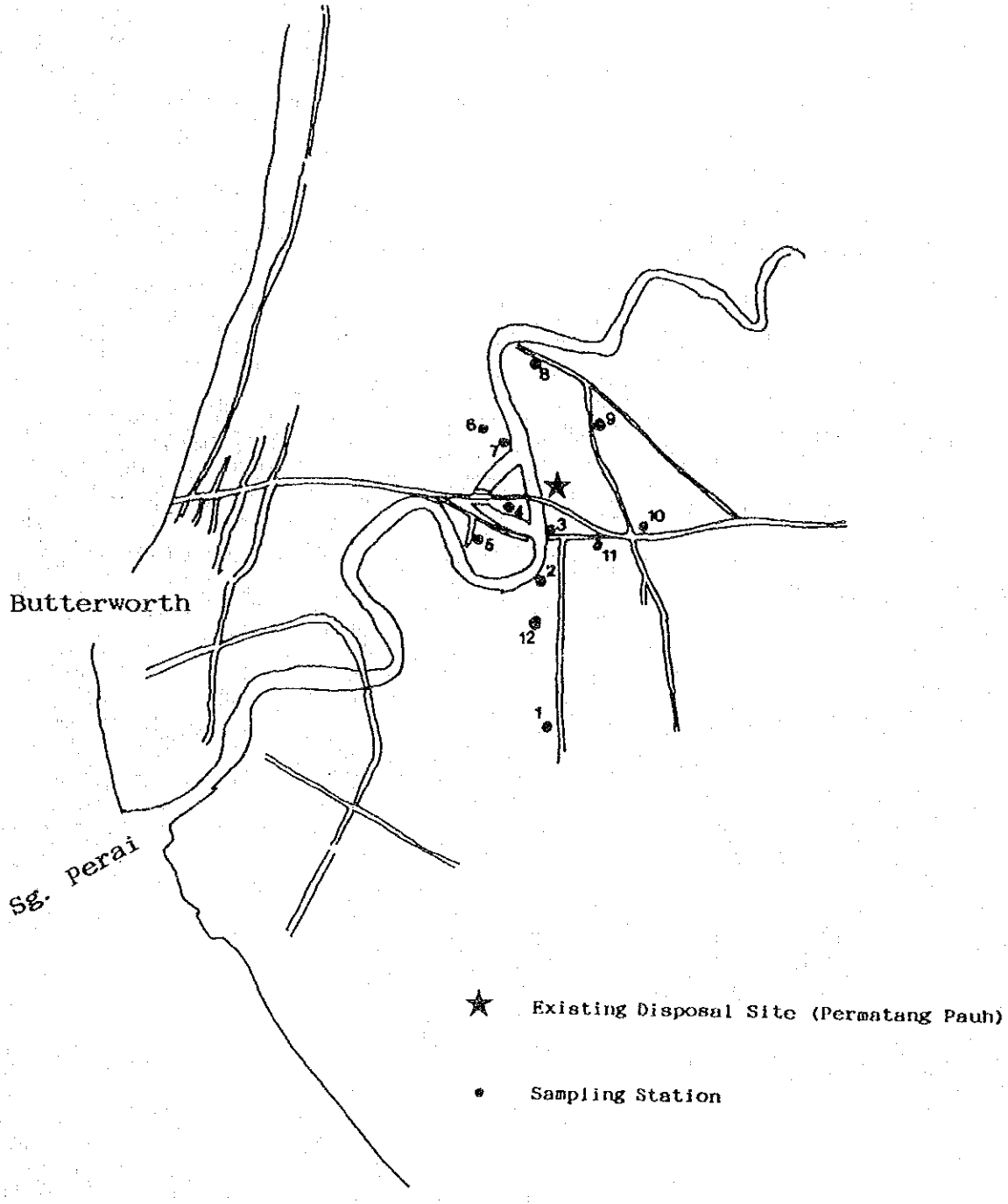


Fig. 6-3 Location Map of Dust Sampling Station

Table 6-1 Total Suspended Particulates Analysis for Permatang Pauh Area

(Unit:mg/m3)

No	Station	Times	Sept.	Oct.	Nov.	Standards*
-	Dump Site	1	0.153	0.115	0.186	
		2	0.137	0.116	0.223	
		3	0.077	0.115	-	
		4	-	0.141	-	
		ave.	0.122	0.122	0.205	
6	Oxidation pond (entrance)	1	0.067	0.061	0.079	
		2	0.064	0.051	0.087	
		3	-	0.045	-	
		4	-	0.070	-	
		ave.	0.066	0.057	0.083	
8	Telecom	1	0.065	0.040	0.045	
		2	0.061	0.046	0.051	24 hours
		3	0.025	0.055	0.040	0.05 mg/m3:
		ave.	0.051	0.047	0.046	Residential/ Common Zone
10	School	1	0.065	0.052	0.028	0.10 mg/m3:
		2	0.035	0.088	0.021	Industrial-
		ave.	0.051	0.070	0.025	Zone
12	JPT Office	1	-	-	0.032	
		2	-	-	0.033	
		3	-	-	0.051	
		ave.	-	-	0.039	

* Proposed Malaysia Air Quality Standards

Table 6-2 Dustfall Analysis for Permatang Pauh Area

(Unit:tons/mile^2/month)

No.	Station	Sept.	Oct.	Nov.	Proposed Malaysia Air Quality Standards
1	PDC	8.3	16.8	10.3	
2	River Bank	5.4	12.7	6.1	
3	Chinese Temple	6.7	17.1	15.6	30 : Industrial Zone
4	Open Field	10.6	11.7	6.9	
5	Sewage Treatment Plant	6.6	20.1	6.6	10 : Residential Zone
6	Oxidation pond (entrance)	9.1	16.8	8,2	
7	Oxidation pond	7.8	20.6	10.7	8 : Specially protected zone
8	Telecom	4.0	10.6	5.7	
9	Malay House	8.6	12.6	5.7	
10	School	7.0	10.6	6.9	
11	Private House	6.1	11.8	9.2	

(2) Carbon Monoxide

Based on the Penang island-wide air quality survey conducted by USM in 1981 - 1983, carbon monoxide (CO) exhaust by transportation sector is the single most important air pollutant in the State of Penang. The contribution rates of pollutants by the transportation sector are as follows: CO (99%), HC (85%), NOx (61%) and particulates (62%).

Since there is no data available on carbon monoxide (CO) in the area near Kuala Muda and PulauBurong, data obtained from tests carried out at Jalan Chain Ferry is adopted and shown in Table 6-3. All CO concentrations are below the proposed Malaysia Air Quality Standards.

(3) Odour

There are no main facilities that cause significant objectionable odour near the candidate sites in Kuala Muda and Pulau Burong.

Table 6-3 Carbon Monoxide Concentrations at Jalan Chain Ferry, Butterworth

Time	Thu. 12 Nov. 87	Fri. 20. Nov. 87	Mon. 30 Nov. 87	Wed. 9 Dec. 87	Tue. 27 Jan. 88	Mon. 1 Feb. 88	Thu. 4 Feb. 88	Wed. 12 Feb. 88	Tue. 23 Feb. 88	Standards
7 - 8	4.83	7.00	4.43	6.16	7.30	6.05	5.98	5.16	4.41	
8 - 9	4.88	5.98	4.28	5.95	5.54	3.80	4.89	4.90	5.63	
9 - 10	3.09	4.63	5.11	3.57	2.71	1.65	3.76	2.09	1.64	8 hours 9.00 ppm
10 - 11	2.09	3.09	3.29	5.08	3.88	2.66	2.89	3.56	1.88	1 hour 35.00 ppm
11 - 12	4.43	5.00	5.35	2.00	6.39	4.20	3.10	4.23	3.06	
12 - 13	5.43	5.58	5.26	1.43	6.09	5.39	5.71	6.86	4.54	
13 - 14	6.10	4.74	5.16	1.36	6.93	5.25	6.41	9.21	5.53	
14 - 15	3.98	5.06	5.99	1.55	5.64	5.64	5.14	4.50	4.09	
15 - 16	4.11	4.18	5.16	1.51	6.04	5.30	5.18	4.30	4.18	
16 - 17	4.36	6.03	4.98	2.45	7.05	4.88	5.19	5.41	5.63	
17 - 18	5.90	7.15	5.08	6.23	8.15	5.56	5.74	5.40	7.24	
18 - 19	6.91	3.69	4.62	4.25	6.57	2.18	5.82	4.01	4.01	

Standards: Proposed Malaysian Air Quality Standards

6.2 Water and Soil Quality

(1) Water Quality

There are no existing data available on water quality in the area near Pulau Burong.

The result of water quality analysis, which was carried out in the river and sea area near the candidate site in Kuala Muda, is shown in Table 6.4. and 6-5.

The Proposed Interim National Water Quality Standards for Malaysia, which is necessary for evaluation of water quality, is shown on Table 6-7.

Though this standard is prepared for fresh water, it will be applied as means of reference in the evaluation for sea water qualities in this report.

The result of water quality survey shows that almost all parameter indices are below the Class IV Standards of the proposed Interim Water Quality.

Water quality in Sungai Muda is in satisfactory and good condition, judging from the BOD and DO indices.

Table 6-6 shows the result of the water analysis conducted in Kuala Muda and Pulau Burong areas by the JICA Study Team.

The levels of almost all items, excluding total coliform, are below the proposed standards class IV.

Table 6-4 Results of Water Quality Analysis near Kuala Muda

	Date	16/Feb 87		21 Apr 87		8 Jun 87		12 Aug 87		26 Oct 87		8 Dec 87		11 Jan 88		14 Mar 88		4 May 88	
	St	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
PARAMETERS	(UNITS)																		
Ammoniacal Nitrogen	mg/L	0.24	0.49	0.05	0.03	0.10	0.02	0.16	0.13	0.20	0.12	0.08	0.07	0.15	0.15	0.43	0.03	0.14	0.24
BOD	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COD	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DO	mg/L	4.2	4.6	5.5	5.7	4.7	4.5	3.5	3.5	4.6	5.8	6.1	5.8	4.8	4.7	5.4	5.6	5.0	4.9
PH		6.8	7.4	-	-	7.3	7.7	7.6	7.2	7.5	6.9	6.5	6.9	6.1	6.3	7.4	7.4	8.4	7.6
Colour	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elec.Cond.	umhos/cm	35500	35500	25000	25000	18000	28000	10	20	60	100	50	100	3000	4000	1500	1800	1500	800
Floatables		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Odour		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	o/oo	23	22	14.5	14	10	16	0.5	1	0	0	0	0	2	2	2	3	2	7
Taste																			
Total Diss. Solid	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Susp. Solid	mg/L	185	80.5	65	5	80	25	45	30	70	45	125	10	220	45	95	110	45	125
Temperature	C	31	30	32	32.7	31	31	29	29	29	29	27	26	28	28	30	30	28	28
Turbidity	NTU	>100	>100	14	14	59	54	80	75	>100	>100	89	76	>100	37	37	21	99	>100
F. Colif.	counts/100mL	$5x10^2$	-	$3.0x10^5$	-	$1.7x10^3$	-	$>3.0x10^3$	-	$1.2x10^3$	-	$2.2x10^3$	-	$8.0x10^2$	-	$>3.0x10^3$	-	$2.5x10^3$	-
Tot. Colif.	counts/100mL	$5x10^2$	$1.3x10^2$	$4.5x10^2$	$1.1x10^2$	$5.5x10^3$	N.D	$5.5x10^3$	$>3.0x10^4$	$1.3x10^4$	$2.0x10^3$	$3.5x10^3$	$7.8x10$	$3.5x10^2$	$5.0x10^2$	$2.0x10^2$	$>3.0x10^3$	$5.0x10^2$	$6.0x10^2$

ST. 1: near the sea shore
ST. 2: 500m from the sea shore

Table 6-5 Results of Water Quality Analysis in Sungai Muda

PARAMETERS	Date / (units)	11 Jan 88	25 Feb 88	7 Mar 88	18 Apr 88	23 May 88	15 Jun 88
Ammoniacal Nitrogen	mg/L	0.10	0.05	0.18	0.11	0.18	0.28
BOD	mg/L	<1	<1	1	<1	<1	<1
COD	mg/L	20	20	20	20	15	20
DO	mg/L	5.9	4.5	8.0	3.4	4.0	4.4
pH		7.1	8.2	6.4	7.1	7.9	6.5
Colour	TCU	-	-	-	-	-	-
Elect. Cond.	umhos/cm	60	50	50	40	35	90
Floatables		-	-	-	-	-	-
Odour		-	-	-	-	-	-
Salinity	‰	-	-	-	-	-	-
Taste		-	-	-	-	-	-
Total Diss. Solid	mg/L	100	105	80	275	120	130
Total Susp. Solids	mg/L	30	50	15	50	5	25
Temperature	℃	29	29	30	30	29	26
Turbidity	(NTU)	(<5)	(30)	(15)	(30)	(160)	(70)
F. Colif.	counts/ 100mL	-	-	-	-	-	-
Tot. Colif	counts/ 100mL	-	-	-	-	-	-

About 13km upstream the mouth of Sungai Muda

Table 6-6 The Results of Water Quality Analysis by JICA Study Team

PARAMETERS	(UNITS)	Kuala Muda		Pulau Burong	
		24 Nov.	2 Dec.	22 Nov.	1 Dec
Ammoniacal Nitrogen	mg/L	-	-	-	-
BOD	mg/L	<1	<1	<1	<1
COD	mg/L	32	15	53	11
DO	mg/L	4.5	4.3	2.5	4.4
pH		6.8	8.0	7.7	8.0
Colour	TCU				
Elect.Cond.	umhos/cm	$32x10^2$	$456x10^2$	-	$425x10^2$
Floatables		-	-	-	-
Odour		-	-	-	-
Salinity	o/oo	-	-	-	-
Taste		-	-	-	-
Total Diss. Solid	mg/L	-	-	-	-
Total Susp. Solid	mg/L	253	264	636	164
Temperature	^oC	26.8	27	27	26.5
Turbidity	NTU	-	-	-	-
F. Colif.	counts/ 100mL	$4.6x10^3$	$9.3x10^2$	$9.3x10^2$	$2.4x10^2$
Tot. Colif.	counts/ 100mL	$9.8x10^4$	$8.0x10^3$	$3.0x10^5$	$1.8x10^4$
Pb	mg/L	0.0029	0.006	0.0033	0.0045
Cd	mg/L	N.D.	0.0019	0.0029	0.001
Hg	mg/L	N.D.	N.D.	N. D.	N.D.
Total N	mg/L	0.2	0.8	3.0	0.7
Organo - P	mg/L	0.013	0.029	0.021	0.009

Continue ...

PARAMETERS	(UNITS)	Muda River 24 Nov.	Muda River 2 Dec.
Ammoniacal Nitrogen	mg/L		
BOD	mg/L	<1	<1
COD	mg/L	58	12
DO	mg/L	5.1	7.3
pH		6.7	7.2
Colour	TCU		
Elect.Cond.	umhos/cm	6.0	50
Floatables		-	-
Odour		-	-
Salinity	o/oo	-	-
Taste		-	-
Total Diss. Solid	mg/L	-	-
Total Susp. Solid	mg/L	185	129
Temperature	^{o}C	26.3	24.5
Turbidity	NTU	-	-
F. Colif.	counts/ 100mL	$1.1x10^{4}$	$2.4x10^{3}$
Tot. Colif.	counts/ 100mL	$2.4x10^{5}$	$1.0x10^{5}$
Pb	mg/L	0.0026	0.0069
Cd	mg/L	N.D.	N.D.
Hg	mg/L	N.D.	N. D.
Total N	mg/L	0.8	0.3
Organo - P	mg/L	0.036	0.001

Table 6-7 Proposed Interim National Water Quality Standards for Malaysia

PARAMETERS	(units)	CLASSES I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/L	0.1	0.3	0.3	0.9	2.7	>2.7
BOD	mg/L	1	3	3	6	12	>12
COD	mg/L	10	25	25	50	100	>100
DO	mg/L	7	5-7	5-7	3-5	<3	<1
pH		6.5-8.5	6-9	6-9	5-9	5-9	-
Colour	TCU	15	150	150	-	-	-
Elect. Cond.*	µmhos/cm	1000	1000	-	-	6000	-
Floatables		N	N	N	-	-	-
Odour		N	N	N	-	-	-
Salinity*	°/oo	0.5	1	-	-	2	-
Taste		N	N	N	-	-	-
Total Diss. Solid*	mg/L	500	1000	-	-	4000	-
Total Susp. Solids	mg/L	25	50	50	150	300	>300
Temperature	°C	-	Normal ±2	-	Normal ±2	-	-
Turbidity	NTU	5	50	50	-	-	-
F. Colif.**	counts/ 100mL	10	100	400	5000 (20000)[a]	5000 (20000)[a]	
Tot. Colif.	counts/ 100mL	100	5000	5000	50000	50000	>50000

N = No visible floatable materials/debris,
or No objectionable odour,
or No objectionable taste.

* = Related parameters, only one recommended for use

** = Geometric mean

a = Maximum not to be exceeded

CLASS	USES
I	Conservation of natural environment Water supply I --practically no treatment necessary (except by disinfection or boiling only) Fishery I - very sensitive aquatic species
IIA	Water supply II - conventional treatment required Fishery II - sensitive aquatic species
IIB	Recreational use with body contact
III	Water supply III - extensive treatment required Fishery III - common, of economic value, and tolerant species Livestock drinking
IV	Irrigation
V	None of the above

Continued ...

PARAMETERS	(units)	CLASSES I	IIA/IIB	III#		IV	V
Al	mg/L		–	–	(0.06)	0.5	
As	mg/L		0.05	0.4	(0.05)	0.1	
Ba	mg/L		1	–		–	
Cd	mg/L		0.01	0.01*	(0.001)	0.01	
Cr(VI)	mg/L		0.05	1.4	(0.05)	0.1	
Cr(III)	mg/L		–	2.5		–	
Cu	mg/L		1	–		0.2	
Hardness	mg/L		250	–		–	
Ca	mg/L		–	–		–	
Mg	mg/L		–	–		–	
Na	mg/L		–	–		3 SAR	
K	mg/L		–	–		–	
Fe	mg/L		0.3	1		1 (leaf) 5 (others)	
Pb	mg/L		0.05	0.02*	(0.01)	5	
Mn	mg/L		0.1	0.1		0.2	
Hg	mg/L		0.001	0.004	(0.0001)	0.002	
Ni	mg/L		0.05	0.9*		0.2	
Se	mg/L		0.01	0.25	(0.04)	0.02	
Ag	mg/L		0.05	0.0002		–	
Sn	mg/L		–	0.004		–	
U	mg/L		–	–		–	
Zn	mg/L		5	0.4*		2	
B	mg/L		1	–	(3.4)	0.8	
Cl	mg/L		200	–		80	
Cl_2	mg/L		–	–	(0.02)	–	
CN	mg/L		0.02	0.06	(0.02)	–	
F	mg/L		1.5	10		1	
NO_2	mg/L		0.4	0.4	(0.03)	–	
NO_3	mg/L		7	–		5	
P	mg/L		0.2	0.1		–	
Si	mg/L		50	–		–	
SO_4	mg/L		250	–		–	
S	mg/L		0.05	–	(0.001)	–	
CO_2	mg/L		–	–		–	
Gross-α	Bq/L		0.1	–		–	
Gross-β	Bq/L		1	–		–	
Ra-226	Bq/L		<0.1	–		–	
Sr-90	Bq/L		<1	–		–	

NATIVE LEVELS

* = At hardness 50 mg/L $CaCO_3$

\# = Maximum (unbracketed) and 24-hr average (bracketed) concentrations

Continued ...

PARAMETERS	(units)	CLASSES I	IIA/IIB	III#		IV	V
CCE	µg/L	↑	500	-		-	-
MBAS/BAS	µg/L	N	500	5000	(200)	-	-
O&G (mineral)	µg/L	A	40;N	N		-	-
O&G(emulsified edible)	µg/L	T	7000;N	N		-	-
PCB	µg/L	L	0.1	6	(0.05)	-	-
Phenol	µg/L	E	10	-		-	-
Aldrin/ Dieldrin	µg/L	V E L	0.02	0.2	(0.01)	-	-
BHC	µg/L	S	2	9	(0.1)	-	-
Chlordane	µg/L		0.08	2	(0.02)	-	-
t-DDT	µg/L	O	0.1	1	(0.01)	-	-
Endosulfan	µg/L	R	10	-		-	-
Heptachlor/ Epoxide	µg/L	A	0.05	0.9	(0.06)	-	-
Lindane	µg/L	B S	2	3	(0.4)	-	-
2,4-D	µg/L	E	70	450		-	-
2,4,5-T	µg/L	N	10	160		-	-
2,4,5-TP	µg/L	T	4	850		-	-
Paraquat	µg/L	↓	10	1800		-	-

N = Free from visible film, sheen, discoloration and deposits
\# = Maximum (unbracketed) and 24-hr average (bracketed) concentration

(2) Soil

a. Geological profile

Soil investigation works have been carried out in the candidate site of Kuala Muda and Pulau Burong by the JICA study team. Based on the works, a geological profiles are made and illustrated in Fig. 6.4 and Fig. 6-5.

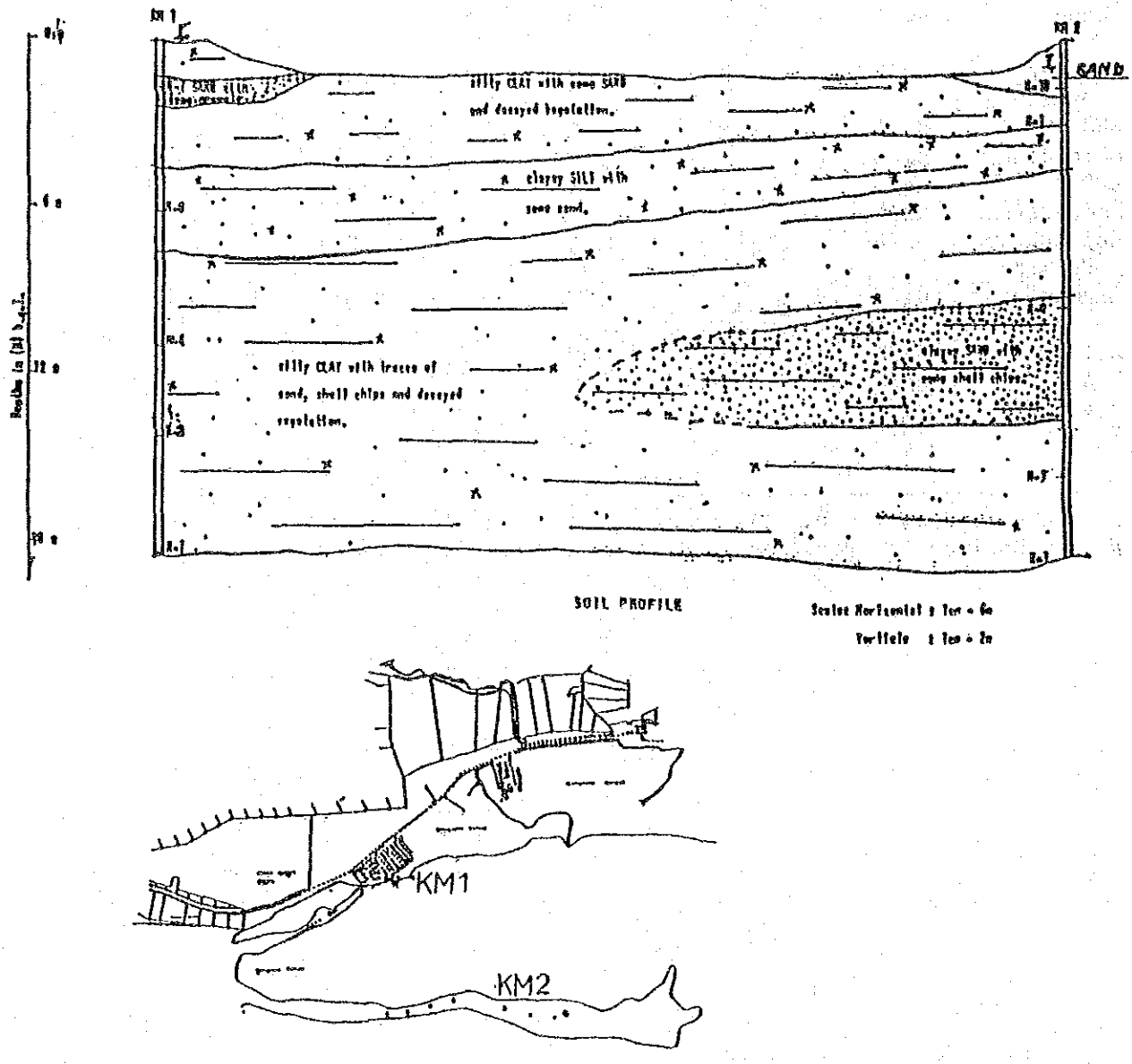


Fig. 6-4 Geological Profile of KMDS

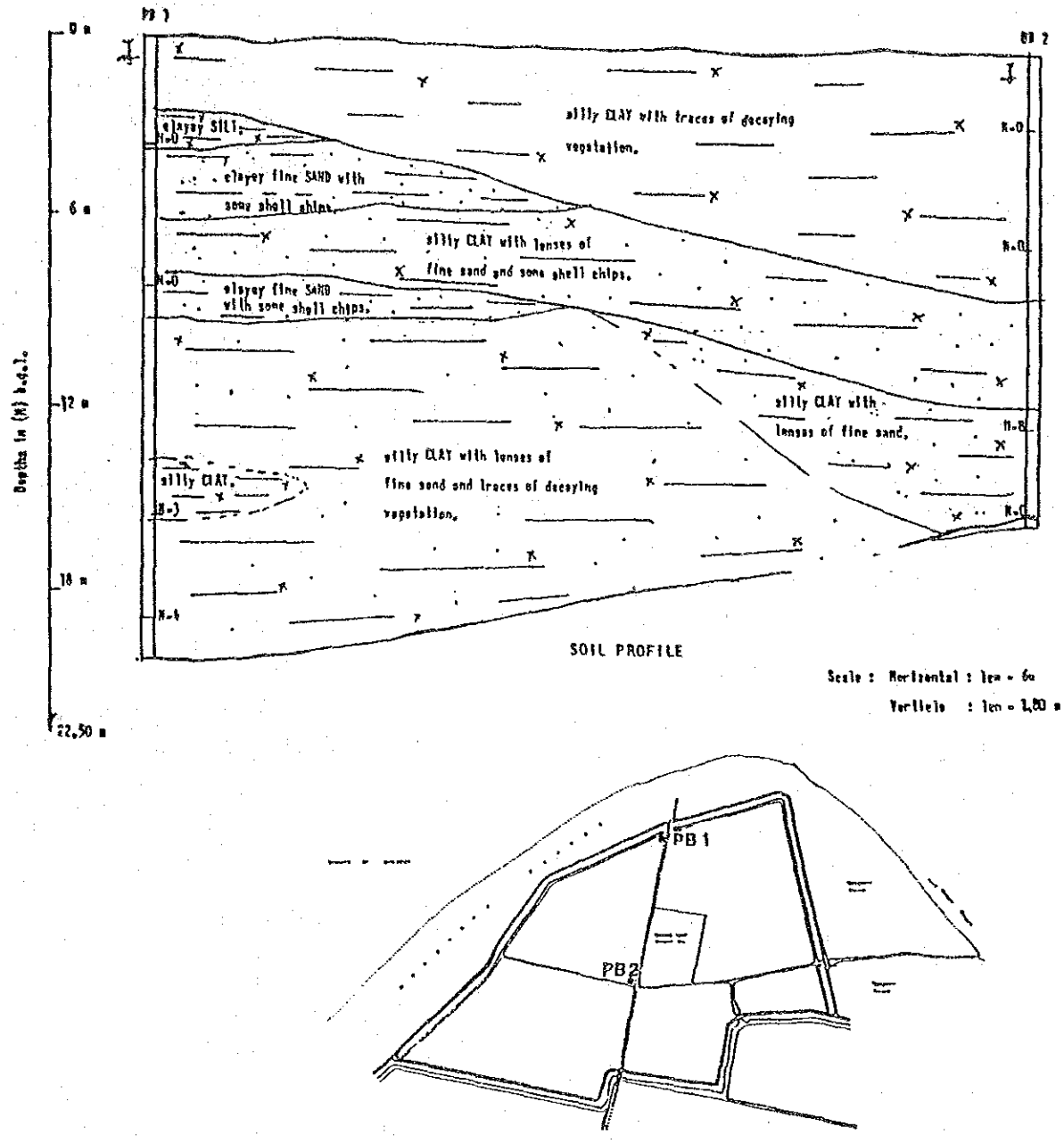


Fig. 6-5. Geological Profile of PBDS

According to the geological profile, marine silty clay exists to a depth of 18 meters below ground level with fine sand and shell fragments partly.

b. Soil characteristics

Laboratory testing on selected soil samples has been performed to evaluate the engineering parameters of the subsoil encountered. Based on soil test, characteristics of marine clay are summarized as follows:

	KMDS	PBDS
Natural Moisture Content (%)	60-80	60-90
Bulk Density (ton/m^3)	1.5-1.6	1.55-1.7
Specific gravity	2.4-2.7	2.4-2.7
Atterberg Limit		
- Plastic Limit (%)	25-40	23
- Liquid Limit (%)	47-90	40-70
Permeability Coefficient (cm/sec)	10^{-6}-10^{-7}	10^{-6}-10^{-7}

6.3 Noise Hazards

Since there has been no available data on noise for Kuala Muda and Pulau Burong at the time this report was written, the data obtained from the Pelan Struktur Seberang Perai Report is adopted as the noise condition in local districts.

There exist very close relationship between the traffic volume and noise level. For this reason, the traffic volume and traffic noise are discussed in the subsequent section.

(1) Traffic Volume

The main source of noise pollution in residential areas comes from vehicles.

The 12 hours traffic volumes relating to the candidate site in Kuala Muda and Pulau Burong are summarized in Fig. 6-6 and Table 6-8. Fig. 6-7 gives hourly traffic volumes at each point.

Table 6-8 Traffic Volumes relating to the Candidate Site

Unit: Vehicles/12 hours

No	Cars (motor cycles)	lorries	Total	% Lorry Traffic
1	1746 (1130)	174	1920	9.1
2	3737 (2510)	131	3868	3.4
3	2252 (1305)	186	2438	7.6
4	9845 (2349)	1567	11412	13.7
5	11899 (3554)	1747	13646	12.8
6	18744 (5831)	3113	21857	14.2
7	1927 (977)	392	2319	16.9
8	516 (326)	106	622	17.0
9	1251 (835)	111	1362	8.1
10	979 (693)	84	1063	7.9

By JICA Study Team on December 20, 1988

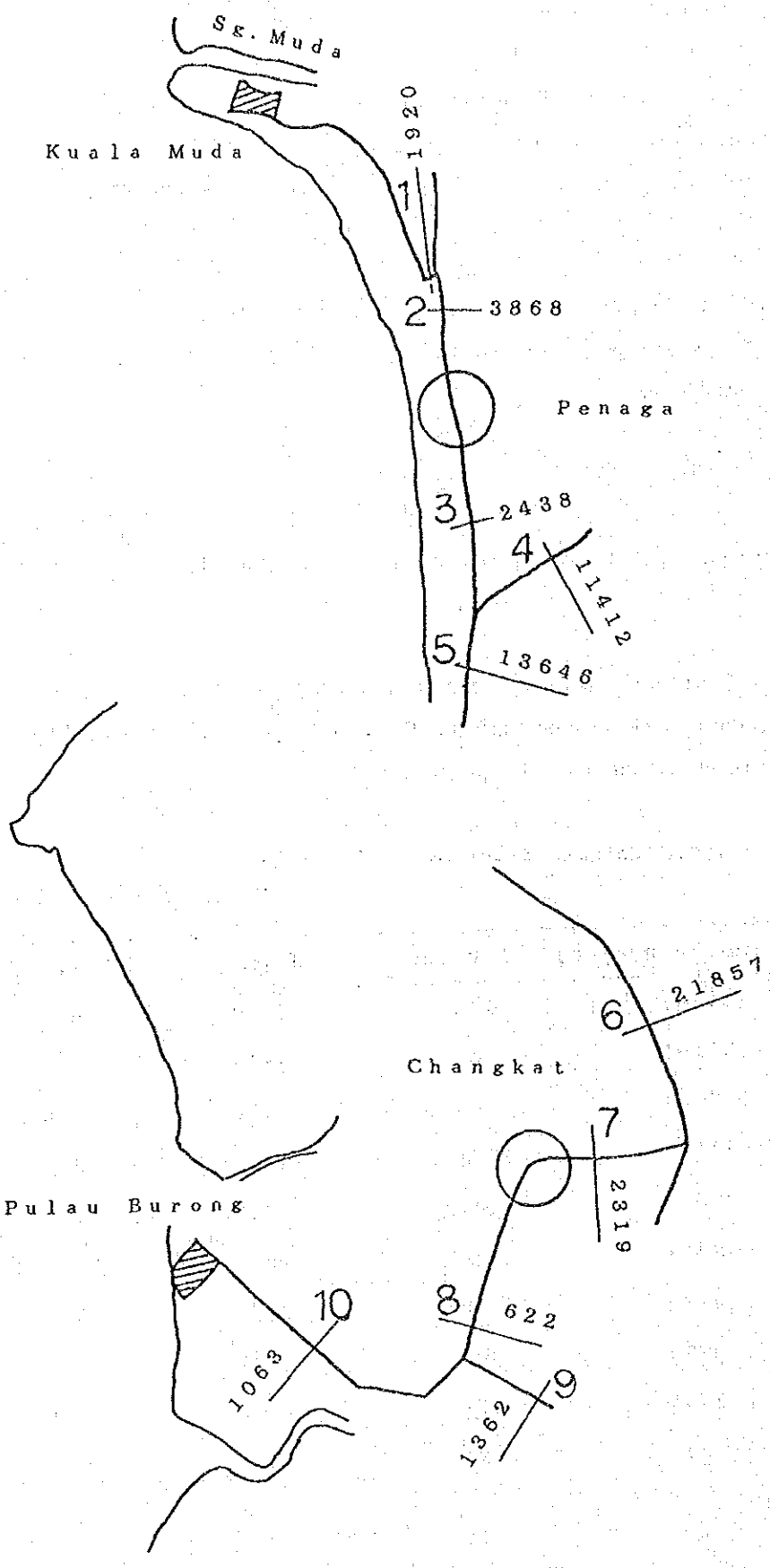
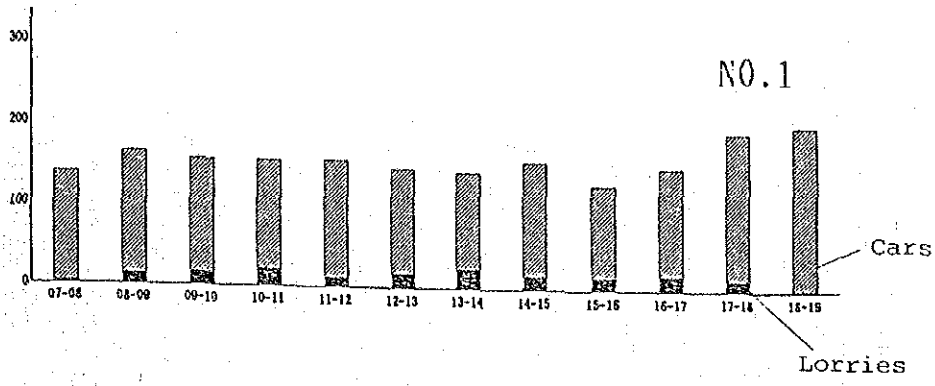
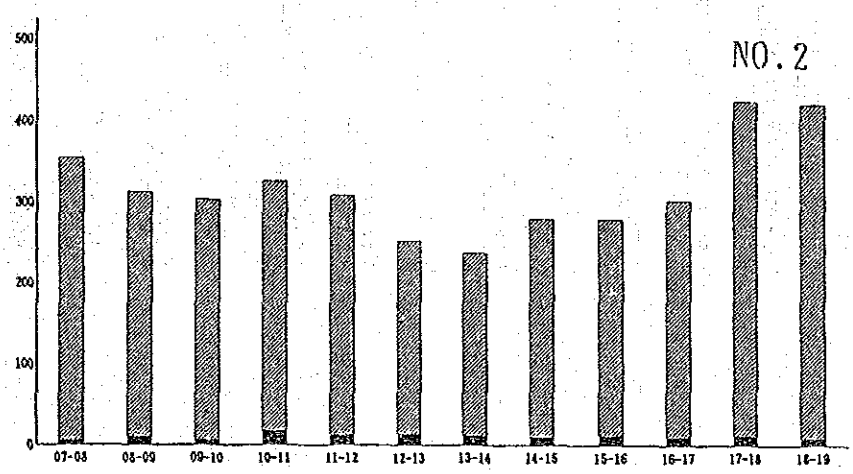


Fig.6-6 Traffic volumes relating KMDS & PBDS





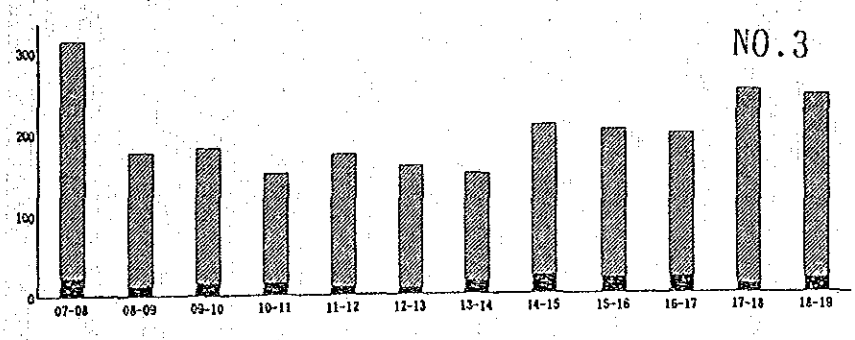


Fig.6-7 Hourly traffic volumes at each point

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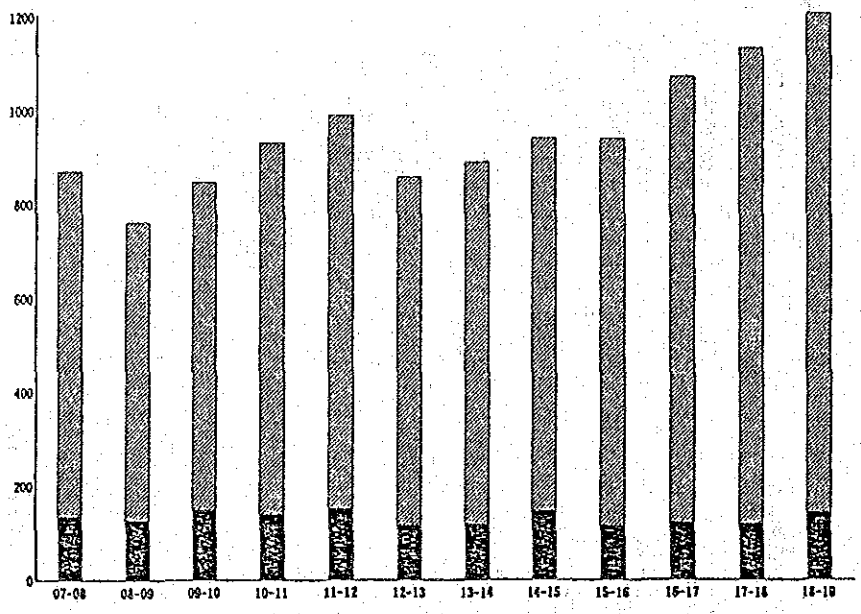

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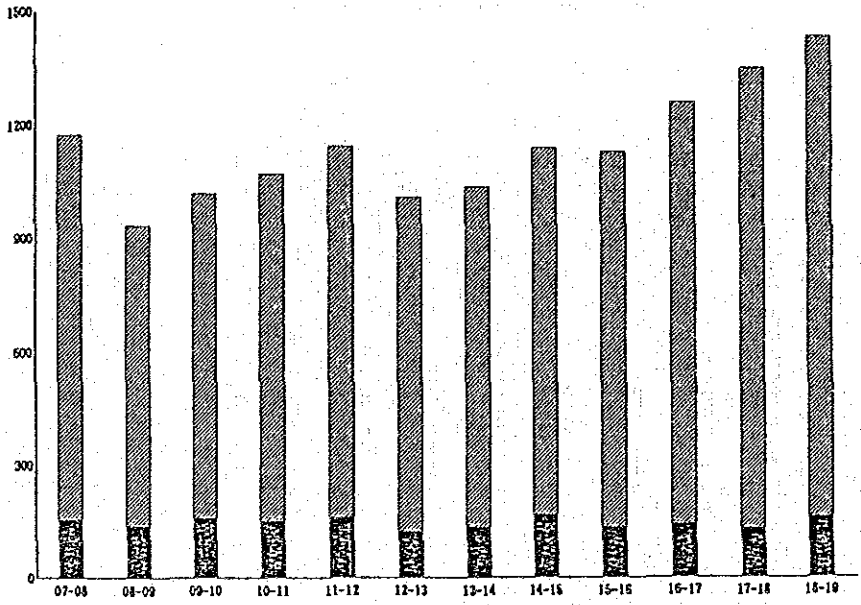

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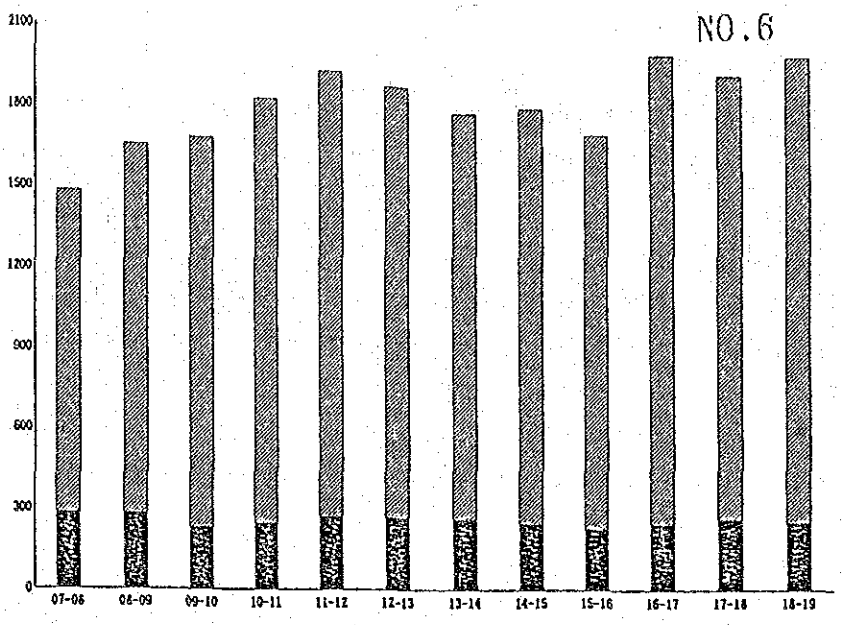
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1800
1500
1200
900
600
300
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07-08
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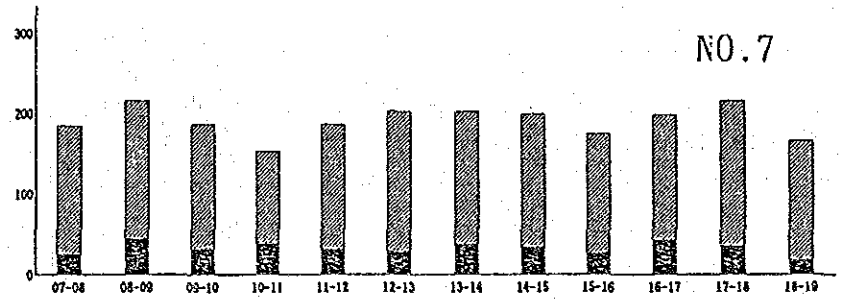
15-16
16-17
17-18
18-19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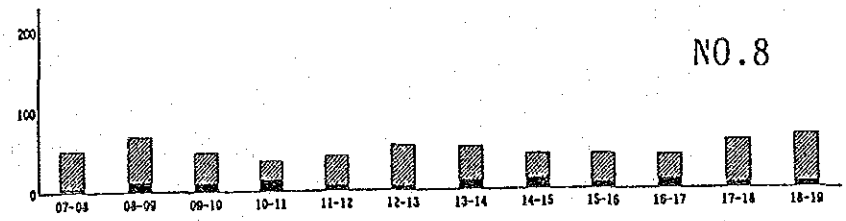
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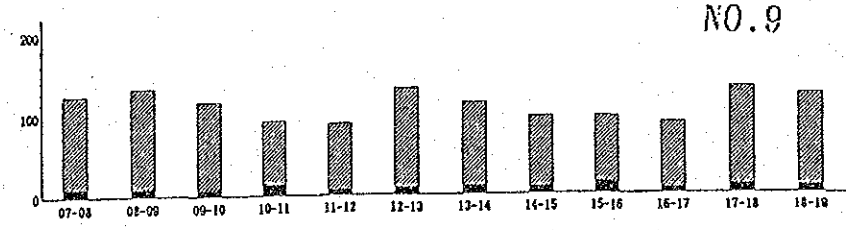
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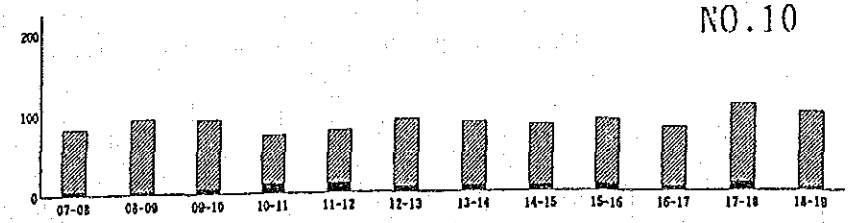
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13-14
14-15
15-16
16-17
17-18
18-19

(2) Traffic Noise

Data on noise collected from the main roads and from the kampong area situated along the roads is shown in Table 6-9 and the locations in Fig. 6-8

Noise levels over the road having heavy traffic flows are very high and exceed 70 dBA. Whilst in the kampong areas set away from the main roads, noise levels are between 5 to 10 dBA less than noise levels over the road. However, all the noise levels from these areas exceed the 55 dBA, recommended by WHO, with a minimum difference of 10 dBA.

Table 6-9. Traffic Noise and Volume in Seberang Perai

ST.	Noise Level (Leq. dBA)	Traffic Volume (Vehicles/hr)	Remark
1	77.5	1339	Kepala Batas
2	77.5	1642	Telok Air Tawar
3	77.1	1894	Jalan Nibong Tebal
4	70.7	979	Jalan Atas, Nibong Tebal
5	66.5	-	Kg. Penaga II
6	65.2	-	Kg. Valdor
7	68.0	-	Nibong Tebal
8	66.5	-	Chinese Primary School, Penaga

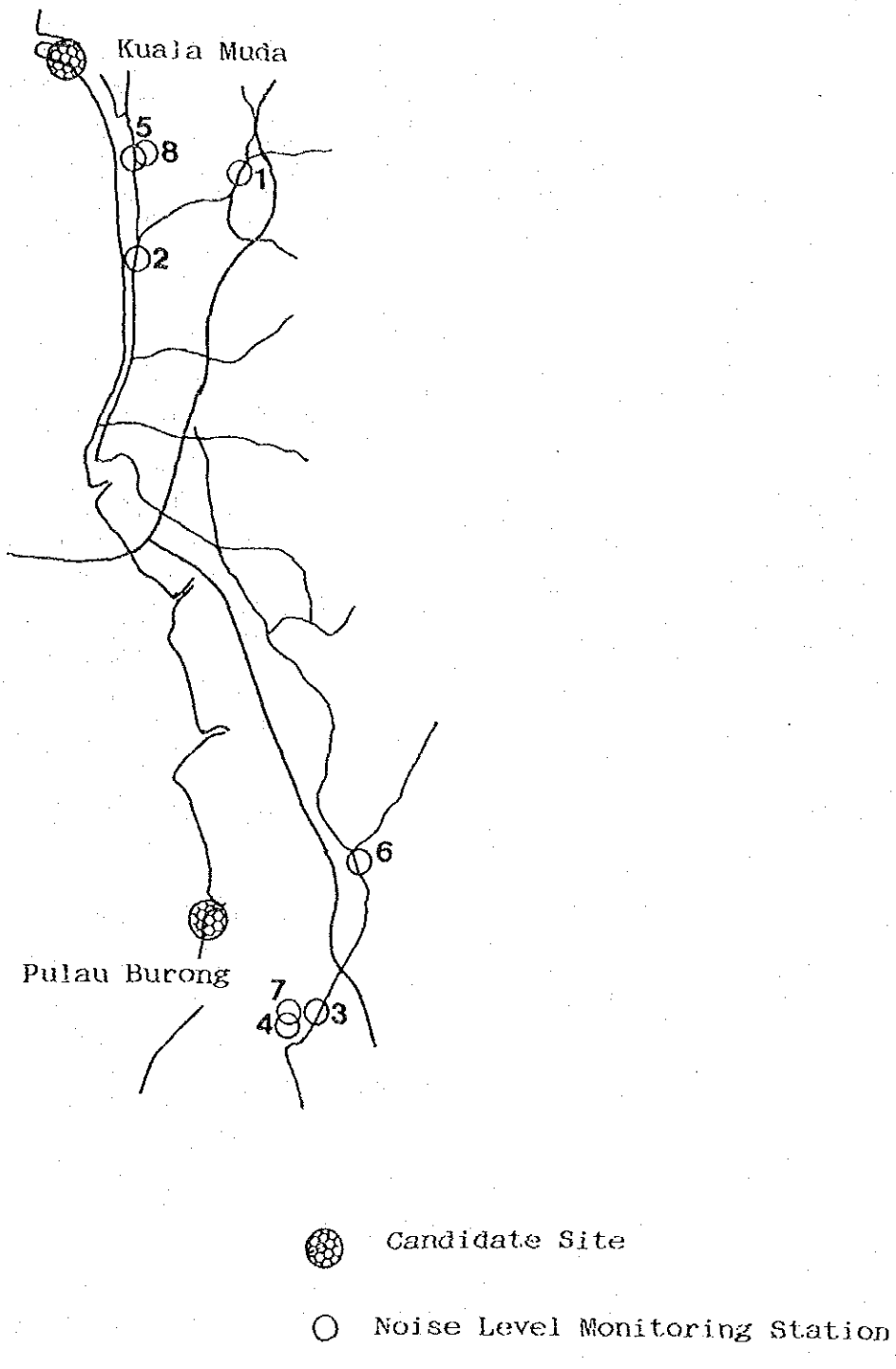


Fig. 6-8 Location of Noise Monitoring stations

(3) Landuse

Residential areas around the candidate sites and along the access roads are shown in Fig. 6-9 and Fig. 6-10.

The distance from the disposal operation area to the nearest house is about 110 m in Kuala Muda. On the other hand, no houses are situated near the site in Pulau Burong. It should also be noted that on both sides of the access roads towards the candidate site in Kuala Muda are lined with houses.

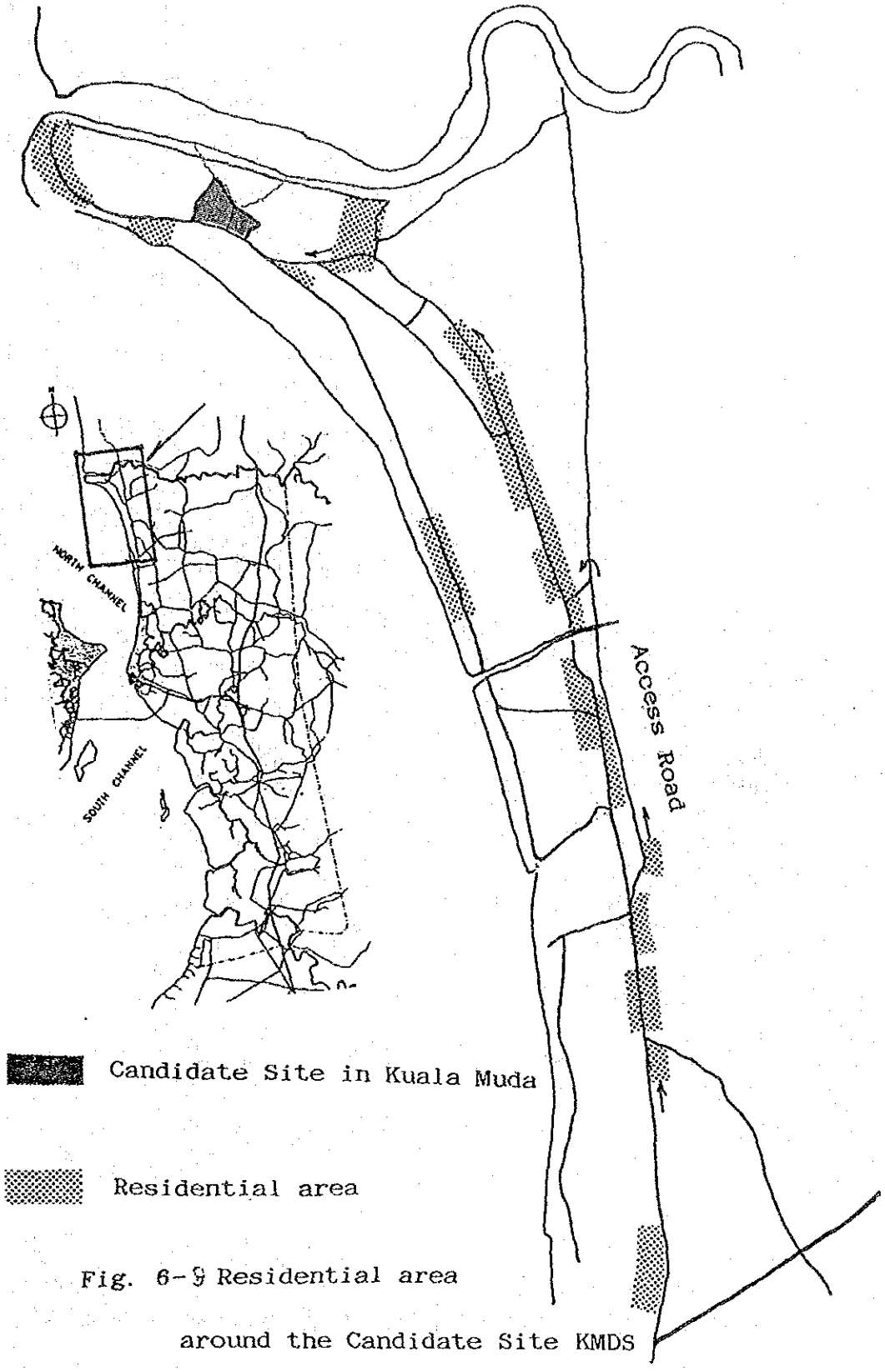


Fig. 6-9 Residential area around the Candidate Site KMDS

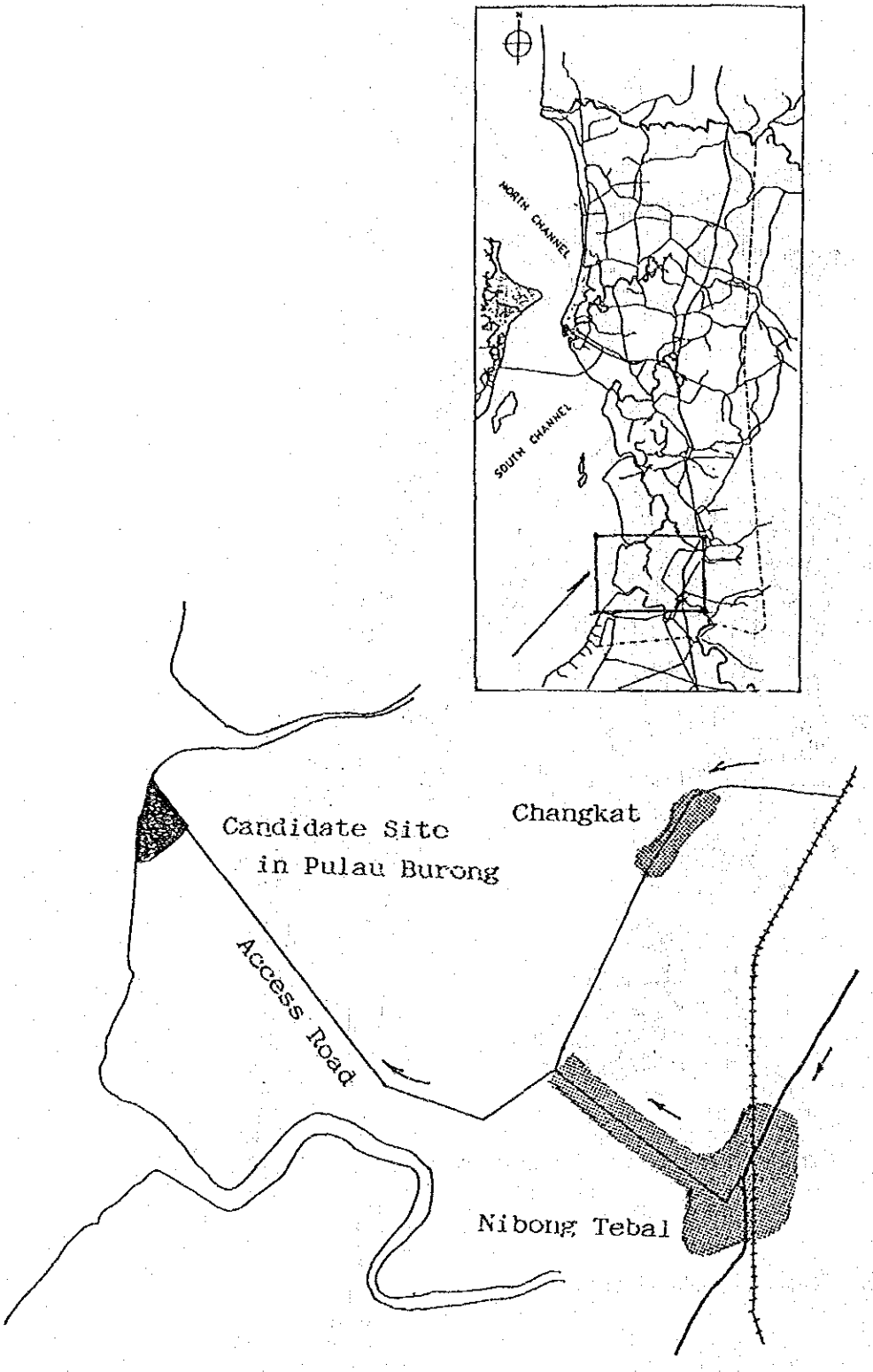


Fig. 6-10 Residential Area around the Candidate Site PBDS

6.4 Vegetation and Animals

6.4.1 Vegetation

(1) Flora and Vegetation

In Kuala Muda, there is very little natural vegetation left in vicinity of the site, as most of the trees have been chopped some time ago. There are very few existing trees, except some planted coconut trees. Parts of the area are covered by shrubs and grass.

Pulau Burong was completely covered with mangrove vegetation in the 1980 aerial photographs. At the present moment, except for a fringe of mangrove vegetation about 50 meters wide, the whole island has been cleared of vegetation.

One part of the island is now the present dump site of the MPSP. The remaining cleared areas are used for agriculture, mainly the growing of maize and the vegetables.

The mangrove trees at the fringe include Rhuzophera, Bruguiera and Avicennia. Some are matured trees and up to about 60 ft (18 m) high.

Detail ecological study has been done by USM.

(2) The Value of Mangrove

Mangrove forests in Malaysia occur mainly along the west coast of Peninsular Malaysia, at the estuaries of the Sarawak, Rejang and Trusan-Lawas rivers of Sarawak and along the east coast of Sabah (Fig. 6-8).

The areal extent of these forests in Peninsular Malaysia, Sabah and Sarawak has been estimated to be about 120,000 ha, 284,000 ha and 173,000 ha respectively about 351,000 ha occur as forest reserves. The values of the mangrove resouce are many and of great importance to the socio-economy of the country.

The importance of the resource derives both from the direct products taken from the mangrove forests and from the amenties provided by the resource from within and beyond their boundaries.

Products taken from the mangrove forests are mainly wood for charcoal, poles and firewood. In terms of economic value per hectare per annum of timber, the mangrove forests have been amongst the most valuable in the country. The leaves of the nipa palm, Nipa fruticans, are used for making roof thatches and cigarrette wrappers while the inflorescences are tapped for nipa sugar for conversion to alcohol. In Sabah and Sarawak, mangrove timber is an important source of wood-chips for the manufacture of rayon.

Other natural products harvested from the mangroves ecosystem include many prawn species which are caught in the mangrove waterways or in adjacent coastal waters. Edible mud crabs and gastropods are common in the mangroves while cockles are abundant on mud flats. Together they provide an important commercial food source. Some prawn species may breed and complete their life cycles in the shallow coastal mangrove waters.

Under natural conditions, mangrove forests act seaward barriers against coastal erosion and help to stabilise the coastline. Erosion often occurs following removal of mangroves by human.

6.4.2 Animals

With the lost of vegetation, all the animal life associated with such vegetation are not around Kuala Muda Site.

A number of birds were observed but more of the birds are those associated with human habitation, such as crows.

According to the villagers, there is no cockle culture at the coast. There were some aquaculture activities reported near the tidal gate, and there are presumably cage culture for fish.

The water from Kuala Muda is very heavily silted and the whole of the estuary mouth and surrounding coastal waters is brown with silt.

There were large number of birds, both at the mangrove as well as the adjoining Byram Forest Reserve in Pulau Burong. This is perhaps the origin of the name "Pulau Burong". A bird list will be complied for this area, as it is likely that a number of the birds are migratory, from northern Asia and Russia.

The present dump site has attracted a large number of scavenger birds, such as the crow and to a lesser extend the mynah. These birds would compete for nesting sites with the indigenous birds.

There were signs of human collectors of crabs and other mangrove invertebrates in the mangrove fringe. An abandoned fish trap was also observed. This would indicate that the normal collecting activities still take place in the mangrove.

There were sounds of boats collecting cockles in the mudflats around Pulau Burong. A collection centre for cockles was located in Sungai Tengah, at the edge of Pulau Burong, where the cockles were being sorted out when the harvesting boats come in.

Details of all species habitating these areas are available after USM has completed their investigation at these areas.

6.5 Landscape

There is no recreational zone, which has excellent landscape to be preserved around the candidate sites.

6.6 Historic and Religious Places

There is no historic or religious places and structures around the candidate sites.

Chapter 7 Result of Preliminary Environmental Evaluation

The following activities might have significant impacts on the environmental components as shown in Table 7-1.

Of these environmental components, vegetation and animals with mark * in the Table which are currently under field investigation, are not fully surveyed. For this reason, these items are examined.

Table 7-1 Project Activities and Environmental Components

Project Activities	Environmental Components
Site Clearing	* Vegetation and Animals
Earth-works	Noise against human life * Noise against animals
Landfill activities	Dust and Odor Water Pollution Noise against human life * Noise against animals
Transportation activities	Air pollution due to vehicle exhaust Noise from haulage vehicles Safety on public roads.

(1) Site Clearing

Before earthworks, in the site clearing, trees and bushes will be cut down and cleared throughout the site. Ecology of the site should be studied.

(2) Earthworks

Noise from vehicles during construction may cause some impact against human environment and on to the wildlife in the mangrove forest. Some species of birds were seen habitating in the mangrove forest during reconnaissance survey. Further study should be executed in determining the possible extent of impact on these wildlife.

(3) Landfill

Since leachate from final disposal site is gathered and pumped up back to the site, it will not be discharged directly out of the site.

However, some leachate will permeate into the ground, and only some will be purified after passing through layers of sand and finally flow out into the sea. Therefore, there may be some impact against the ground water due to this.

Odour will be generated during landfill work, but it can be reduced by completely covering the waste with soil. Spontaneous combustion of waste would give off smoke and it is undesirable to the environment. However, it can be controlled by covering it with soil and timely sprinkling with water. Water trucks shall have to be prepared for sprinkling.

Suspended particulate matter and dust generated from solid waste and residue can also be mitigated by regular timely sprinkling of water and adequate covering soil.

There is a development possibility of tourist resort area to the north of the site and a traditional village center to the south of the site. Therefore, this disposal site will reserve about 50 meter wide green belts as buffer zones on the north and south areas respectively, and impact against landscape will be abated.

Noise from landfill equipment may give some impact against wildlife in the adjacent mangrove forest. However, to determine its extent, further detailed study is required.

(4) Transportation

SWM vehicles cause impact to three environmental components of air quality, noise and physical safety.

The traffic noise and unsafe traffic will not always be in direct proportion to the increase of traffic volume. However, the SWM vehicles may give some impacts on noise and traffic safety, because general traffic volume is not very much at present.

Chapter 8 Detailed Examination of Impact

Result of preliminary environmental evaluation provided the basis for detailed examination of the following environmental components.

(1) Air Quality
(2) Water Quality
(3) Noise
(4) Safety

8.1 Air Quality

(1) Dust and Odor

In the Kuala Muda area, the predominant wind direction is East throughout the year. This wind blows from the candidate site of the central district of Kuala Muda, but is not expected to have adverse impact to the residential area, because a bund will be constructed with a 50m wide green belt.

The generation of dust can be controlled with the proposed plan in which water sprinkler trucks will stand ready for water sprinkling whenever necessary.

The proposed sanitary landfill in which soil covering will be conducted every day can minimize the generation of odor.

(2) Air Pollution from Haulage Vehicles

The most serious pollutant derived from car exhaust gas in Penang State is carbon monoxide (CO). The number of haulage vehicles is not so large in comparison with the general traffic volume, but it is necessary to evaluate the degree of the adverse effect of increasing haulage vehicles because the traffic volume on the access road to the disposal sites are is not so large. Then, the method proposed by Management and Control of Air Pollution in Penang (Dr. Lim Poh Eng and Dr. Koh Hock Lye, USM) was adopted.

$$CO = (0.5 + 0.65\ Tt - 0.6\ W)/(1-a)$$

CO : Steady state or mean CO level (ppm)

Tt : (traffic count) x 10^{-3} (per hour)

W : Wind speed (km/hour) = 6.12

a : 0.39 - 0.64 (=0.64)

Result of the calculation is given in Figure 8-1. Concentrations of Carbon Monoxide are very low. The general traffic volume is calculated on the assumption of the annual increase rate of 5% in which the year of 1988 is the base year and the year of 1995 is the target year. Hourly haulage vehicles are assumed to be 20 vehicles.

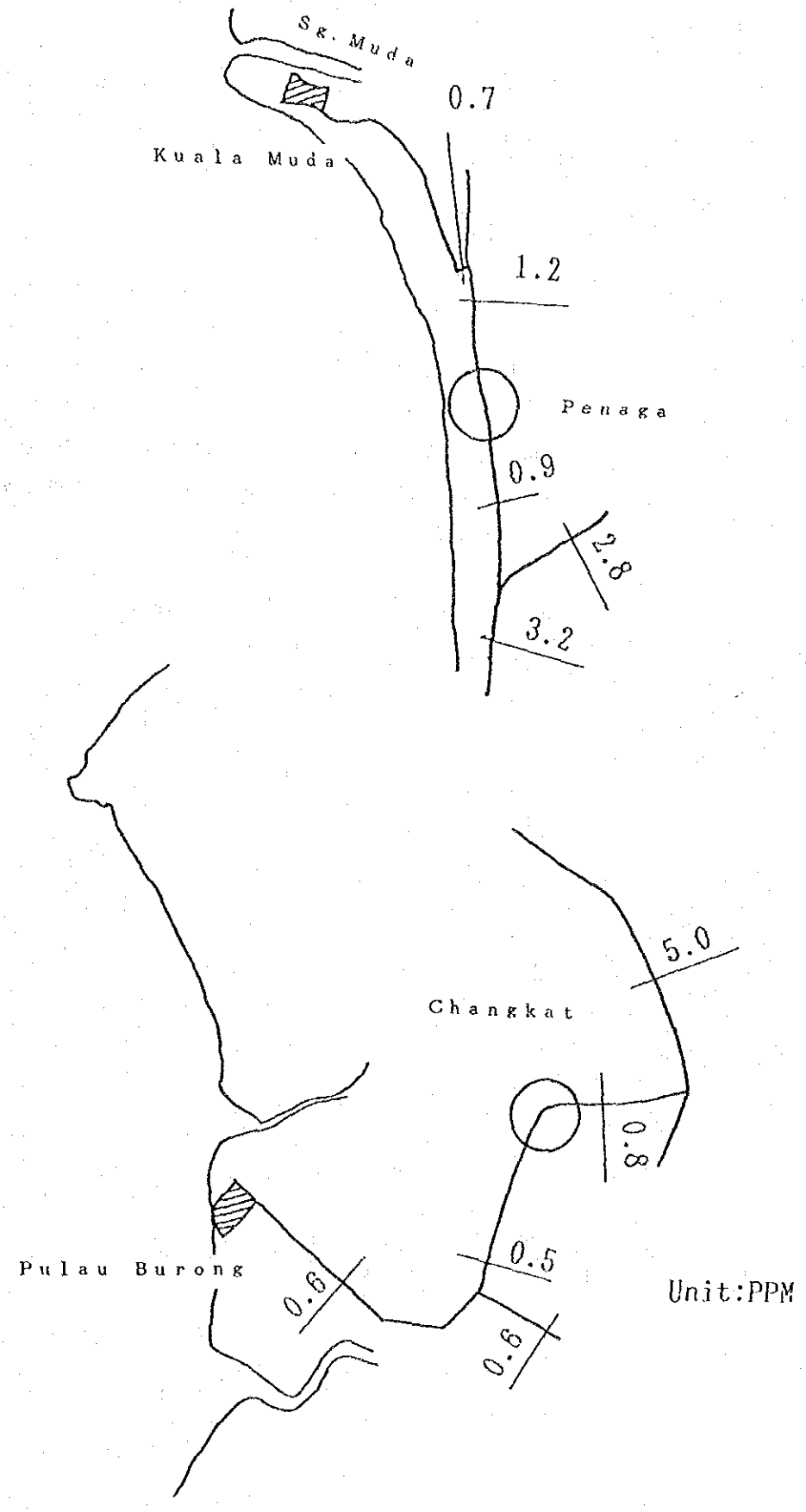


Fig. 8-1 Concentrations of CO along the road to KNDS & PBDS

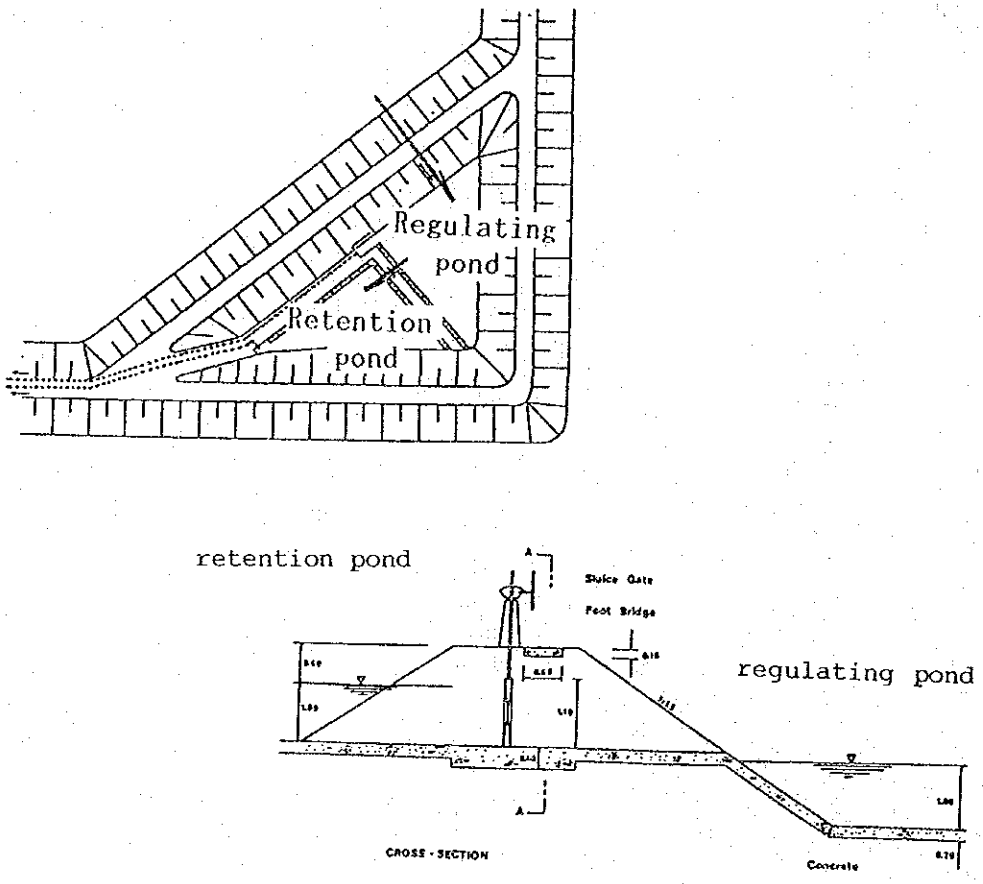
8.2 Water Quality

Control of leachate from the landfill is planned as follows (Refer to Supporting Report VOL.III P.107-P.130) :

Regulating and retention ponds are prepared as shown in Fig. 8.2.

Leachate is discharge into the regulating pond and usually pumped up back to the disposal area by leachate cycling facilities. Leachate cycling facilitates self-purification by the wastes disposed of. Leachate is not usually discharged directly into the sea. In case of heavy rain, the sluice gate is to be opened and leachate diluted in the regulating pond is flown into the retention pond. Then, the leachate in the retention pond is pumped up and discharged into the sea area.

Fig. 8-2 Regulating and Retention Pond



The effluent is pressured to send through pipes to the sea area where the water depth of approximately 0.5m can be assured even in low tide. The concentration distribution in this measure was assumed by using a simple prediction equation (Joseph - Sendner):

$$(S-S_1)/(S_0-S_1)$$
$$= \exp(Q/\pi\, dp(1/r_0 - 1/r))$$
$$\times(\exp(Q/\pi\, dpr_1) - \exp(Q/\pi\, dpr))$$
$$\div(\exp(Q/\pi\, dpr_1) - \exp(Q/\pi\, dpr_0))$$

where S : concentration at r = r
So : concentration at r = ro
S1 : concentration at r = r1
Q : water discharge per unit time
d : depth of mixing (=0.5 m) and
P : rate of diffusion (=0.01 m/sec)

The concentration at r = r1 (S1 = 0) is described from the following equation (Nitta, Japan) :

$$\text{Log}\ (\pi r_1^2/2) = 1.226 \log Q + 0.0855$$

where Q : discharge

In case of KMDS and PBDS, the volumes of leachate are 0.0048m^3/sec (=415m^3/day) and 0.0056m^3/sec (=484m^3/day) respectively.

Thus, S = 3 ppm at r = 30m on the assumption of So = 800 ppm at r = ro. That is, when the effluent is discharged at 800 ppm BOD, the effluent is diluted to less than 3 ppm in the outer sea area of 30m radius centering around the discharge point. This low level is because of the extremely low volume of the effluent.

When the effluent is discharged at 1200 ppm COD, then it is diluted to less than 4 ppm in the outer area of 30m radius.

These levels are below the class II (3 ppm) for BOD and Class I(10 ppm) for COD set by the proposed Interim National Water Quality Standards for Malaysia.

In addition, when tidal current is taken into consideration, because this equation does not include this factor, diffusion will be further promoted.

Therefore, almost no adverse effect on aquatic flora and fauna is expected in the sea of Kuala Muda and Pulau Burong.

Furthermore, there is more than 10 meter depth of marine clay layer which exists under the bottom of the KMDS and PBDS. The permeability coefficient of marine clay is very low; i.e.10^{-6} to 10^{-7} cm/sec. This indicates that the possibility of ground water contamination by leachate is very little even without liner on the bottom.

8.3 Noise

(1) Noise during Construction Phase

Types of major construction works and machines which are expected to be major noise sources, and power levels of these noise sources are summarized in Table 8-1.

The levels of these noise sources are all round 100-110 dB(A).

A general equation to predict the effect of a point noise source is given by the following:

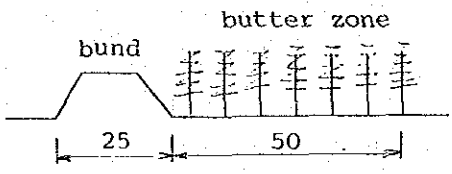
$$Lr = Lw + 10 \log (1/2\pi r^2)$$

where Lr; noise level at a point r meter distant from the noise source, and

Lw : power level of the noise source

The distance from the noise source to the site border including the 50m width of the buffer zone and the 25m width of the bund becomes approximately 75m.

$$L75 = 55 - 65 \text{ dB(A)}$$



In some cases the noise level may be higher than the WHO's standard of 55 dB(A), but noise level near the houses would be 50-60 dB(A) because the distance from the noise source to the houses would be more than 110 m. Any possible adverse effects on animals in the surroundings are expected to be negligible, because the construction period is not so long and points for construction works always move so that they will come back very soon after the completion of the construction.

Table 8-1 Construction Works and Power Level of noise sources

Type of Construction Work	Machines to be used	Noise level (power level) dB(A)
Clearing	Bulldozer	100 - 110
Levelling	Scraper	100 - 110
Bund construction	Drug line	100 - 110
	Back hoe	
Paving	Asphalt finisher	100 - 110
Concrete placing	Small mixer	100
Piling	Small piling machine	100

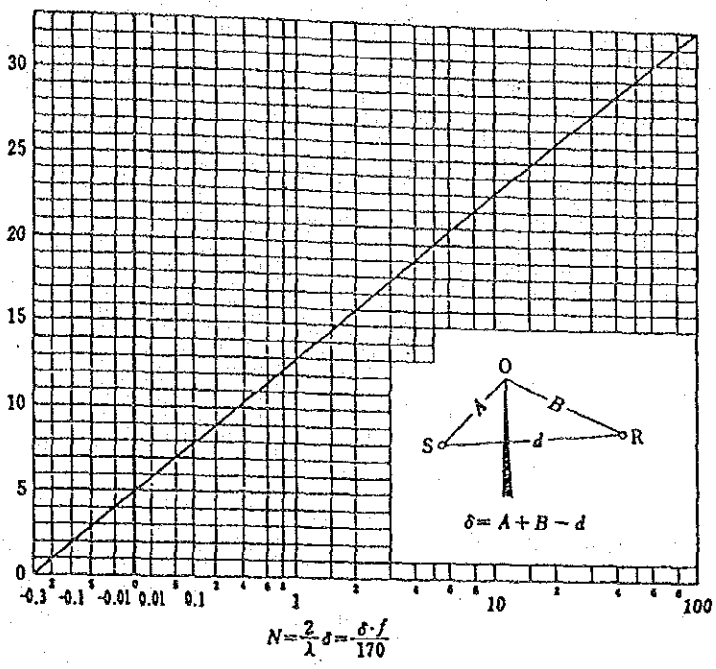
(2) Noise from Sanitary Landfill Equipment

Of sanitary landfill equipments, the major noise source is bulldozers. On the site, 1-2 bulldozers are planned to be operated regularly. One bulldozer generates noise of 55-65dB(A), similarly in the construction phase. However, more than 10 dB(A) of noise is expected to be attenuated as shown below because 5 meters high bund around the disposal area will arrest the noise and thus bulldozers being operated simultaneously can yield the energy shown below;

$$L = 10 \log \sum_{i=1}^{2} 10^{\frac{Li}{10}}$$

$$= 10 \log \left(10^{\frac{45}{10} \sim \frac{55}{10}} + 10^{\frac{45}{10} \sim \frac{55}{10}}\right)$$

$$= 48 - 58 \text{dB(A)}$$



N : Fresnel Number

λ : Wave length

f : frequency

Around the candidate site in Kuala Muda there are houses, but they are not exposed to the same noise level for a long time because landfill area near the houses will be used only for three or four months.

(3) Noise from Haulage Vehicles

The noise level from haulage vehicles can be estimated from the following prediction equation:

$$Leq. = Lm + \Delta Lstro + \Delta Lv + \Delta Lstg - \Delta Ls,l + \Delta Lk$$

$Lm = 37.5 + 10 \log M(1 + 0.082\ P)$

M : traffic density (vehicles/hour)

P : percentage of lorries

Δ Lstro = 0 in case of not rough asphalt

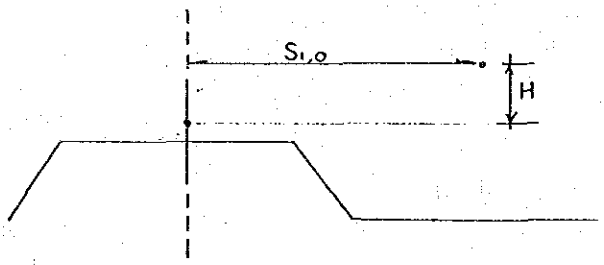
$\Delta Lv = (23 - 3.5\sqrt{P} + 0.2P)(\log v - 2)$¥

v : speed (km/hour)

Δ Lstg = 0 in case of slope $\leq$ 5%

$\Delta Ls, l = -13.8 + 3.5\ x + x^2/2$

$x = \log (S_1^2\ 1.0 + H^2)$



Lk : Distance between receive point and junction

Lk = 0 in case of more than 100 m

The noise levels on roads to Kuala Muda and Pulau Burong are shown in Table 8-2 at points shown in Figure 8-3. The traffic volume is increased at the annual rate of 5%, using the mean hourly traffic volume in 1988 as the base and that in 1995 as the target year. Noise levels exceed WHO's standard 55dB, but noise impact from waste transportation vehicles will be 0-4dB(A) increase in noise level. These noise level is low in comparison with the existing condition in Seberang Perai (Refer to P.204).

Table 8-2 Noise levels on roads to KMDS and PBDS

Unit : dB(A)

No.	'88	'95(1)	'95+ Haulage Vehicles (2)	L = (2) - (1)
1	55	56	59	3
2	56	57	59	2
3	55	57	59	2
4	64	65	66	1
5	64	66	66	0
6	67	68	69	1
7	58	59	61	2
8	52	54	58	4
9	53	55	58	3
10	52	43	57	4

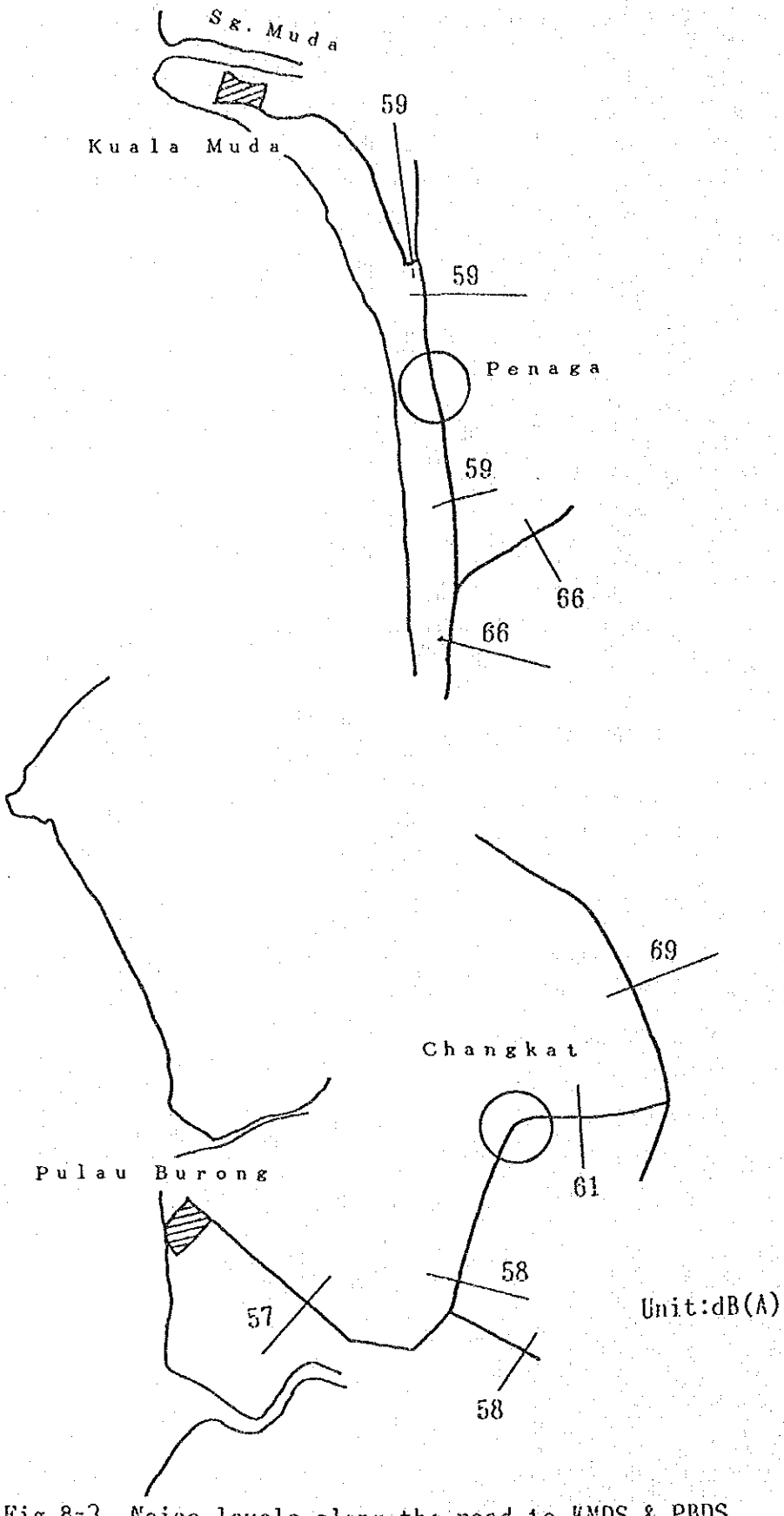


Fig.8-3 Noise levels along the road to KMDS & PBDS

8.4 Safety

The trasporation route by haulage vehicles is given in Figure 8-4. As shown in this figure, the access roads in Penaga, Changkat and Nibong Tebal are all narrow.

Along some parts of the roads, shops stretch and cars parking on the both sides make the road narrower.

Safe waste transportation to prevent any traffic accidents requires education of residents. At the same time, it is necessary to conduct rigid enforcement of regulations against tarffic offenses and to teach haulage vehicles' drivers to reduce the speed at these neckpoints.

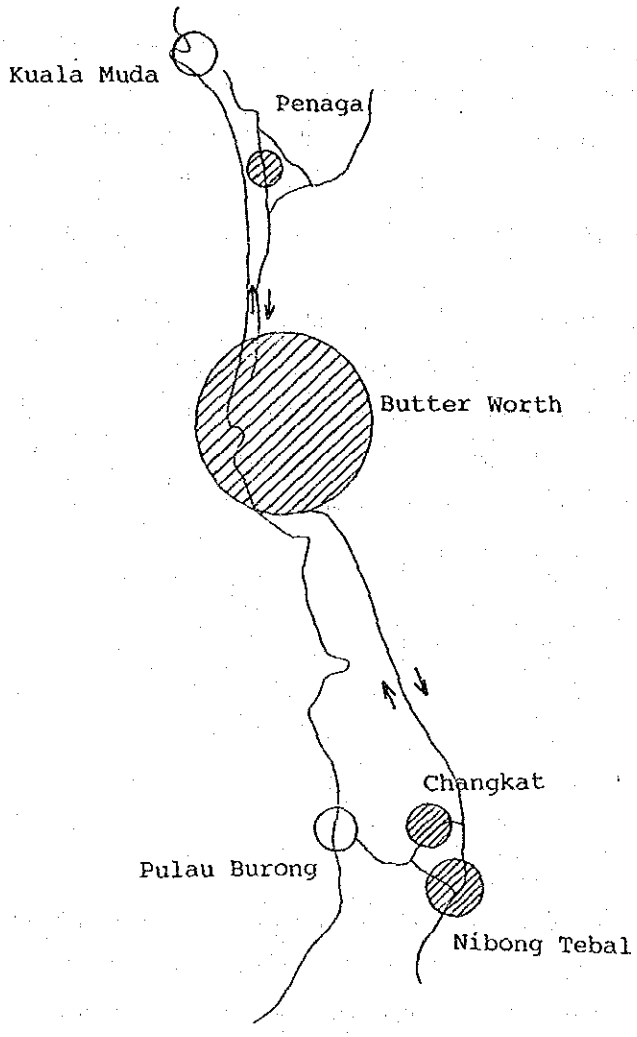


Fig. 8-4 Haulage Route

Chapter 9 Mitigation and Abatement Measures

9.1 Construction Phases

In the first stage of sanitary landfill construction, bund which contain the sanitary landfill site and settling basin will be constructed. This step is to ensure that the muddy flow within the bund is collected and settled before discharging the clear water out of the bunded area. To further eradicate possibility of muddy flow discharge, the discharge is again collected and settled into another basin outside the bund before being discharged finally into the sea.

Existing tall trees will be left as intact as possible for the green belt, and this rule will be strictly observed during the construction phase.

In constructing the green belt, the bund will be built. At that time, full consideration will be given so that the mangrove forest to be left outside is not damaged by dropping soil for banking.

9.2 Operational Phase

Although sanitary landfill could be the better way of disposal, it is undeniable that nobody would want to have it in front or at the backyard of their houses. Based on this understanding, the buffer zone of green belt is prepared to isolate the site from common view of the public. Its other purposes are to blend the existence of the disposal site with the surroundings and mitigate odor dispersion from the disposal site to the surrounding areas.

The landfill operation area will be divided into several smaller work areas by bunds within the site. The division into smaller operation area would help to reduce the volume of leachate to be treated because of smaller area for higher rainfall infiltration.

After the first landfill sub-division is completed, a final layer of earth will be applied over the top. In addition to this, the area would be sloped and drains will be provided. With the existence of these measures,

the surface run-off infiltrating into the ground would be minimized. All surface run off would be drained directly out of the site as surface water. In the next sub-division, leachate would be abated in the same manner explained previously and the completed sub-division of landfill would be furnished with drains and cover material.

For the remaining areas to be used in the disposal site, water run-off will be discharged directly out of the site as general surface water.

Regulating and retention ponds are prepared.

Leachate is discharged into the regulating pond and usually pumped up back to the disposal area by leachate cycling facilities. Leachate cycling facilitates self-purification by the wastes disposed of. Leachate is not usually discharged directly into the sea.

In case of heavy rain, the sluice gate is to be opened and leachate diluted in the regulating pond is flown into the retention pond. Then, the leachate in the retention pond is pumped up and discharged into the sea area.

The leachate will be pressured to send through pipes to the point where the water depth of approximately 0.5m can be assured even in low tide, so that aquatic organisms inhabiting in the coastal mangrove forests are not adversely affected. Therefore, it is expected that no adverse effect will reach the sea areas fifty meters away from the discharge point.

Odor, dust and spontaneous combustion can be controlled by covering with soil and timely sprinkling with water. Water trucks will b prepared for sprinkling.

Gas generation in a landfill area due to decomposition of waste cannot be eliminated, but impact can be mitigated because gas dispersion measures will be adopted in the site.

Education of haulage vehicles' drivers for safety promotion, enlightment of dwellers along the roads, and tight control over illegal parking will be

conducted.

As for the collection vehicles route, the following mitigation and abatement measures are to be considered prior to the operation of the KMDS and PBDS, respectively.

i. To Kuala Muda

At the town of Penaga, due to the narrow width and constantly parking vehicles, there often occurs traffic jam in the morning evening, and it seems to be hard for a big collection lorry to pass through.
Therefore, it is recommended that a haulage vehicle take the route which pass through Permatang Sinpoh, Jalan Permatang Rambai and north of Penaga. However, the proposd route is 2km longer than the existing one.

ii. To Pulau Burong

At the town of changkat, as the route pass through the residential area, the traffic of the collection vehicles may give adverse effects on the residents along the route.
Therefore, haulage lorries drivers shall keep going slowly. In addition to that, in order to reduce traffic volume, the returning route should be the route passing Nibon Tebal.
And at the intersection of Nibon Tebal, a traffic signal should be installed.

Chapter 10 Residual Impact and Monitoring System

There seems to be no residual impacts because many mitigation and abatement measures are adopted. However, to enhance more safety, method such as monitoring systems are recommended.

In order to examine impacts on surrounding environment by landfill operation, the following monitoring systems are introduced in operation.

a. Water monitoring system

The following monitors of water are proposed.

i. Groundwater monitoring by monitoring well
ii. Surface water monitoring at surrounding drain
iii. Leachate monitoring at the inlet of the regulation pond
iv. Effluent monitoring at effluent pump pit and effluent outlet.

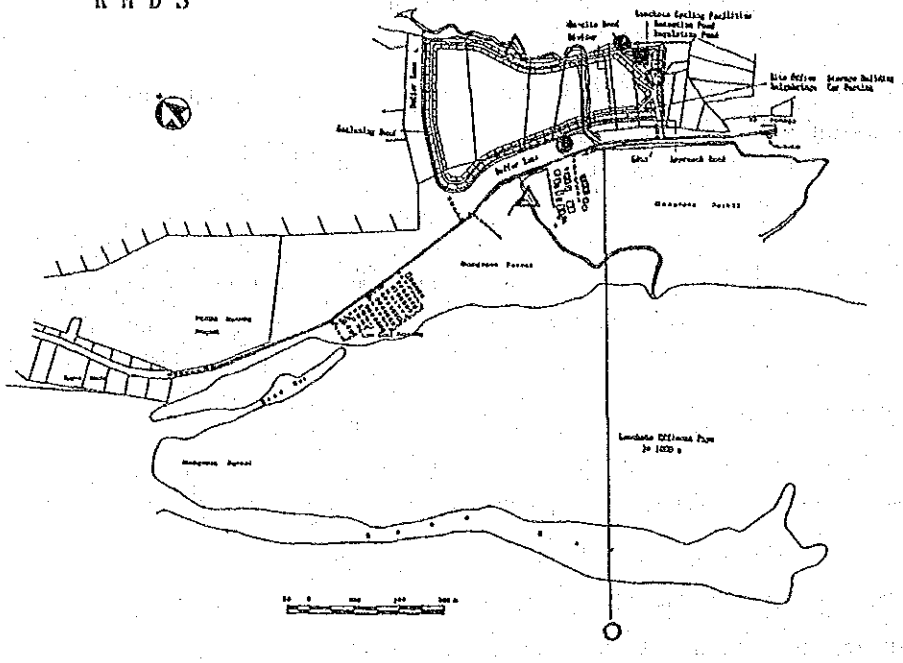
The locations for above mentioned monitoring are illustrated in Fig. 10-1.

b. Waste Monitoring System

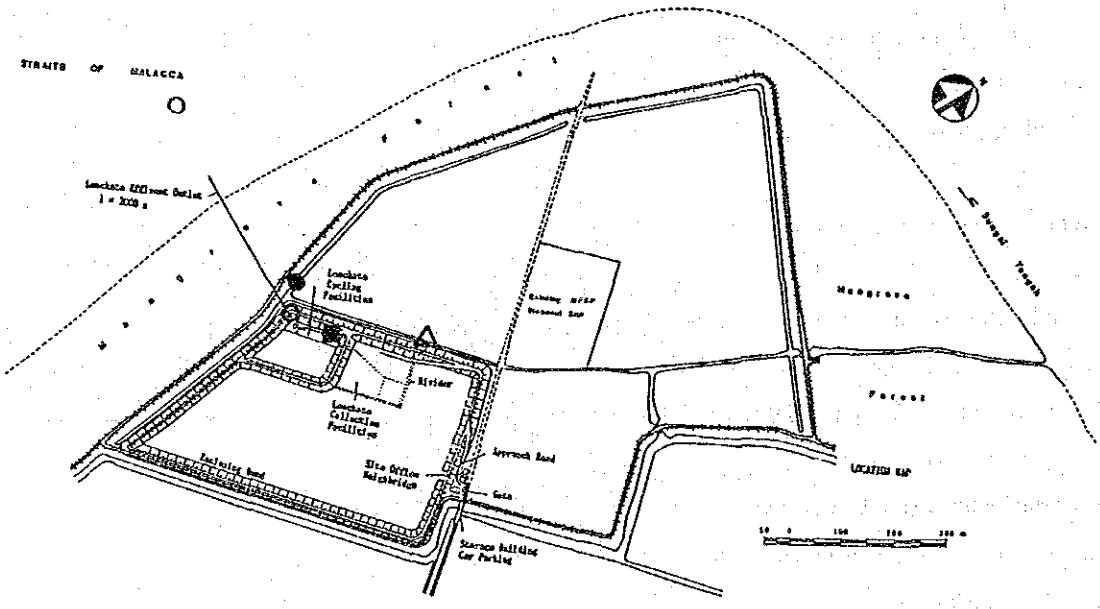
The following monitor of wastes are proposed.

i. Inspection of direct haul wastes by private sector including industrial wastes.
ii. Monitoring of littered wastes
iii. Patrol of surrounding area of site for the prevention of illegal dumping.

KMDS



PBDS



LEGEND

- ● Monitoring Well
- △ Surface Water Sampling
- □ Leachate Sampling
- ○ Effluent Sampling

Fig.10-1 Location of Water monitoring system

Table 11-1 summarizes the environmental evaluation. In the table, environmental aspects are discussed in comparison between "with project" and "without project".

Implementation of the project will result in acquisition of a sufficient capacity of landfill and sanitary landfill. Because implementation of some of the mitigation measures can minimize possible adverse impacts caused from the site, the city can be maintained clean with nearly no adverse effect.

On the other hand, the existing disposal site is very likely to havw serious impacts on the surrounding environment, and further filling operation would lead to the shortage of filling capacity. If the same type of dumping is conducted after a new site is built, adverse effects on the surrounding environment will very possibly appear. Without a new site, wastes and garbage would fill the city, and clog the water channel, with resultant flooding at many places.

Table 11-1 Project Evaluation

Environmental Aspects	With Project: Kuala Muda	With Project: Pulau Burong	Without Project
I. Discharge & storage			
Aesthetic	In residential areas collection is made three times a week. Garbage will not be seen except on the designated day for collection, because one can put garbage only at a fixed time on a fixed day.		In residential areas, currently door to door collection and container collection are conducted Regular placement of containers and littery garbage around them damage seriously the aesthetics of the city.
Odor and waste water	The use of standard plastic bags can solve almost perfectly the problems of odor and waste water overflow.		Because currently plastic bags are not used, we can find odor and waste water outflow problems here and there.
Others	In Kampong area, collection service will be made with communal containers.		Kampong area where nearly no collection service is available is littered with garbage.
II. Transportation			
Odor, waste water, garbage flying, and working environment	All collection vehicles will be shifted to compactor vehicles and at the same time the maintenance system will be strengthened. Therefore, odor generation during transportation, dropping of waste water and garbage flying will disappear, and the working environment will be improved.		Current sideloaders and open trucks have no cap, and odor generation, waste water dropping and garbage flying have become serious problems. Loading of garbages to sideloaders and open trucks in the dusty air is not desirable for workers' health. With currently used compactor vehicles, which are poorly maintained and very old, the problems of odor generation and waste water dropping have become serious.

Continue/...(1)

Environmental Aspects	With Project		Without Project
	Kuala Muda	Pulau Burong	
Roadside environment (air pollutant)	Air pollutants derived from traffic of waste transportation vehicles will have a minor impact on the roadside environment.		Air pollutants from waste transportation vehicles do not have a serious impact on the roadside environment.
Roadside environment (noise)	The possible noise impact associated with traffic of waste transportation vehicles will be a 0-4dB(A) increase in noise level.		The noise impact associated with traffic of waste transportation vehicles can be seen slightly against houses along the road.
III. Final Disposal			
Impact on surface water quality	Because the leachate is not usually discharged directly into the sea, nearly no adverse effect is expected. Although the leachate is discharges in case of heavy rain, no adverse effect will reach the sea area thirty meters away from the discharge point.		Leachate flows directly into the waterway with resultant pollutant of the surroundings.
Impact on groundwater	Although no water proofing works are made, the possibility of groundwater contamination is very low because of clay layer with a relatively low permeability on the site bottom. In addition, no ground-water is utilized in the surroundings.		At the existing disposal site, leachate infiltrates into the underground with resultant possibility of groundwater contamination.
Noise, odor and dust problems	The distance from the site to the central part of Kuala Muda	The distance from the site to surrounding private hou-	Of the existing disposal sites, Pulau Bulong is away from residential areas, while Permatang Pauh has many private

is approximately 1km, but that to the closest private house is about 100m. Since a bund of 5m height and a green buffor zone of 50m width will be constructed in between, almost no adverse effects of noise and dust are expected, but odor may reach private houses depending on wind directions	ses is long, and noise, odor and dust generated from the final disposal operation will have no adverse impact in daily life	houses in its periphery, where open dumping causes a odor problem depending on meteorological conditions.

Continue/...(2)

Environmental Aspects	With Project		Without Project
	Kuala Muda	Pulau Burong	
Compatibility with landuse of adjacent area	Promimity to private houses and a planned land development project for housing in the neighborhood present a slight difficulty	Good	There is no problem at Pulau Burong, while at Permatang Pauh with many private houses in its periphery some problems may be resulted in. Leachate from the site directly discharged to a water channel is likely to pollute the coastal area of Pulau Burong
Impact on fisheries	Because leachate from the site will not usually be discharged, nearly no adverse effect is expected.		Leachate from the site directly discharged to a water channel is likely to pollute the coastal area of Pulau Burong.
Impact on terrestrial vegetation and wildlife	Almost no adverse effect are expected because of very poor vegetation and fauna.	The reduction of habitats for birds and other animals may may have a little adverse effects.	There is not problem at Permatang Pauh, while occasional fire due to spontaneous ignition oan have an adverse effect on the surrounding environment
Impact on marine flora and fauna	Almost no adverse effect is expected on marine flora and fauna.		The adverse effect on marine flora and fauna.
Impact on natural landscape	There is no aesthetic elements to be conserved. In addition, planning of planting for better natural landscape will hide disposal operation.		At Permatang Pauh, where one can see open dumping operation from all directions, the scene of a ascending black smoke looks very grotesque.
Impact on historical places or structures	No impact.		No impact.
Impact on religious places or structures	No impact.		No impact

Continue/...(3)

Environmental Aspects	With Project		Without Project
	Kuala Muda	Pulau Burong	
Impact on traffic safety	Since many cars park on the both sides of narrow streets in the urban district of Penaga, education of drivers are necessary.	Drivers' special attention to traffic safety will be required in driving on access road passing through Chang-Kat to Dulau Burong.	At Changkat where the access road towards Pulau Burong passes through, traffic accidents are very likely without implementation of drivers' education.
Harmful insects and others	Perfect implementation of sanitary landfill will prevent any such problems.		The existing site is the food source for fly, mosquito, rat, and other harmful insects.

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