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SOLID WASTE MANAGEMENT STUDY FOR PULAU PINANG AND SEBERANG PERAI MUNICIPALITIES

MAIN REPORT

PART III

FEASIBILITY STUDY FOR SEBERANG PERAI

AUGUST 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PULAU PINANG AND SEBERANG PERAI MUNICIPALITIES

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ABBREVIATION

ABC	:	Action Plan for a Beautiful and Clean Malaysia
BSDS	:	Bakau Street Disposal Site
BPTS	:	Balik Pulau Transfer Station
CIF	:	Cost, Insurance and Freight
DBKL	:	City Hall of Kuala Lumpur
DID	:	Drainage and Irrigation Department
DOE	:	Department of Environment
EIA	:	Environmental Impact Assessment
ENSEARCH	:	Environmental Management and Research Association of Malaysia
EPU	:	Economic Planning Unit
FTZIP	:	Free Trade Zone Incineration Plant
FTZTS	:	Free Trade Zone Transfer Station
GRDP	:	Gross Regional Domestic Product
IKU	:	Public Health Institute
JICA	:	Japan International Cooperation Agency
JKKK	:	Village Development and Security Committee
JMPDS	:	Jelutong Mole Previous Disposal Site
JMTS	:	Jelutong Mole Transfer Station
JPBD	:	Town and Country Planning Department
KEMAS	:	Community Development, Ministry of National and Rural Development
KMDS	:	Kuala Muda Disposal Site
LWL	:	Low Water Level
LA	:	Local Authority
M	:	Million
MC	:	Municipal Council
MMTS	:	Mak Mandin Transfer Station
MPPP	:	Majlis Perbandaran Pulau Pinang
MPSP	:	Majlis Perbandaran Seberang Perai
MOH	:	Ministry of Health
MHLG	:	Ministry of Housing and Local Government
M/P	:	Master Plan
MSWM	:	Municipal Solid Waste Management
M$	:	Malaysian Dollar
NEB	:	National Electricity Board
NEP	:	New Economic Policy

PADS	:	Pantai Acheh Disposal Site
PBDS	:	Pulau Burong Disposal Site
PDC	:	Penang Development Corporation
PERDA	:	Penang Rural Development Authority
PHA	:	Public Health Assistant
PHI	:	Public Health Inspector
PICIP	:	Prai Industrial Complex Incineration Plant
PSD	:	Public Services Department, Prime Minister's Department
JKR/PWD	:	Public Works Department
PPC	:	Penang Port Commission
S/R	:	Supporting Report
SWM	:	Solid Waste Management
SWMIS	:	Solid Waste Management Information System
TDC	:	Tourist Development Corporation
UDS	:	Urban Drainage System
USD	:	Urban Service Department
USM	:	University Sains Malaysia

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1. Phase I Project

This Feasibility Study Report covers the Phase I Project identified in the Master Plan Study for MPSP.

1.1 Preliminary Financial Evaluation

As referred to in the Master Plan, the introduction of sanitary landfill will require a large investment relative to the financial scale of the Council.

This section examines an appropriate level of disposal system to be constructed in Phase I in view of the required investment amounts and the financial situation of MPSP.

In general, the landfill system for waste disposal can be categorized into the following four levels.

a. Level 1 Controlled Tipping

- Consolidation of roads on premises
- Periodical soil covering
- Introduction of haulage control system

b. Level 2 Sanitary Landfill

- Clear determination of a disposal site; to be separated from surrounding areas to prevent entry by scavengers

- Clear determination of the disposal site by construction of embankments

- Restricting the landfill; introduction of compartmental system to decrease volume of leachate

- Establishment of a rainwater drainage system to prevent flow of rainwater into the landfill site from surrounding areas

- Introduction of instruments to prevent environmental pollution, including a buffer zone, facility to prevent waste and odour dispersion, gas extraction facility

- Introduction of welfare facilities

- Partial introduction of quasi-aerobic landfill structure by gas extraction facility

c. Level 3 Sanitary Landfill

- Introduction of proper leachate control system by introducing leachate drainage and circulation facility with monitoring system

- Introduction of quasi-aerobic landfill structure by leachate drainage

- Prevention of dust by water sprinkling

d. Level 4 Sanitary Landfill

- Introduction of leachate treatment facilities
- Introduction of impermeable structure on site

Local Authorities in any country select certain levels of the landfill system depending on their respective local conditions.

In view of the topography and geology of the proposed disposal sites, the estimated project costs for Level 3 and 4 in Phase I are as follows.

Level 3 : M$8.1 million
Level 4 : M$23.5 million*

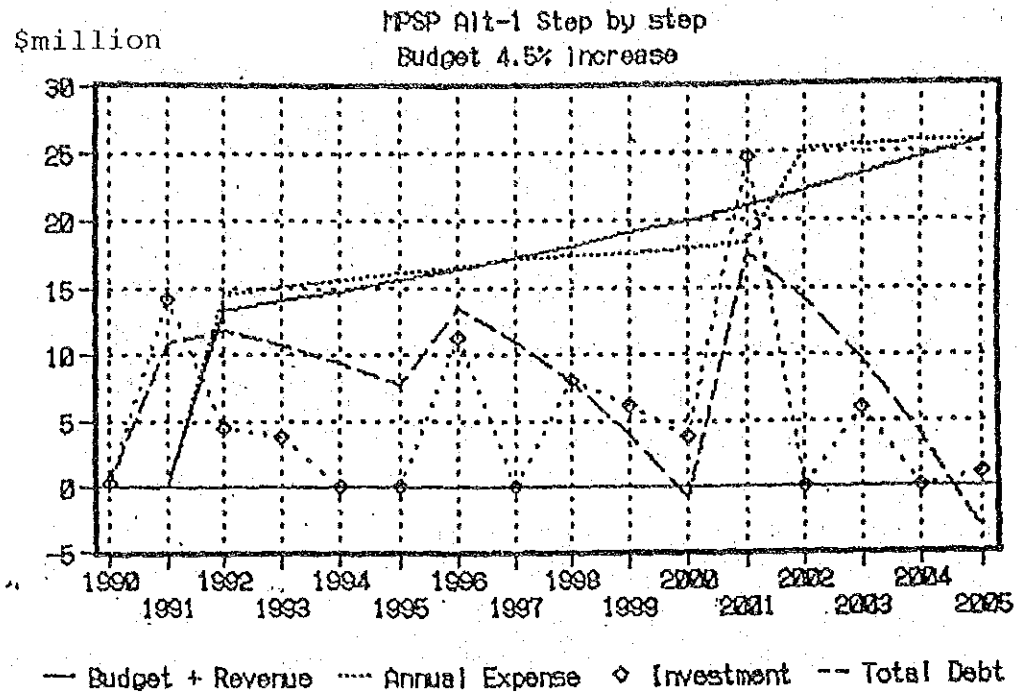
* This amount does not include costs for bottom liner because it is not necessary in view of very low permeability of the bottom soil.

With the successful cost reduction of the solid waste management due to various improvement measures, and based on the assumption that collection and tipping fees are imposed for commercial waste and solid waste taken directly to disposal sites respectively, the cash flows for the above two cases are as shown in Fig. 1.1-1.

Given this cash flow prospect, if the budgetary allocation is increased by 4.5% annually in real terms, the total debt will be reduced to zero by 2005 provided that Level 3 and Level 4 landfills are constructed in Phase I and Phase III respectively. The possibility of raising funds for Phase IV, therefore, appears bright. In comparison, if Level 4 landfill is constructed from the Phase I, there is no prospect of repaying the debt even in 2005, in view of the total investment amount of M$91.5 million required for the latter (Level 4) which is 10% (M$8.1 million) higher than the M$83.4 million required for the former. In addition, the cummulative operation and maintenance cost of the latter till 2005 is M$6.2 million higher than the former.

A rapid rise in the cost of solid waste management appears inevitable, particularly in MPSP, due to the introduction of costly sanitary landfill, long distances to the new disposal sites and the increase in waste collection service coverage.

In view of the facts that the implementation of a project which requires substantial investment against limited financial resources may destroy the financial basis of the municipality and that the balanced development of the infrastructures including sewage system, solid waste management system and flood control, etc. is essential for the environment conservation, it has been decided that the disposal facilities to be constructed in Phase I will be of Level 3, and that these will be improved to Level 4 in Phase III onwards. This decision is also supported by the environmental impact assessment results which show the impact of Level 3 sanitary landfill on the surrounding environment is minimal.



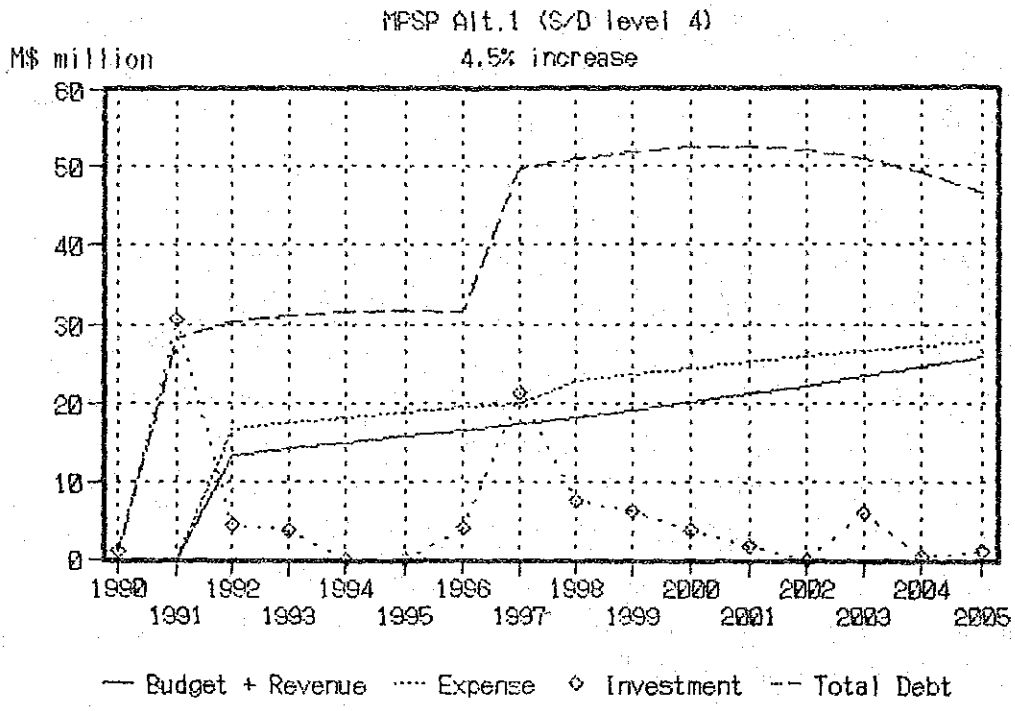


Fig. 1.1-1 Cash Flow

1.2 Contents of Phase I Project

To complete the Master Plan by 2005, the stage plan for MPSP (see Chapter 13 of Part I) will be actually implemented in the following 3 phases.

Phase I: 1991 - 1995
Phase II: 1996 - 2000
Phase III: 2001 - 2005

Phase I Project will consist of the consolidation of the basis for solid waste management in MPSP. Its successful implementation is a precondition for the achievement of the various targets given in the Master Plan. The Master Plan for solid waste management in MPSP is considered important on a national level.

As shown in Fig. 1.2-1, the objectives of Phase I Project are the achievement of a pleasant living environment and contribution to the socioeconomic development of the city by improving the living environment, in turn achieved by improving the service level, expanding the service area and implementing sanitary landfill at disposal sites far from urban areas through a reduction of solid waste collection and cleansing costs.

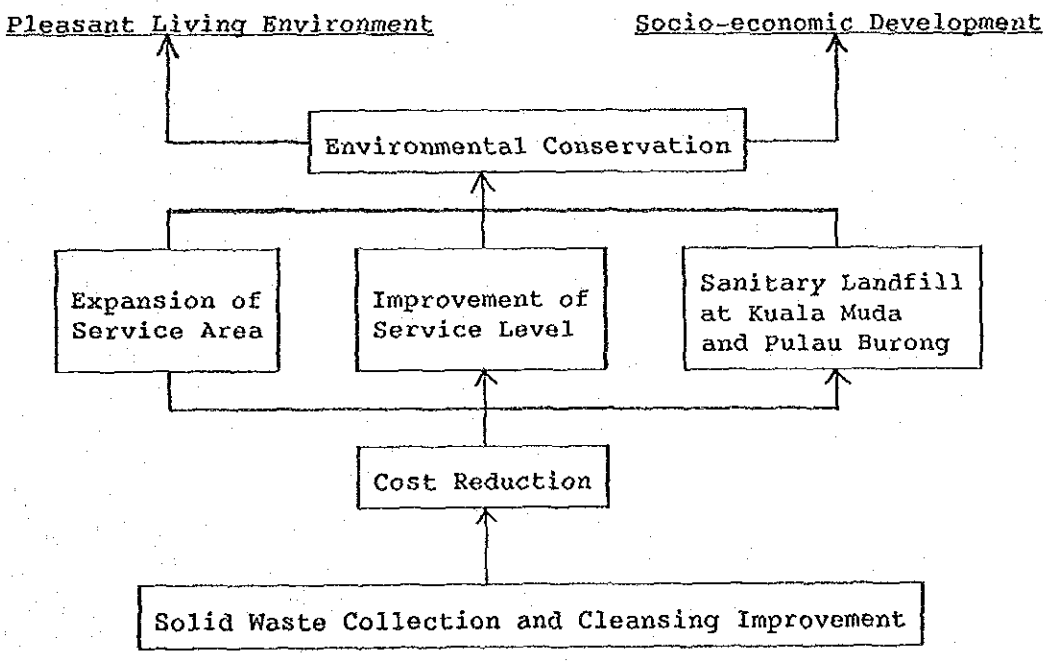


Fig. 1.2-1 Objectives of Phase I Project

Fig. 1.2-2 shows the concrete contents of each component of the Phase I Project.

o Collection Improvement

- 3 times/week door-to-door collection (urban areas)
- 3 times/week station collection (suburban areas)
- Establishment of bulky waste collection system
- Introduction of 10 m^3 compactors

o Expansion of Contracting-Out

- Achievement of 50% private contracting-out ratio (in terms of waste amount)
- Combined contract for collection and cleansing
- Review of collection zones (1 zone: 30 t/day)
- Advice on introduction of 10 m^3 compactors

o Cleansing Improvements

- Introduction of team work and weekly cleansing (Residential areas)
- Mechanization of main road sweeping
- Introduction of grass cutters

o Construction of Kuala Muda Disposal Site

- Development area : 17.9 ha
- Landfill volume : 560,000 m^3
- Daily disposal amount: 199 tons
- Operation period : 6 years

o Disposal Method

- Target level : Level 3
- Landfill method : Cell method

o Construction of Pulau Burong Disposal Site

- Development area : 16.7 ha
- Landfill volume : 660,000 m^3
- Daily disposal amount: 238 tons
- Operation period : 6 years

Fig. 1.2-2 Phase I Project of MPSP

1.3 Design Conditions

(1) Target Year

Target year is 1995. Due to the limited disposal capacity of the present sites, the disposal operation will be transferred to Kuala Muda and Pulau Burong disposal sites in 1992 and operation will be continued till 1996.

(2) Target Area

While the entire MPSP is the target area, collection Will be limited to the Priority Operational Areas as shown in Fig. 1.3-1.

(3) Design Population

As shown in Table 1.3-1, the design population in 1995 is 627,100. Population of the Priority Operational Areas is 485,100, the collection rate will be 77% in 1995 in terms of population.

Table 1.3-1 Design Population and Service Population

	Present (1987)	1992	1995
a. Design Population (persons)			
- North	244,300	272,400	289,600
- Central	199,900	222,500	236,300
- South	87,100	95,200	101,200
Total	531,300	590,100	627,100
b. Service Population (persons)			
- North	134,400	182,500	214,500
- Central	129,900	178,000	207,900
- South	22,600	45,700	62,700
Total	286,900	406,200	485,100
c. Collection Rate (%)			
- North	55	67	77
- Central	65	80	88
- South	26	48	62
Total	54	69	77

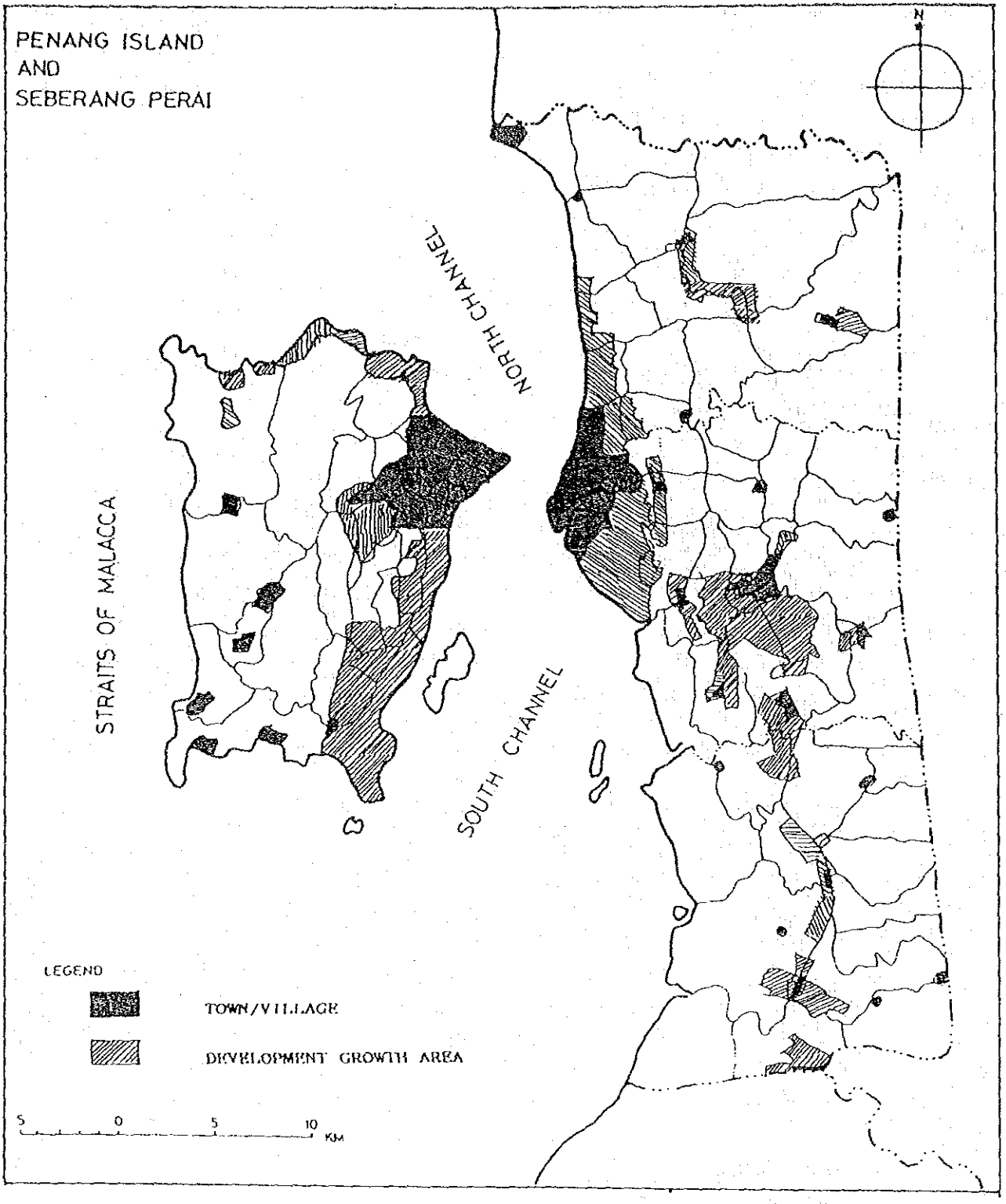


Fig. 1.3-1 Priority Operation Area

(4) Design Collection Amount of Solid Waste

Three collection systems will be employed, i.e. for domestic waste, bulky waste and large amount waste. Table 1.3-2 shows the design collection amount for each system. Collection of large amount waste will only be conducted in the North and Central Districts where urbanization is in progress.

Table 1.3-2 Design Collection Amount

(t/day)

	PRESENT (1987)	1992	1995
a. Domestic Waste Collection			
- North	91	109	132
- Central	84	102	125
- South	16	30	41
Sub-total	191	241	298
b. Bulky Waste Collection			
- North	-	3	4
- Central	-	3	3
- South	-	1	1
Sub-total	-	7	8
c. Large Amount Waste			
- North	-	18	20
- Central	-	15	16
- South	-	-	-
Sub-total	-	33	36
Total	191	281	342

(5) Roads Subject to Sweeping

As shown in Table 1.3-3, the total road length subject to sweeping in 1995 will be 1,292km.

Table 1.3-3 Road Length Subject to Sweeping

(km)

	PRESENT (1987)	1992	1995
Federal road	62	62	62
State road	865	765	765
Village road	306	306	306
Newly Developed Areas	-	110	159
Total	1,133	1,243	1,292

(6) Design Disposal Amount

The daily disposal amount of collected waste and directly brought-in waste will be 437 tons in 1995 as shown in Table 1.3-4.

Table 1.3-4 Design Disposal Amount

(t/day)

	PRESENT (1987)	1992	1995
Collected Waste			
- Domestic Waste	191	241	298
- Bulky Waste		7	8
- Large Amount Waste		33	36
Sub-Total	191	281	342
Directly Brought-In Waste	69	85	95
Total	260	366	437

(7) Design composition of Solid Waste

The design composition of solid waste is given in the Master Plan and is shown in Table 1.3-5.

Table 1.3-5 Design Composition of Solid Waste

	DOMESTIC WASTE		COMMERCIAL WASTE	
	PRESENT (1987)	1992	PRESENT (1987)	1995
a. Composition				
- Paper	25.5	27.5	31.5	34.0
- Textile	3.4	3.4	2.9	2.9
- Plastic	11.2	12.1	11.8	12.7
- Rubber	0.8	0.8	0.8	0.8
- Wood	14.4	13.3	9.7	8.9
- Garbage	32.8	30.8	30.9	28.5
- Metal	2.6	3.3	3.3	4.1
- Glass	1.4	1.7	1.0	1.2
- Stone	0.2	0.2	1.0	1.2
- Others	7.8	7.6	7.3	5.8
Total	100.0	100.0	100.0	100.0
b. Moisture Contents (%)	55.2	54.1	53.5	52.3
c. Organic (%)	35.4	35.6	36.1	36.3
d. Ash (%)	9.4	10.3	10.4	11.3
e. Net calorific value (Kcal/kg)	1600	1600	1600	1700
f. Density (t/m^3)	0.19	0.19	0.17	0.16

2. Preliminary Design

2.1 Collection Improvement

2.1.1 Collection Methods

(1) Collection System in 1995

The collection system to be achieved by 1995 is shown in Table 2.1-1.

Table 2.1-1 Collection System to be Achieved by 1995

a. Collection Rate	77% in terms of population	
b. Collection Frequency and Discharge Points	- Commercial Areas	: daily, door-to-door
	- Residential Areas	: 3 times/week, door-to-door
	- Housing Complexes with container	: daily, dust chute
	- Housing Complexes without container	: 3 times/week, station
	- Kampongs	: 3 times/week, station
c. Waste discharge Method		: Plastic bags
d. Collection Amount	- 342 t/day	
e. Collection System	- Ordinary Waste Collection - Bulky Waste Collection - Large Amount Collection	
f. Collection Vehicle	- Ordinary Waste	: compactor
	- Bulky Waste	: dump truck
	- Large Amount Waste	: compactor
g. Share of Private Companies	- 50% in terms of waste amount collected	

(2) Promotion of Discharge Using Plastic Bags

The planned waste discharge methods are shown in Table 2.1-2. The use of standard plastic bags for the discharge of domestic and commercial waste will be promoted together with the introduction of 3 times/week collection.

Table 2.1-2 Waste Discharge Methods

TYPE OF WASTE	DISCHARGE METHOD
Shop-houses	Plastic Bags + House Bins
Houses	Plastic Bags + House Bins
Housing Complexes	Containers + Dust Chutes
Kampongs	Plastic Bags + Containers
Large Amount Waste	Containers

Table 2.1-3 shows the standard plastic bag and bin sizes.

Table 2.1-3 Standard Plastic Bag and Bin Sizes

a. Plastic Bags		: 50cm x 80cm
b. House Bins	- Fixed Type	: 87 - 110 ℓ
	- Mobile Type	: 40 - 70 ℓ
c. Containers		: 1 m^3

Due to the fact that collection of large amount waste is entrusted to the private sector, containers for large amount dischargers are prepared by consignors.

In principle, plastic bags and bins will be provided by the waste generators while the Council will be responsible for the provision of containers in kampongs.

(3) *Introduction of 3 Times/Week* Collection System

The present daily door-to-door collection service will be continued in commercial areas and shopping streets in the Project Area, and an efficient 3 times/week collection service will be introduced in all the residential areas by 1995 with the cooperation of residents. This 3 times/week collection service will be provided in those places where its introduction appears easy and will then be extended to all other areas as shown in Fig. 2.1-1. The order of its introduction is as follows.

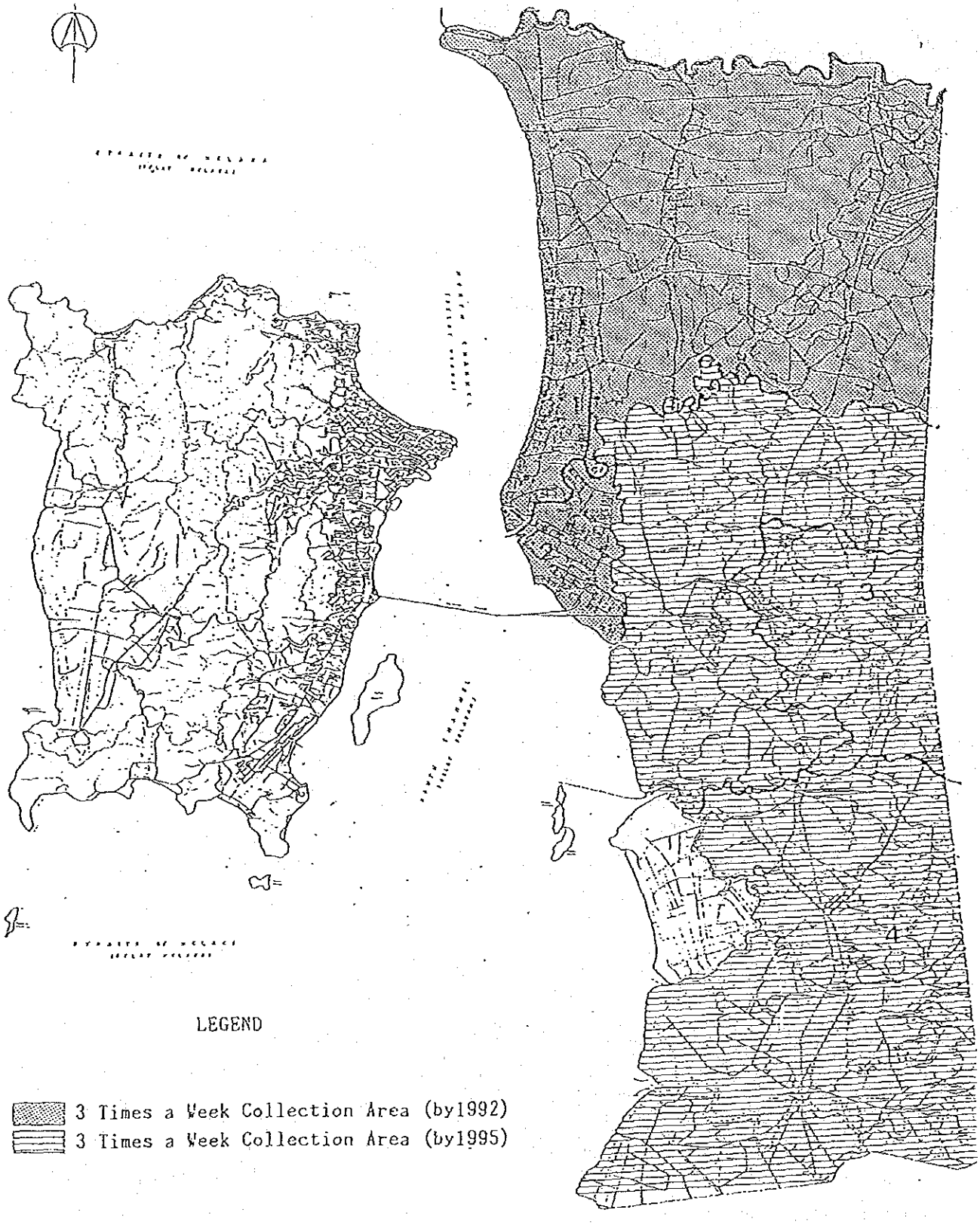


Fig. 2.1-1 Collection Improvement Plan

a. First Step (1989) - Model Area

b. Second Step (1989 - 1991) - Expansion to other Residential Areas . North District . Perai

c. Third Step (1992 - 1995) - Expansion to Kampongs . Central District . South District

Collection from housing complexes with container will be conducted daily as part of the large amount collection service. Plastic bags will be used and station collection will be conducted 3 times/week for housing complexes where containers are not provided.

(4) Bulky Waste Collection

Bulky waste collection will be regularly conducted to maintain environmental sanitation with a collection frequency of once a month in 1995. The initial introduction of bulky waste collection will be conducted together with the 3 times/week collection described in (3) above, and the initial collection frequency will be once a week in order that residents may obtain a proper understanding of the system. Residents will be reminded to keep the following rules in mind at the time of discharging bulky waste.

a. The maximum length of items discharged is less than 1 m and the waste should be bundled.
b. The waste should only be discharged on actual collection days.

(5) Large Amount Collection

The large amount collection will be initially introduced in the North and Central Districts where urbanization is in rapid progress. The subjects of this collection service will include large businesses (hotels, stores and offices) and housing complexes with container. A list of the subject premises must be prepared. The target collection amount in 1995 is 36 t/day which will be half of the daily commercial waste amount. Compactors will be used and the work will be contracted to the private sector.

(6) Collection Amount by Different Collection Systems

Table 2.1-4 shows the collection amount according to the different collection systems.

Table 2.1-4 Collection Amount

(t/day)

	PRESENT (1987)	1992	1995
a. Daily Collection			
- Ordinary Waste	191	136	0
- Bulky Waste	-	-	0
Sub-Total	191	136	0
b. 3 Times/Week Collection*			
- Ordinary Waste	-	109	298
- Bulky Waste	-	3	8
Sub-Total	-	112	306
c. Large Amount Collection	0	33	36
Total	191	281	342

* Commercial areas will be subject to daily collection.

(7) Withdrawal of Double Handling System

MPSP currently employs the door-to-door double handling collection system which requires a large number of heapers for primary collection, resulting in a high collection cost. The single handling system will, therefore, be adopted together with the introduction of 3 times/week collection system and discharge using plastic bags. In regard to collection from kampongs with poor access, assistant collection workers will be employed for each collection vehicle and the residents will be requested to cooperate by taking their waste to the collection points.

2.1.2 Introduction of Large Collection Vehicles

(1) Domestic Waste Collection

As 1.5 - 2 hours are required for a return journey between Butterworth or Bukit Mertajam and the KMDS or PBDS, the current side loaders can only make a maximum of 2 trips a day, largely reducing the vehicle operation efficiency and consequently increasing the collection cost. However, the collection cost will be reduced by the introduction of compactors (10 m^3) in addition to the reduction of the loading time by the introduction of 3 times/week collection system and the use of plastic bags. Therefore, compactors will be used for collection in the future with a target of 2 trips a day on average. With regard to vehicle size, compactors with a loading capacity of 10 m^3 will be used as the introduction of larger vehicles than those currently used is impossible due to the road conditions. Conversion to compactor type of vehicle will take place in 1992 in accordance with the commencement of operation of the new disposal sites.

(2) Bulky Waste Collection

Given the nature of this collection service, dump trucks which does not depend on the waste size will be used despite their relatively low collection efficiency.

(3) Large Amount Collection

Larger containers like hauled container are suitable for such places as markets where a particularly large amount of waste is generated though, similar compactors to those used for ordinary waste collection will be used in order to standardize the collection vehicles in MPSP. This vehicle standardization is supported by the fact that MPSP has only a small number of places generating large amount waste.

(4) Haulage Route

While waste to be collected in the North District will be hauled to KMDS, Central and South District will be hauled to PBDS through the main roads as shown in Fig. 2.1-2.

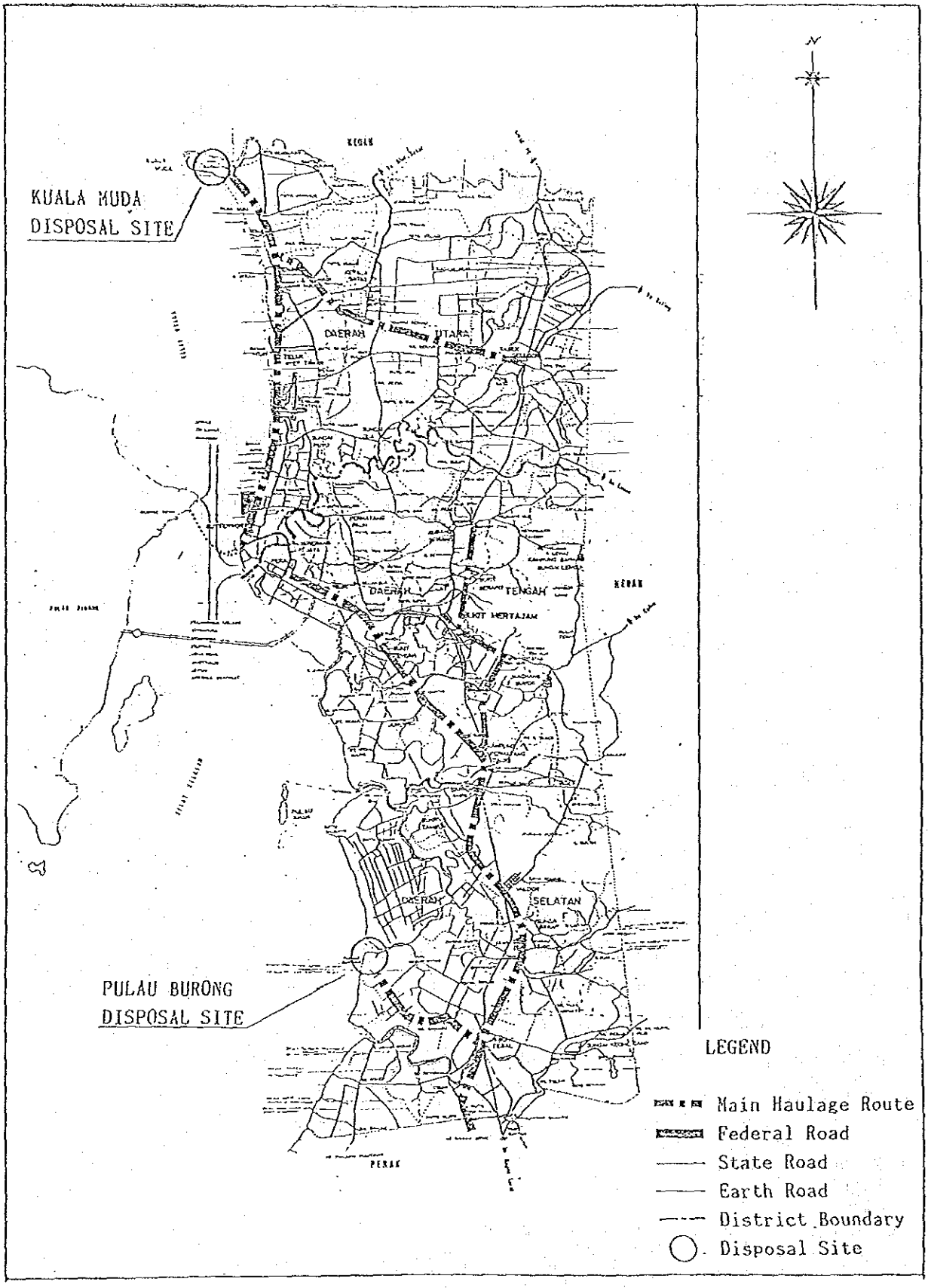


Fig. 2.1-2 Haulage Routes

2.1.3 Review of Collection Zones for Private Contractors

(1) Contract Rate

At present, 24% of the solid waste is collected by private contractors. However, in view of maintaining an appropriate solid waste management size following the expansion of the service areas and the introduction of compactor vehicles, it is planned to increase the contract rate to some 50%. Road and drain cleansing will also be contracted to the private sector in addition to the collection of domestic and bulky waste. In the case of large amount collection, the entire work will be conducted by private contractors.

(2) Collection Zones

The present collection zones assigned to private contractors will be expanded, as shown in Fig. 2.1-3 on the basis of a daily collection amount exceeding 30 t/day with the introduction of 3 times/week collection system and using compactor vehicles.

a. The two zones in the North District will be combined.

b. The Perai zone in the Central District will be expanded to cover the entire Perai area. The two zones in Bukit Mertajam will be combined.

c. The two zones in the South District will be combined.

(3) Collection Amount

As shown in Table 2.1-5, the daily collection amount by private contractors will be 157 tons and 191 tons in 1992 and 1995 respectively.

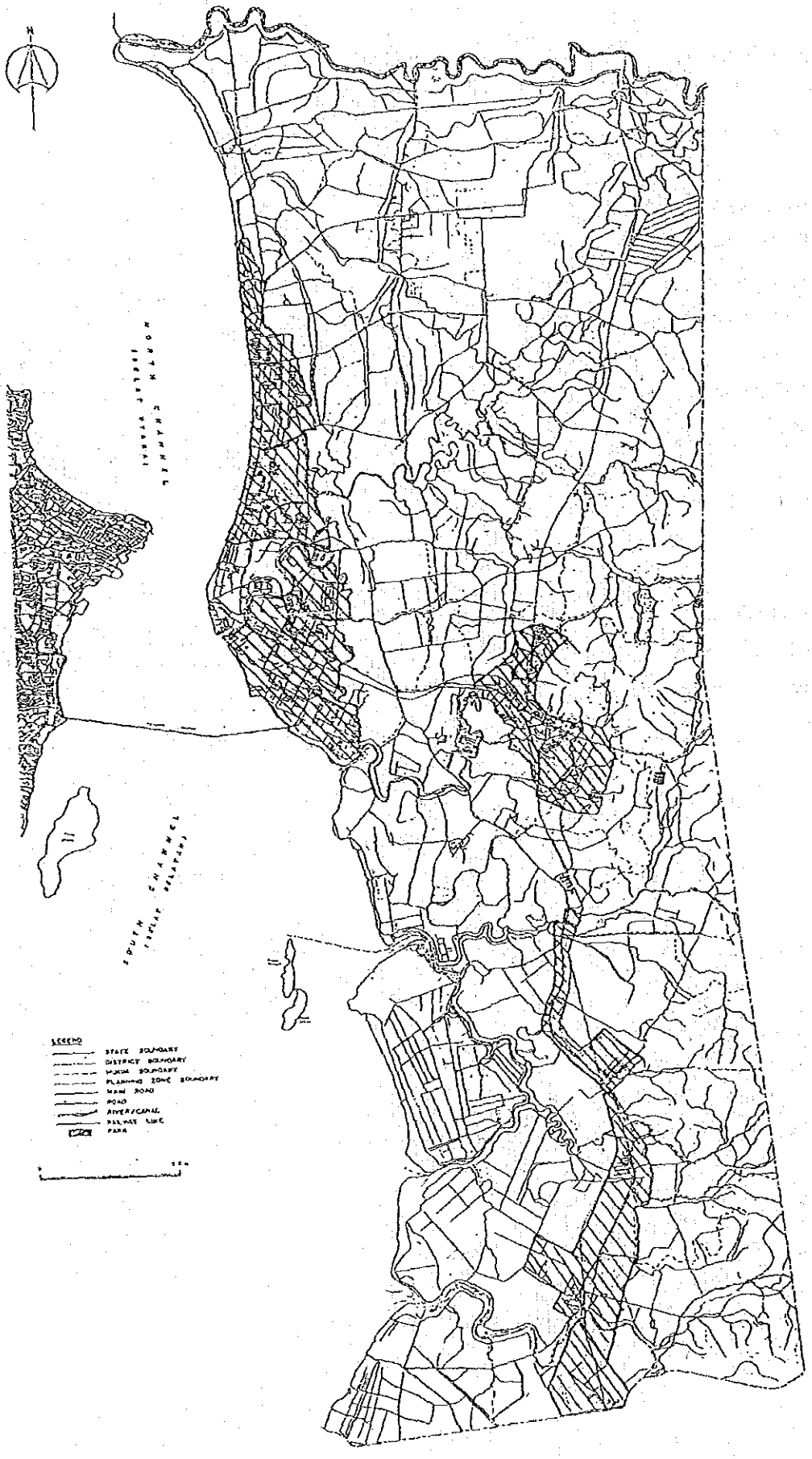


Fig. 2.1-3 Area to be Contracted Out

Table 2.1-5 Collection Amount by Contract Zone

(t/day)

ZONE NO.	AREA	1992	1995
1	Butterworth	47	57
2	Perai	27	33
3	Bukit Mertajam	26	33
4	South District	23	32
5	Large Amount Collection	32	36
Total		157	191

As a result, the Council's collection service will be mainly suburban areas in the North and Central Districts with a collection amount of 154 t/day, resulting in a contract rate of 56%.

(4) Contract Changes

In view of the locations of the new disposal sites and the introduction of 3 times/week collection system, the present contracts must be accordingly changed. Since the present contracts enter their third year in June, 1991, it is recommended that they will be extended until 1992 when the new disposal sites will commence its operation. New contracts should then be made under the consideration of expanded zones. At the same time, the use of compactor vehicles will be advised. Contracts for large amount collection will be made in accordance with the opening of the new disposal sites.

2.1.5 Collection Equipment and Manpower

(1) Collection Amount and Standard Collection Methods

Since 56% of the solid waste to be collected in MPSP will be collected by private contractors following the expansion of the contract areas, the Council's collection service will be suburban areas in the North and Central Districts with a collection amount of 151 t/day in 1995. Table 2.1-6 shows the collection amount by the different collection systems.

Table 2.1-6 Collection Amount by the Council in 1995

(t/day)

TYPE OF WASTE	FREQUENCY	AMOUNT
Domestic Waste		
- Commercial Areas	- Daily	15
- Residential Areas	- Daily	0
- Residential Areas	- 3 Times/Week	131
Bulky Waste	- Monthly	5
Total		151

Domestic waste collection amount will vary depending on the day of the week, i.e. 15 tons on Sundays, 212 tons on Mondays and Tuesdays, and 146 tons on the remaining days. Only some collection vehicles will operate on Sundays while overtime will be necessary on Mondays and Tuesdays. 2 trips a day to the KMDS and PBDS will be possible with the introduction of 3 times/week collection system. The standard work for each type of vehicle will be as shown in Table 2.1-7.

Table 2.1-7 Standard Work

ITEMS	3 TIMES/WEEK	DAILY	MONTHLY (BULKY WASTE)
a. Type of Vehicle	Compactor (10 m^3)	Compactor (10 m^3)	Dump truck (9.5 m^3)
b. Loading Capacity	5 tons	5 tons	2 tons
c. No. of Trips/Day	2 trips	1.5 trips	2 trips
d. Haulage Amount	8 t/day	6 t/day	4 t/day
e. No. of Workers			
- Driver	1 person	1 person	1 person
- Collection Workers	4 persons	4 persons	4 persons
- Heapers	2 persons	2 persons	2 persons
f. Working Hours	7 hrs	7 hrs	7 hrs
g. Reserve Vehicle Ratio	20%	20%	20%
h. Reserve Manpower Ratio	20%	20%	20%
i. Fluctuation Coefficient of Waste Amount	1.15	1.15	1.15

(2) Required Number of Vehicles and Manpower

As shown in Table 2.1-8, 31 compactors, 3 dump trucks and 238 workers will be required. Since the amount of waste is big in Monday and Tuesday, collection work can be done by overtime. Sunday collection will require 5 units operation and it will be inefficient because of scattered collection points.

Table 2.1-8 Required Number of Vehicles and Manpower

	North District	Central District	South District	Total
Collection Volume (t/day)	78.7	62.6	9.8	151.1
Collection Frequency	3 time/week	3 times/week	3 times/week	
Vehicle Type	compactor	compactor	compactor	
No. of Trips	2	2	2	
Haulage Amount/Vehicle (tons)	8	8	8	
Required No. of Vehicles	12	10	2	24
No. of Reserve Vehicles	3	3	1	7
Tipper (Dump Truck)	1	1	1	3
Required Manpower				
- Drivers	16	14	4	34
- Workers	96	84	24	204
Total	112	98	28	238

(3) Vehicle Purchasing Schedule

Collection vehicles will be purchased in 1991 and 1992 as shown in Table 2.1-9, since it may be difficult to purchase new vehicles before 1991 because of financial constrain of MPSP. However, it is desirable to replace old vehicles as soon as possible because many vehicles of MPSP were purchased before 1980.

Table 2.1-9 Vehicle Purchasing Schedule

(units)

	1990	1991	1992	1993	1994	1995
Compactor						
- Purchasing	-	17	17	0	0	0
- Scrapping	-	(11)	(4)	0	0	0
- Operating	(15)	21	34	34	34	34
Tipper						
- Purchasing	-	0	3	0	0	0
- Scrapping	-	(20)	(11)	0	0	0
- Operating	(31)	11	3	3	3	3

Note 1: ( ) means existing vehicles
2: This figure includes stand-by vehicles

(4) Manpower Schedule by the Year

About 250 workers are currently employed for waste collection services with daily collection and double handling collection systems excluding the laborers who make mixed work.

Around same number of laborers will be required in 1995 even though 3 times a week collection will be introduced and privatization will be expanded. However, heaping work will not be necessary for the laborers who make mixed work presently as shown in Table 2.1-10.

Table 2.1-10 Required Manpower by the Year

(persons)

	1990	1991	1992	1993	1994	1995
Driver	38	37	37	36	35	34
Collection	152	148	148	144	140	136
Heaping	76	74	74	72	70	68
Total	260	259	259	252	245	238

2.1.6 Management Plan

(1) Working Time

A working day of 8 hours is set from 6:30 a.m. to 2:30 p.m.

(2) Work Load

The standard work load for domestic waste collection is 8 t/day per collection vehicle or 1.2 t/day per worker, while the standard work load for bulky waste collection is 4 t/day per collection vehicle or 0.6 t/day per worker. It is a fact, however, that the actual work load declines up to 65% because of the number of reserve vehicles and workers.

(3) Formation for Collection Work

The collection work will be conducted under the 2 or 3 overseers in each District and inspection of each contract zone will be conducted by 1 or 2 overseers.

(3) Management Plan

Waste collection services will be managed under the following plan:

- Collection route and zoning maps;
- Vehicle arrangement plan for Sunday collection;
- Maintenance schedule for collection vehicles;
- Assignment schedule of workers;
- Daily and monthly role call records;
- Maintenance records of each vehicle;
- Daily and monthly records of operation for each vehicle;
- Daily and monthly work load of each vehicle;
- Record of claims and transactions.

(4) Rules and Standard

Rules and standards should be prepared in order to encourage public cooperation.

- Waste discharge
- Illegal dumping
- Fee collection

2.2 Cleansing Improvement

2.2.1 Cleansing Method

(1) Cleansing System in 1955

The following improvement measures will be implemented in Phase I.

a. Introduction of weekly cleaning in residential areas.
b. Mechanization of main road sweeping and grass cutting.
c. Introduction of team work.

The cleaning system to be achieved by 1995 is shown in Table 2.2-1.

(2) Introduction of Once-a-week Cleansing System in Residential Areas

Once-a-week cleaning system will be introduced in residential areas together with the introduction of the 3 times/week collection system. In view of the fact that cleansing work is currently conducted by 440 workers, the once-a-week cleansing system will be gradually implemented as shown in Table 2.2-1 to avoid a drastic cut in manpower.

Table 2.2-1 Cleansing System and Subject Length

(km)

	PRESENT 1987	1992	1995
a. Road Sweeping			
- Daily	322	118	123
- Weekly (Manual)	275	375	418
- Weekly (Mechanized)	-	215	215
- Monthly	536	536	536
Total	1,133	1,244	1,292
b. Drain Cleansing			
- Daily	1,194		
- Weekly	-	1,416	1,512
c. Grass Cutting (Monthly)	1,194	1,416	1,512
d. Beach Cleansing (Daily)	10	20	20

(3) Mechanization of Cleansing Work

Mechanical sweeping of main roads will be planned in view of the extensive land area of MPSP. While grass cutting is currently conducted manually together with drain cleansing, mechanized grass cutters will be introduced to improve work efficiency, and each worker will be provided with a cutting machine which can be carried by hand.

(4) Introduction of Team Work

In principle, a weekly street sweeping and drain cleansing by team work system will be introduced in residential areas. Streets in markets and commercial areas will, however, be swept daily. A sample system of team work for standard residential areas is as follows:

Total Area	:	180 ha
Total Street Length	:	36 km
Number of Households	:	9,000
Street Length Subject to Daily Sweeping	:	3.6 km
Street Length Subject to Weekly Sweeping	:	32.4 km
Drain Length Subject to Cleaning	:	72 km
Total Grass Cutting Length	:	72 km
Manpower - Daily Sweeping	:	3-4 persons
- Team Sweeping	:	18 persons
- Grass Cutting	:	4 persons
- Mandor	:	3 persons
- Overseer	:	1 person
- Total	:	30 persons

A total of 12 teams will be required to cover all residential areas and each team will comprise 30 workers for cleansing in their assigned area.

2.2.2 Equipment and Manpower

The main equipment for cleansing work will be mechanical sweepers, trucks and grass cutting machines, and the required number of equipment in 1995 is as follows:

a. Mechanical sweepers : 2 units + 1 unit (reserve)
b. Trucks : 6 units (2 units for each district)
c. Grass cutting machines : 48 units (1 unit for each worker)

The required manpower is shown in Table 2.2-2.

Table 2.2-2 Required Manpower

(persons)

WORK ITEMS	TOTAL LENGTH	COUNCIL WORKERS	CONTRACTORS	TOTAL
a. Worker				
- Street Sweeping				
* Daily	123 km	71	71	142
* Weekly	418 km	34	35	69
* Monthly	536 km	22	0	22
* Mechanized	215 km	8	0	8
- Drain Cleansing (Weekly)	1,512 km	158	90	248
- Grass Cutting	1,512 km	48	27	75
- Beach Cleansing	20 km	27	0	27
- Reserve		20	0	20
b. Mandor		39	23	62
Total		429	246	673

2.2.3 Management Plan for Cleansing Works

(1) Working Hour

Daily working schedule is from 6:30 a.m. to 2:30 p.m.

(2) Work Standard

a. Street Sweeping
   - manual : 1.2 km/woprker/day
   - mechanical : 1.2 km/worker/day

b. Drain cleansing: 1.2 km/worker/day

c. Grass cutting : 0.5 km/worker/day

(3) Management System

Cleansing services are provided by the Council in 3 District with an independent team for mechanical street sweeping.

Cleansing works are controlled by means of providing several planning maps with working shedule and records as follows:

a. Maps of roads and streets to be swept;
b. Route maps for mechanical sweeping;
c. Zoning maps for cleansing works;
d. Daily working schedule for cleansing works;
e. Purchasing schedule for equipment and tools;
f. Role call record including overtime work;
g. Operation and maintenance records of equipment and vehicles;
h. Working records by work and zone;
i. Record of complaints.

2.3 Final Disposal Site at Kuala Muda and Pulau Burong

2.3.1 Planning Conditions

(1) Basic Policy

The basic principals for the preliminary designs regarding Phase I of the project have been conceived of and are arranged in the following.

a. An adequate landfill volume exists
b. The design appropriately pertains to the topography, geology and surrounding environment.
c. The wastes disposed of at the site are to be harmless and stabilized quickly.
d. During and after completion of the filling, the area does not became a pollution outbreak source.
e. During and after completion of the filling, safety from disaster is guaranteed.
f. The completed site will be of a configuration harmonious with the surrounding environment.
g. Throughout and after completion of the filling, the operation and maintenance expenses will be kept low.

(2) Designed Landfill Volume

a. Conditions for Estimation

i. Landfill periods : 1992 - 1996 (Phase I)

ii. Unit weight of waste disposed: 0.8 t/m^3
(after compaction)

iii. Cover material : 30% of the waste volume

b. Designed Landfill Volume

The designed landfill volumes for the Kuala Muda and Pulau Burong disposal sites within Phase I, II and III are listed below.

Table 2.3-1 Designed Landfill Volume

ITEM	UNIT	KMDS			PBDS			REMARKS
		Phase I	II	III	I	II	III	
Disposal Amount	t/day	210	264	311	250	312	368	Phase I 1992 - 1996 Phase II 1997 - 2001 Phase III 2002 - 2005
Cumulative Disposal Amount	1,000 t	345	442	429	409	523	506	
Cumulative Disposal Volume	1,000 m^3	431	552	536	511	653	634	Specigrav. 0.8
Cumulative Cover Material	1,000 m^3	129	166	161	153	196	190	30% of abvove volume
Cumulative Landfill Volume	1,000 m^3	560	718	697	664	850	823	

(3) Topography and Geology

The Topography and geology of KMDS and PBDS are summarized as shown below.

a. Topography

i. KMDS

At this location, there are two sites available for landfilling. The inland site is at the northern tip of the Penang State between the Muda River and the national road. The lagoon site is within the lagoon which is located near the mouth of the Muda River. Both sites are flat and low lying land.

ii. PBDS

This site is located in the southern tip of the Penang State, as a flat marsh at the mouth of the Tengah River.
The present land use is for Byram Forest Reserve.

b. Geology

i. KMDS

- Inland site

  The surface soil is silty sand, however, the basement layer is made up of marine clay.

- Lagoon site

  A natural bund is made up of 3 m of sandy soil. Its lower portion is made up of marine clay partly mixed with loose sand layer. The lagoon enclosed by the natural bund is also made up of marine clay. The marine clay permeability coefficient is 10^{-6} - 10^{-7} cm/sec.

ii. PBDS

- The accumulated marine clay in the site has a permeability coefficient of 10^{-6} - 10^{-7} cm/sec.

iii. Characteristic of marine clay

Laboratory testing on selected soil samples has been performed to evaluate the engineering parameters of the subsoil encountered. Based on soil testing, the characteristics of marine clay are summarized as in Table 2.3-2, and geological profiles are shown in Fig. 2.3-1 and 2.3-2.

Table 2.3-2 Characteristics of Marine Clay

ITEMS	UNIT	KMBS	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	20 - 37
- Liquid limit	%	47 - 90	40 - 70
Permeability coefficient	cm/sec	10^{-6} - 10^{-7}	10^{-6} - 10^{-7}

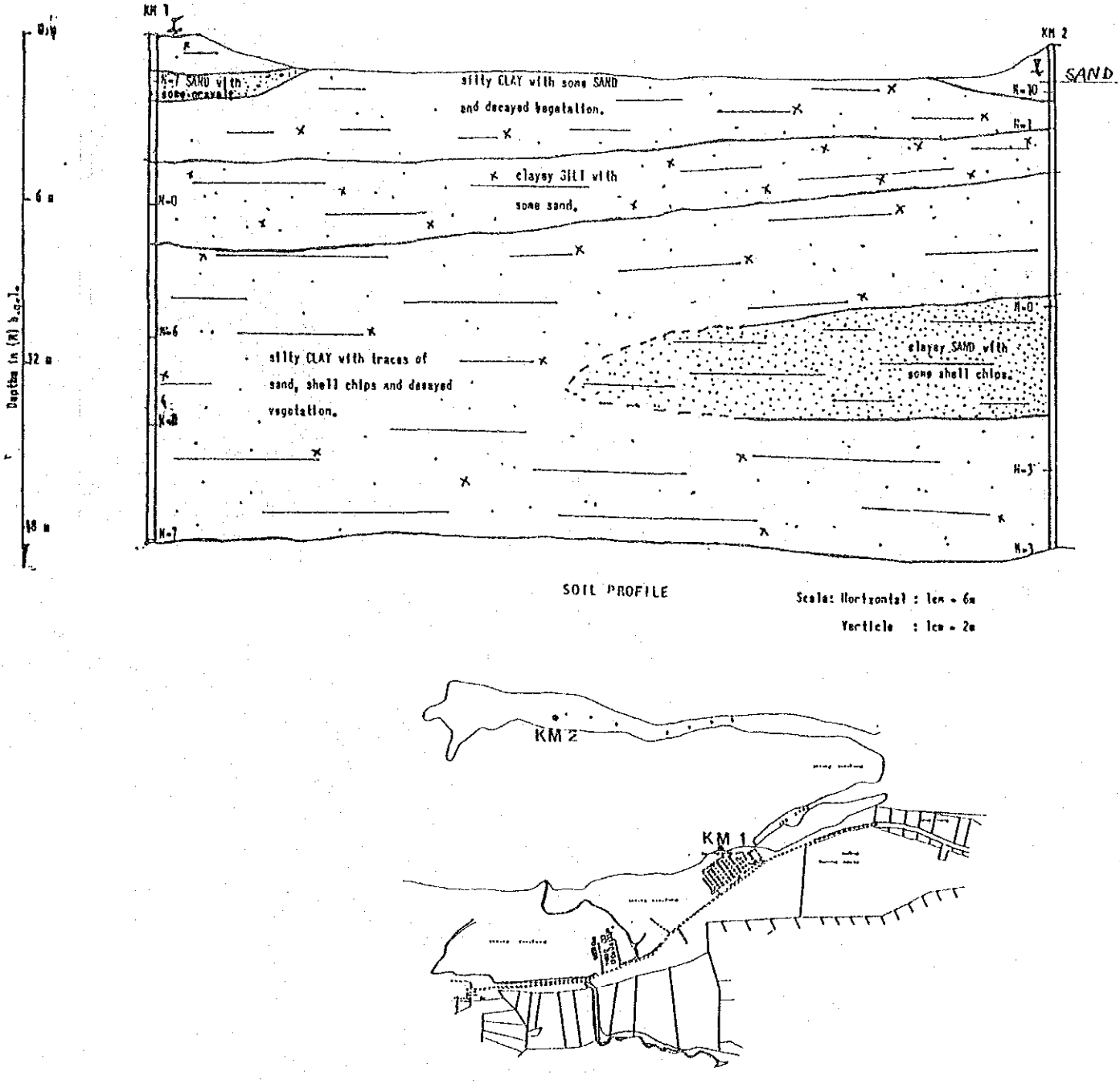
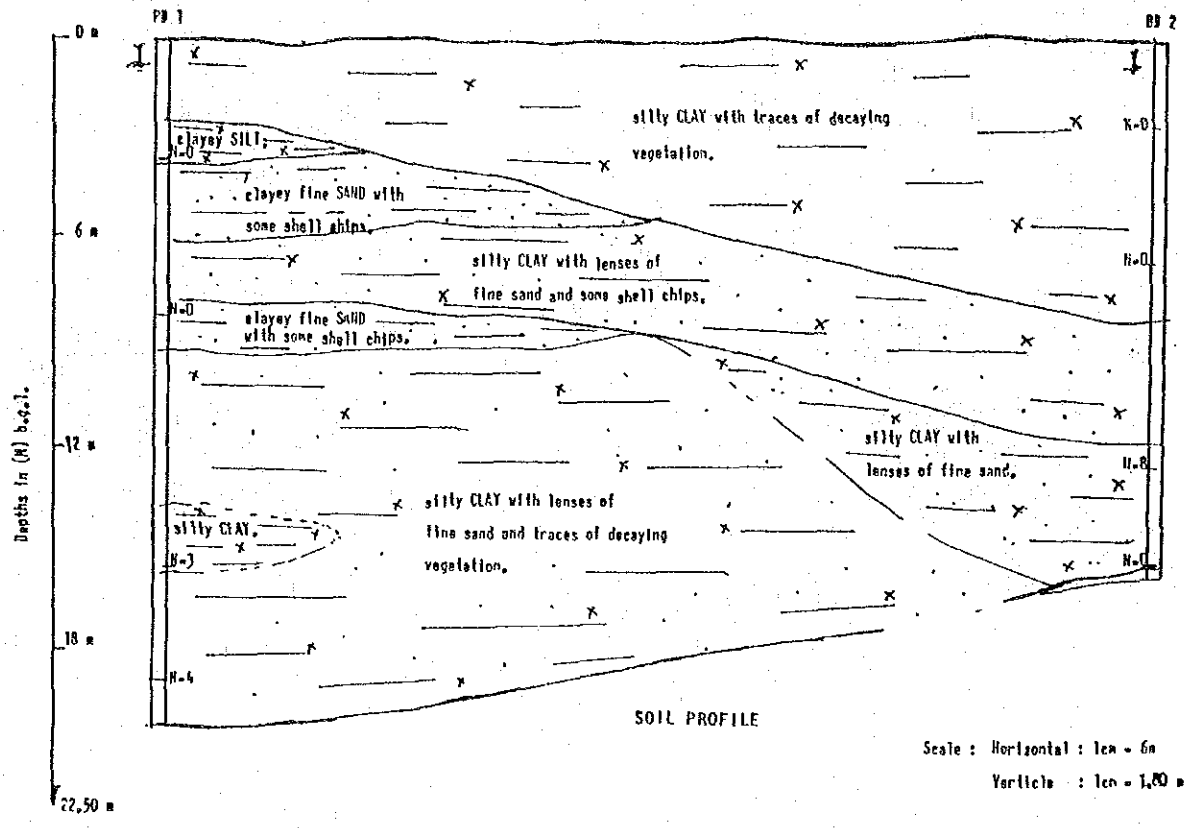


Fig. 2.3-1 KMDS Geological Profile

PULAU BURONG SITE



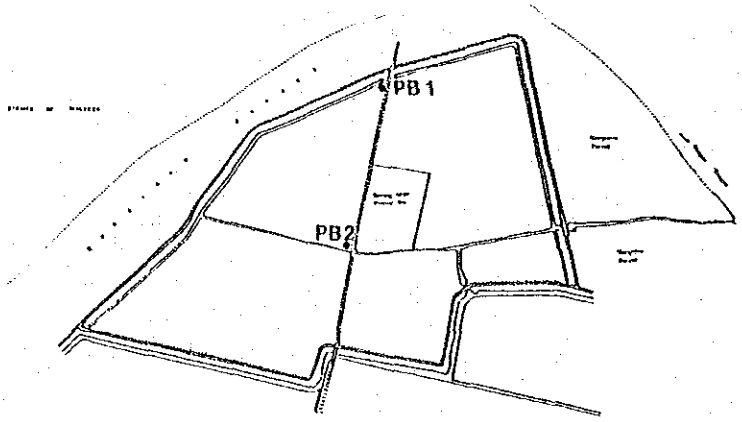


Fig. 2.3-2 PBDS Geological Profile

2.3.2 Facility Design

(1) Facility Lay-out

a. Basic Considerations

The basic considerations for the facility lay-out are as follows.

i. The design is to smooth the execution and transitions in the work from Phase I through to Phase III.
ii. Regarding the surrounding land use conditions, the consideration is that each facility casts no bad effects on the local area.
iii. The on-site roads/or landfill flow are to be uncomplicated and harmonious.
iv. The administration facilities are to be erected near the entrance to the disposal site for full supervision of the waste collection vehicles.
v. The leachate circulation facilities are to be placed as far away as possible from residential areas.

b. Facilities to be Constructed

i. Main Facilities
- Enclosing structure
- Drainage system
- Access

ii. Environmental Protection Facilities
- Buffer zone
- Litter control facilities
- Gas removal facilities
- Leachate collection facilities
- Leachate cycling facilities
- Leachate outlets
- Monitoring facilities

iii. Building and Accessories

- Site office
- Weigh bridge
- Storage building
- Safety facilities
- Fire prevention facilities
- Other

c. Lay-out

The lay-out of the major facilities for KMDS and PBDS are done and shown in Fig. 2.3-3 and 2.3-4 respectively.

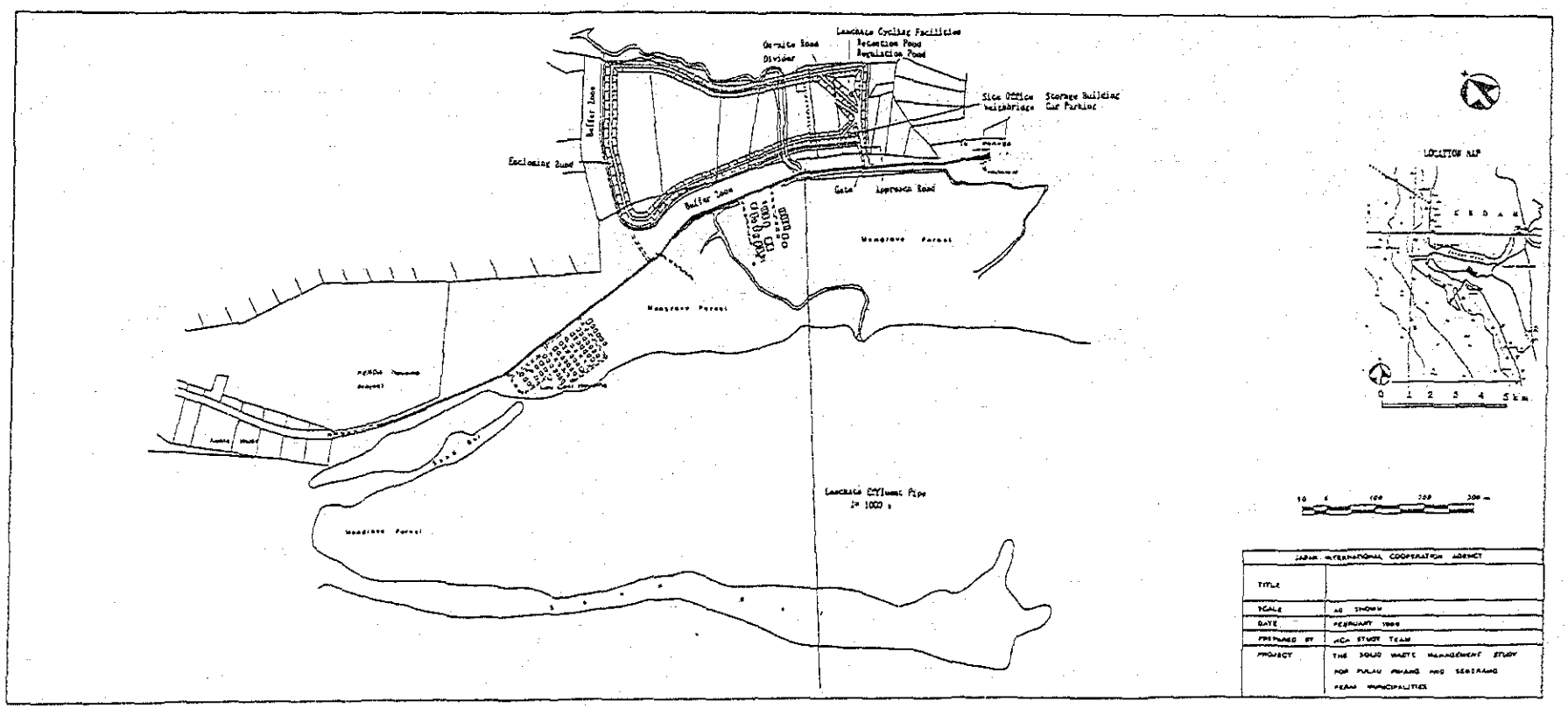


Fig. 2.3-3 Lay-out of Major Facilities for KMDS

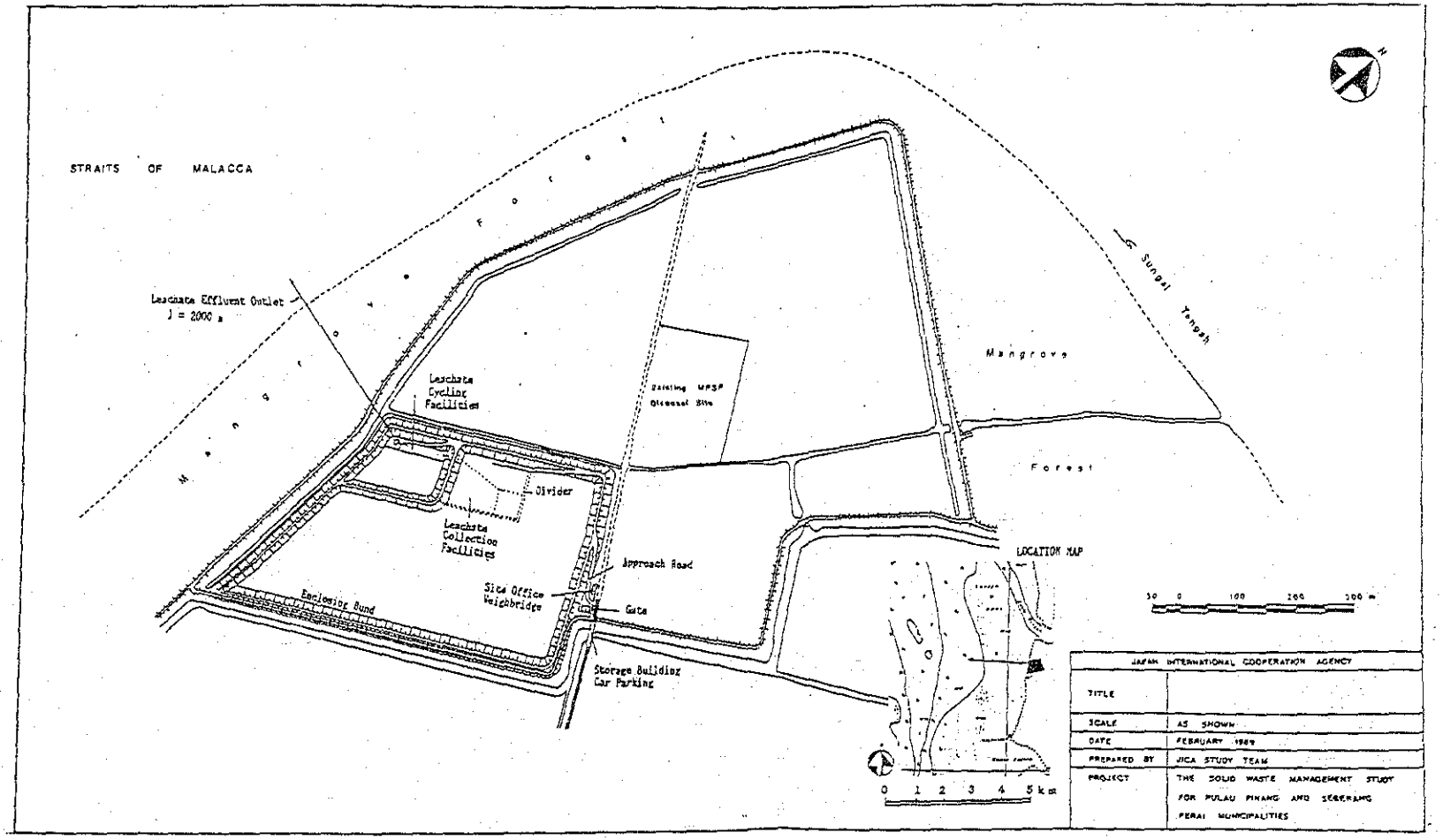


Fig. 2.3-4 Lay-out of Major Facilities for PBDS

(2) Main Facilities

a. Enclosing structures

i. Enclosing bund

Since the disposal sites are located on flat land, enclosing bund will be constructed earth for the prevention of rain water invation and the guarantee of the designed landfill volume. The enclosing bund is designed at 5m height. The top of the bund, functioning as the on-site road and the administrative road, is of a 4 m width and a gravel pavement. Land sliding and settlement were examined based on the geological data for safety and typical cross section is determined as shown in Fig. 2.3-5.

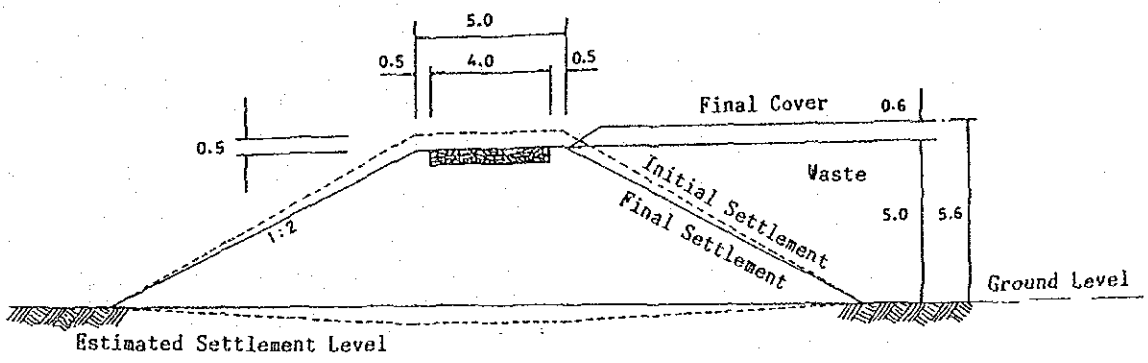


Fig. 2.3-5 Typical Cross Section of Enclosing Bund

ii. Divider

The divider is constructed within the enclosing bund so as to reduce the leachate quantity generated and achieve efficient landfill operations.

The divider is constructed by imported soil and a typical cross section is shown in Fig. 2.3-6.

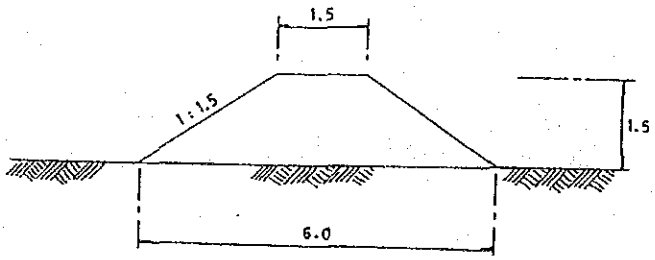


Fig. 2.3-6 Typical Cross Section of Divider

b. Drainage Systems

i. The principal purposes for the systems

The principal purposes for the systems are as follows:

- Surrounding drain : Elimination of rainwater inflow from outside of the landfill site.
- On-site Drain : Elimination of rainwater from the non-landfill site partitioned-off by the divider within the enclosing bund.
- Drain for Reclaimed Area: Elimination of rainwater inflow after the completion of the landfill operations.

ii. Design conditions

The drainage system is designed in accordance with the "Urban Drainage Design Standards and Procedures for Peninsular Malaysia". Designed discharge by drain system will be calculated by the unit discharge per ha as shown in Table 2.3-3.

Table 2.3-3 Designed Discharge

DRAIN SYSTEMS	RETURN PERIOD (year)	UNIT DISCHARGE (m^3/sec/ha)	REMARKS
Surrounding Drain	2 / 5	0.064 / 0.078	Rainfall duration is one hour
On-site Drain	0.5	0.167	Rainfall duration is 30 min.
Drain for Reclaimed Area	0.5	0.150	- ditto -

iii. Design of drainage systems

1) Surrounding drain

The typical cross section of a surrounding drain is illustrated in Fig. 2.3-7.

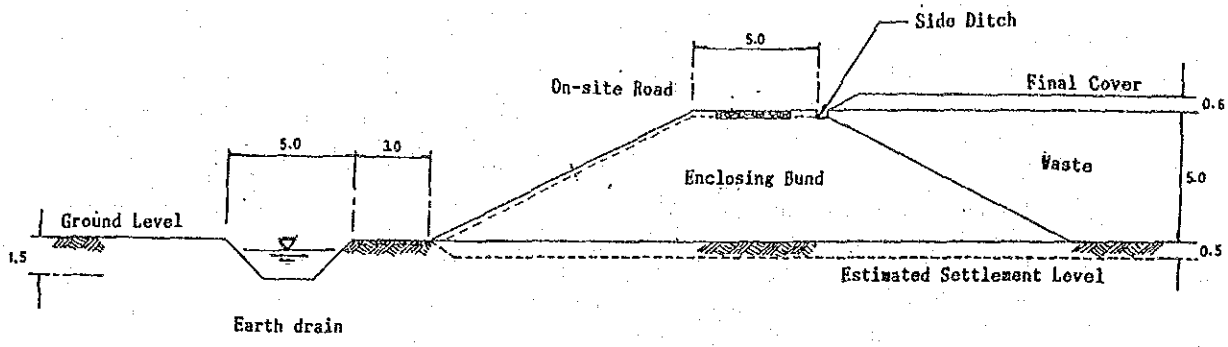


Fig. 2.3-7 Typical Cross Section of Surrounding Drain

2) On-site drain (surface)

Since the ground is composed of marine clay, an unlined drain area is installed.

The drainage from the inside of the enclosing bund to outside is discharged by gravity flow as shown in Fig. 2.3-8.

3) Drain for reclaimed area

This drain is established after the completion of the final covering. Rainwater is discharged outside of the enclosing bund.

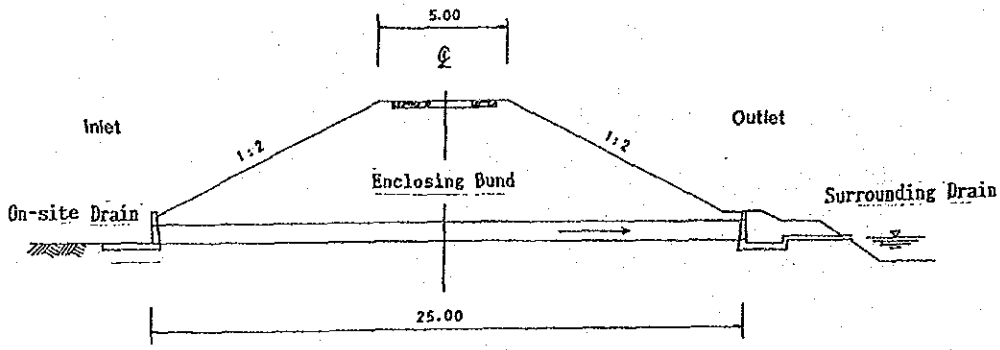


Fig. 2.3-8 Drain Outlet Profile

c. Access

i. Approach Road

This road will link the disposal site to the public road.

The road will be wide enough for two-way traffic with a carriageway of 6 m width paved by asphalt concrete. Typical cross section is shown in Fig. 2.3-9.

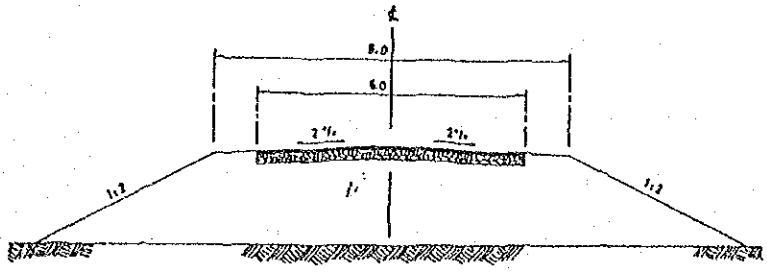


Fig. 2.3-9 Typical Cross Section of Approach Road

ii. On-site Road

The typical cross section of on-site road is shown in Fig. 2.3-10. The road width is to be 4 m with gravel paved at a thickness of 30 cm.

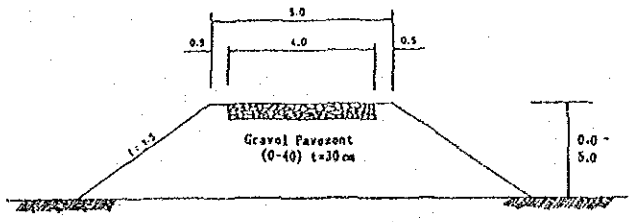


Fig. 2.3-10 Typical Cross Section of On-site Road

iii. Improvement of the existing pavement

The existing dirt road to the PBDS will be paved with asphalt.

- Pavement width ..... 6 m.
- Pavement structure ... same as the approach road

(3) Environmental Protection Facilities

The facilities are for the prevention of secondary pollution out break during and after completion of landfill.

a. Buffer zone

The buffer zone is hoped to occupy quite a bit of space. The zone is set at a 50 m width.

i. KMDS

- The buffer zone will be established along the existing road and on the PERDA Housing Development side.
- Along the existing road, a forest will be planted and on the PERDA side the existing forest will be left as is.

ii. PBDS

- Because the site is far located from residential areas, no need was found for the establishment of a buffer zone.

b. Litter Control Facilities

There looms the inevitability of litter scattering during the landfilling operations before the covering materials has been placed. As a means of prevention, a movable fence to catch flying litter will be installed.

c. Gas Removal Facilities

As for the out break of gas in landfill sites, gushing and exhaust are common at the weak points on the boundary surface between landfill sites and surrounding structures.

In order to prevent disasters such as fires and odor disseineration by unexpected gushing, gas removal facilities by evacuation are to be installed.

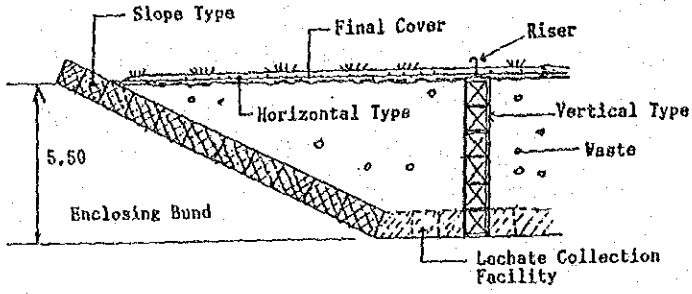
The waste characteristics, stratum thickness and operational conditions for the design conditions of the gas removal facilities by evacuation are the following.

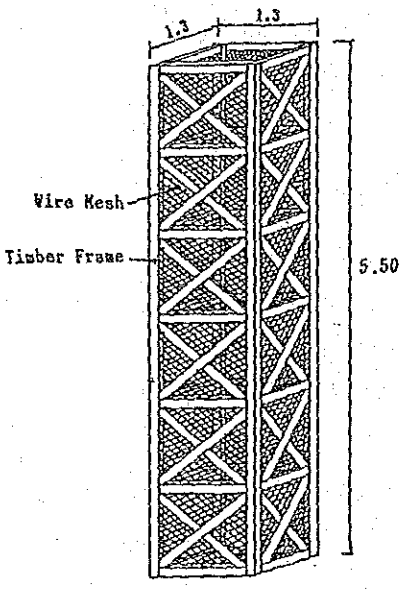
1) waste type ..... municipal waste
2) landfill layer thickness ..... approx. 6.1 m
3) operational conditions ..... the landfill site area is at 9 ha at KMDS and 13 ha at PBDS, with a divider occupying 1-2 ha.

Based on the above conditions, during landfilling operations the individual gas evacuation method is followed and after the completion of landfill, from the point of view of safety and control, the collective the gas evacuation method is followed by connecting individual vertical shafts with a horizontal shaft.

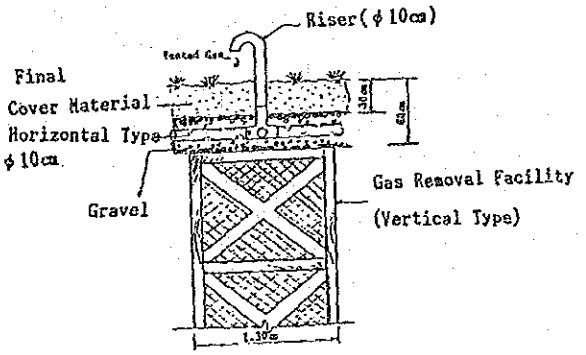
An outline of the gas removal facilities is shown in Fig. 2.3-11.

3 to 4 gas removal facilities will be provided per hectare. Covering material is the most important, as it is necessary not to leave waste exposed over a long term.





VERTICAL TYPE



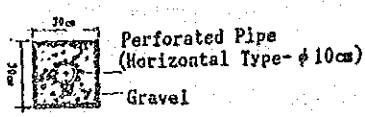


Fig. 2.3-11 Gas Removal Facilities by Evacuation

d. Leachate collection facilities

i. Purpose and design flow

The purpose of these facilities is

1) to discharge to the retention pond
2) to reduce the leachate head (pressure) in the landfill
3) for the expansion of the aerobic area in the landfill layer by their (leachate collection facilities) connection to the gas removal facilities

The following is a flowchart on the design of the leachate collection facilities.

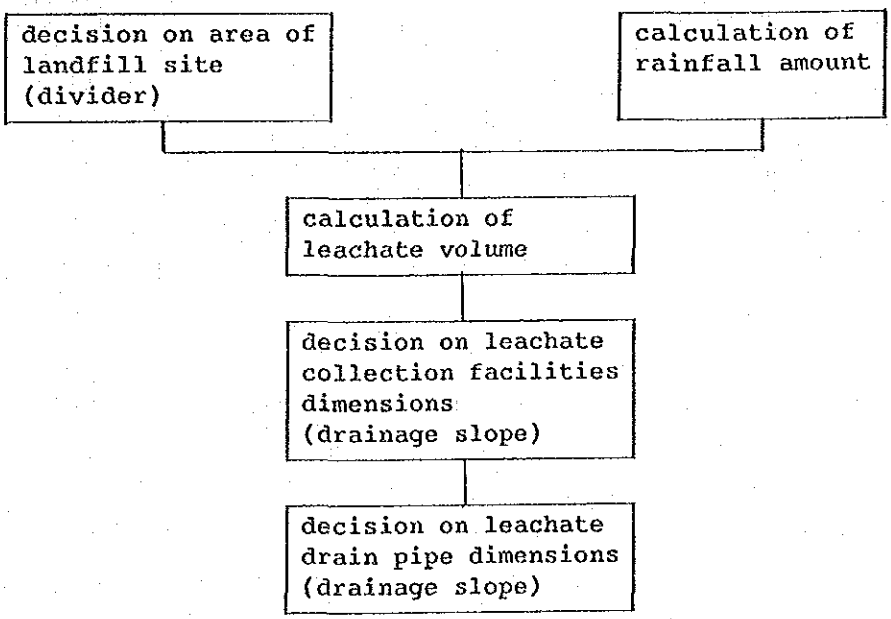


Fig. 2.3-12 Design Flowchart of Leachate Collection Facilities

ii. Area of landfill site

The study on the area in relation to the divider is described as follows:

	PMDS	PBDS
Rainy season (Jul. - Nov.)	1.0 ha	1.0 ha
Dry season (Dec. - Jun.)	1.5 ha	2.0 ha

iii. Calculation of Leachate Volume

The leachate volume in the month of the largest average rainfall is calculated as follows.

Site	Leachate volume (m^3/day)
KMDS	87
PBDS	101

iv. Decision on dimension of leachate collection facilities

As collection facilities, gabions are constructed of which the dimensions are shown in Fig. 2.3-13.

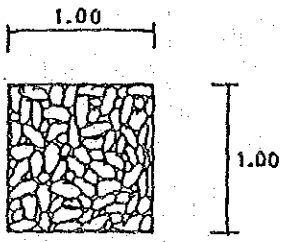


Fig. 2.3-13 Leachate Collection Facility Dimensions

v. Leachate Drain Pipe

The leachate drain pipe diameter KMDS and PBDS is selected to be 0.20 m. The leachate is drained to the leachate collection facility situated within the site.

Finally it is discharged out into the retention pond through drain pipe.

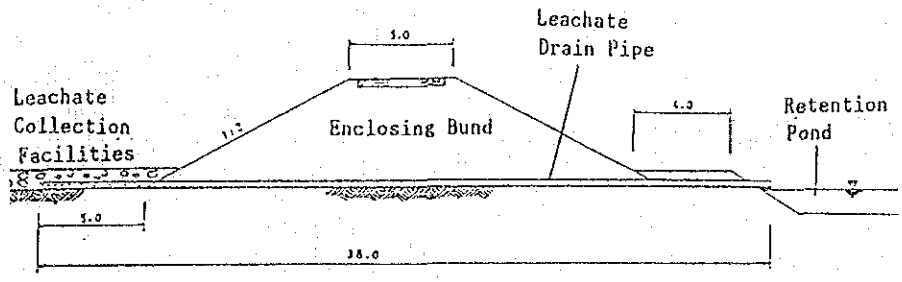


Fig. 2.3-14 Leachate Drain Pipe

e. Leachate Circulation Facilities

The leachate circulation facilities are established in the third level of sanitary landfill development operations which is the pre-stage of the fourth level where leachate treatment is established. With the leachate circulation system, some purification by waste disposed of and cover materials at the disposal site can be achieved. Leachate control and monitoring system are established, offering valuable data on the quality and quantity of leachate.

i. Design flowchart

The design flowchart for leachate cycling facilities is show in Fig. 2.3-15.

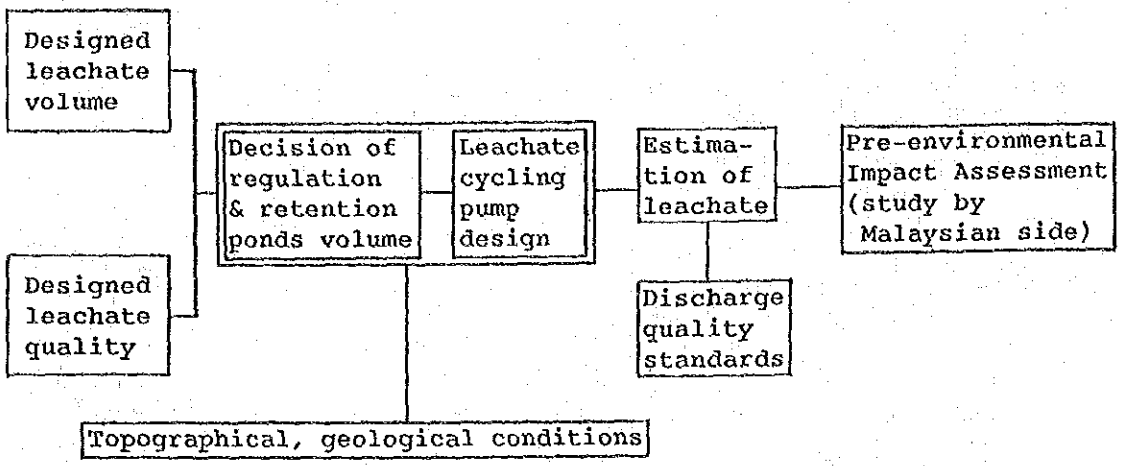


Figure 2.3-15 Leachate Circulation Facility Design Flowchart

ii. Design conditions

1) Designed leachate volume

KMDS	87 m^3/day
PBDS	101 m^3/day

2) Leachate quality estimation

BOD	1,300 mg/ℓ
COD	1,500 mg/ℓ

iii. Leachate circulation facility design

1) Decision of regulation and retention ponds capacity. Both regulation and retention ponds are to hold leachate temporarily. Because the volume fluctuates, depending on rainfall, each pond is to be big enough to hold 10 days' volume of the largest monthly rainfall. The capacity of both ponds is shown below.

ITEM	KMDS		PBDS	
	RETENTION POND	REGULATION POND	RETENTION POND	REGULATION POND
Necessary capacity (m^3)	870	870	1,010	1,010
Water depth (m)	1.0	1.0	1.0	1.0
Pond area (m^2)	870	870	1,010	1,010

2) Leachate circulation pump

Since the leachate volume is about the same at the KMDS and the PBDS, that of the PBDS will be used to represent both. The immersed pump has a mouth diameter of 50 mm and an output power of 57.5 kW.

iv. Effluent leachate quality estimation

Dilution and purification rate of leachate in terms of BOD and COD are as follows:

BOD 40%

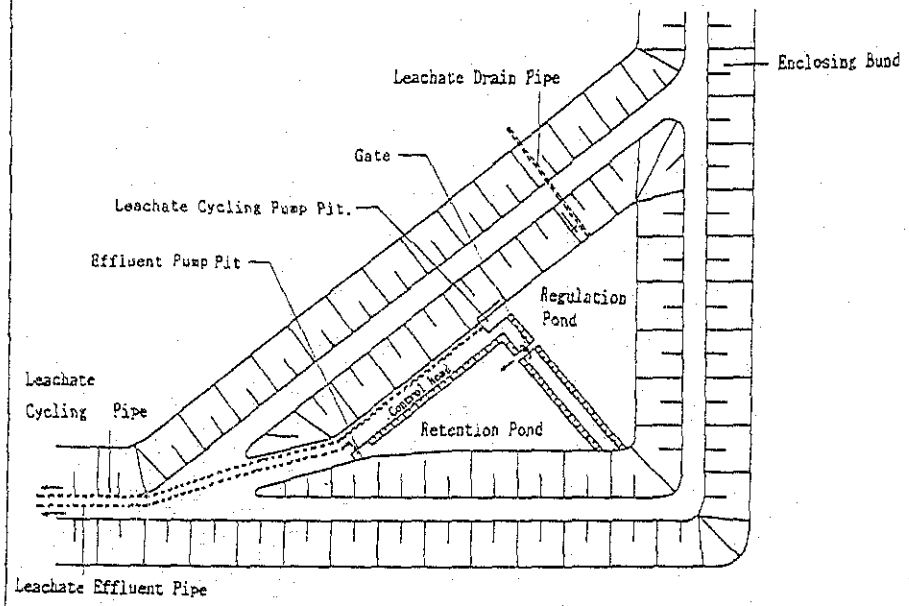
COD 20%

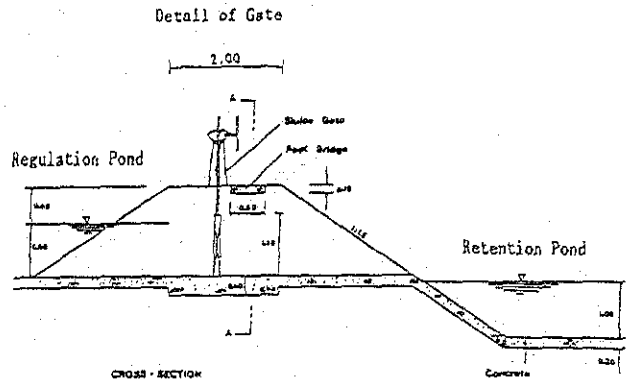
The estimated final leachate quality will be as follows:

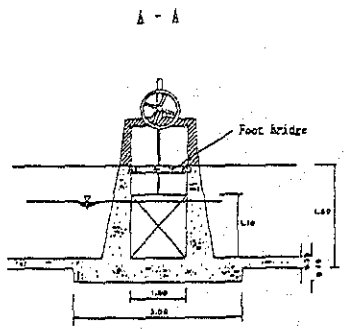
BOD 800 mg/ℓ

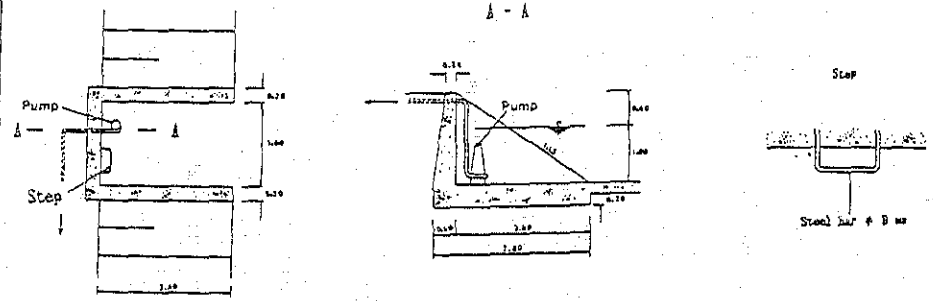
COD 1,200 mg/ℓ

As for heavy metals within leachate, from the observation data during landfilling operations at municipal disposal sites in Japan, Hg and Cd were hardly found. The reason is that waste disposed of was municipal but not industrial one and also, soil absorption occurred by covering operations. However, Fe and Mn, in anaerobic conditions where leaching was known, were found. However, within this design, heavy metal treatment is not considered necessary.









Leachate Cycling And Effluent Pump Pit

LEGEND	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

Fig. 2.3-16 Detail of Leachate Circulation Facilities for KMDS and PBDS

f. Leachate effluent facilities

It is suggested by Pre-EIA that a leachate effluent outlet from a retention pond shoul dbe set up in the sea (LWL should be deeper than 50 cm.) out of the lagoon and mangrove forest so as not to have effect on fauna which lives in the lagoon and forest.

i. Design conditions

- Designed effluent volume ; KMDS 870 m^3, PBDS 1,010 m^3
- Effluence time ; discharge every 5 days, in operation 10 hrs. a day.
- Velocity in Pipe ; approx. 1 m/sec (to avoid sedimentation)

ii. PipeLine

An outline of the pipeline is shown in Fig. 2.3-17.

- Pipe type ; Steel pipe
- Diameter ; 0.10 m
- Length ; KMDS 1,000 m
; PBDS 2,000 m
- Installation ; 1 m under the seabed

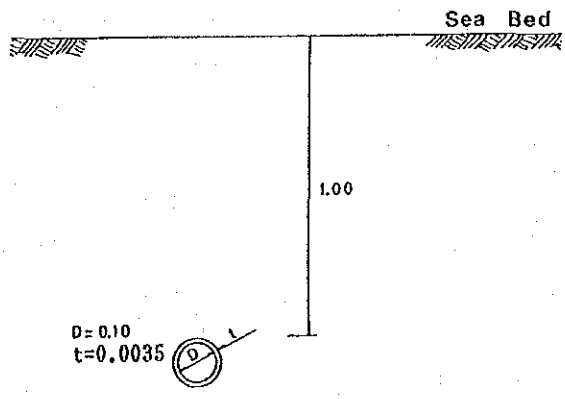


Fig. 2.3-17 Pipe Installation Profile

iii. Effluent outlet

In order to be not clogged by inflowing sand, the outlet is designed to be placed above sea level. The effluence outlet structure is shown in Fig. 2.3-18.

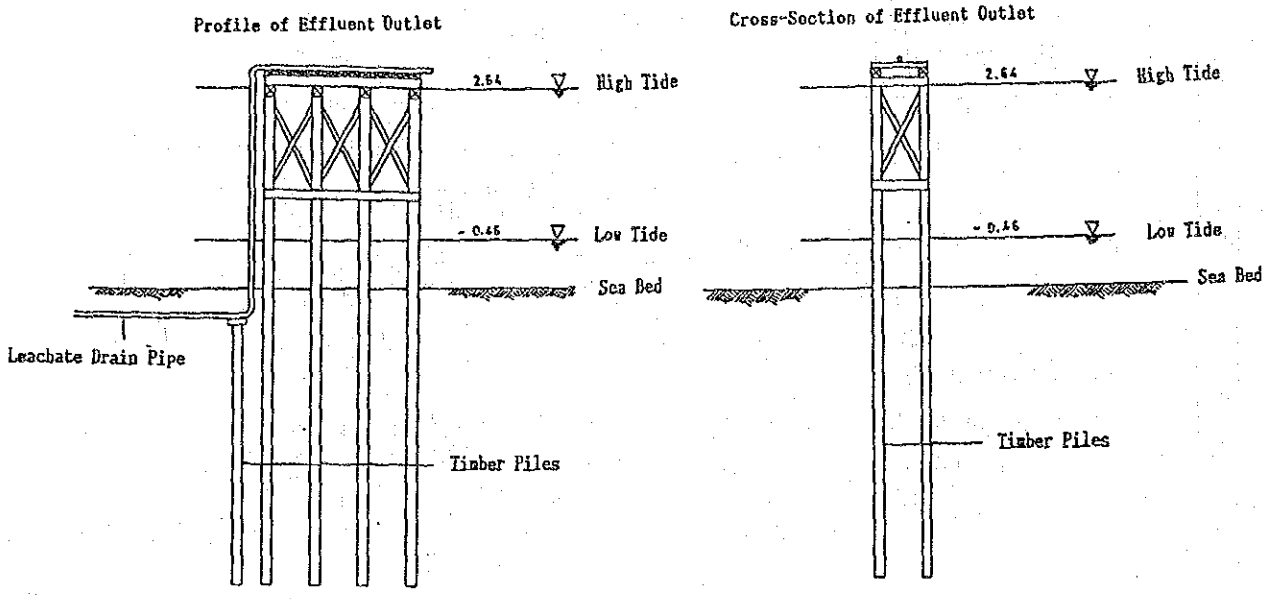


Fig. 2.3-18 Detail of Effluent Outlet

iv. Leachate circulation pump

The design calls for an immersed pump with a mouth diameter of 40 mm and output power of 52.2 kW for the KMDS and 57.5 kW for the PBDS.

g. Monitoring Facilities

The monitoring facilities are to be monitoring wells constructed at both disposal sites in order to monitor groundwater quality.

(4) Building and Accessories

a. Site office

This will be established for the administration of the site such as the weighing of waste and the monitoring of hygenic conditions for the employees. The floor areas of each office are about 100 m^2.

b. Weighbridge

Incoming waste must be weighed for proper operation within the disposal site. One weighbridge is to be constructed at each of the sites. The weighbridge consists of a load-cell type scale, a 4-point support system, a digital counter (separated fro the main body) and an underground system, and has a weighing capacity of up to 30 tons.

c. Fire prevention facilities

A fire extinguisher and reserve water pond are to be assured for the site office and other facilities to the prevention of fire.

d. Storage building

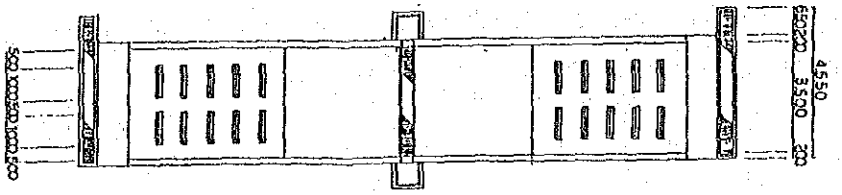
A storage building is to be constructed at each disposal site for repair of landfill and other equipment.

e. Others

In order to prevent anyone from illegally entering the sites, a gate and fence are to be constructed. Flashlights will also be provided for the guard.

A parking lot will be constructed for visitors and the staff. In order to keep public road clean by collection vehicles, a car wash will be provided as shown in Fig. 2.3-19.

PLAN



CROSS SECTION

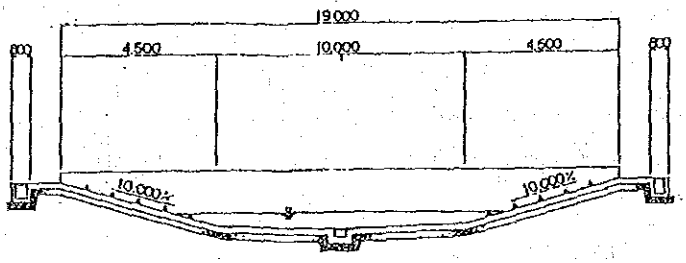


Fig. 2.3-19 Car Wash

2.3.3 Operation and Maintenance Plan

(1) Landfill Plan

a. Basic Policy

The following basic policy is sustained for the preparation of the landfill plan.

i. Solid wastes are spread and compacted sufficiently.
ii. The scattering of solid wastes is minimized.
iii. The diffusion of offensive ordor is minimized.
iv. Stabilization of wastes as early as possible is arranged.

b. Landfill structure

Regarding landfill structure, the semi-aerobic landfill method is selected.

c. Landfill method

In order to prevent the surrounding environment, the cell method should be applied.

d. Cover materials

The covering material is to be placed in the manner shown in Fig. 2.3-20 and the thickness of each cover is as follows:

- Daily cover material : 20 cm thick
- Intermediate cover material: 30 cm thick
- Final cover material : 60 cm thick

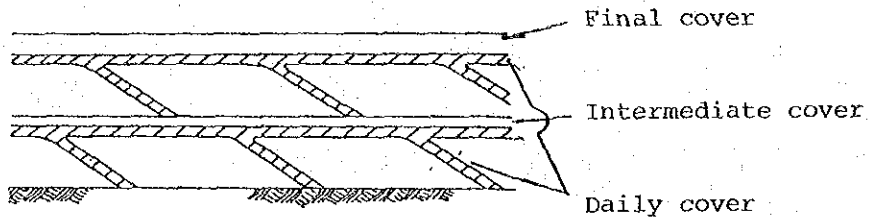


Fig. 2.3-20 Covering by Cell Method

Accordingly, the cover material will be placed in a 30% ratio to the disposal volume waste.

The following cover materials are required because of their appropriate qualities.

- Daily cover material: sandy soil for good ventilation
- Intermediate and final cover material : clayey silt of a small permeability coefficient, and for good vegetation in final cover.

e. Landfill equipment plan

i. Content of the work

The content of the work for the landfill equipment is summarized as follows.

WASTE HANDLING	COVER MATERIAL HANDLING	OTHER
pushing (moving)	excavation	levelling (site access road & unloading site
crushing	loading, hauling, spreading and levelling	site maintenance
compaction	compaction	

ii. Equipment selection

The following equipment is selected for efficient landfill operations and maintenance.

1) Bulldozer

For leveling and compaction of waste and covering material, a bulldozer excells in leveling and compaction of waste and covering material and has various other uses. A bulldozer for swamp use and of a 21-ton class weight is to be selected.

2) Back hoe (Hydraulic excavator)

For drain excavation, a back hoe is inferior in loading capacity to a crawler-loader, but is excellent in excavation, in which a bulldozer is inferior.

iii. Selection of number of equipment

1) Bulldozer (21-ton class)

According to the 1995 daily landfill estimations, 2 bulldozers will be necessary for each disposal site.

2) Back hoe (Hydraulic excavator)

Principally for drain excavation, one will be necessary.

f. Landfilling operations

The landfilling operations are outlined in the following.

i. The waste is dumped at places directed to the driver by the staff.
ii. The dumped waste is spread and crushed by a bulldozer forming a thin layer with 1:3 slope for sufficient compaction.
iii. After the completion of the compaction operations, the covering operations will be performed on a daily basis by the cell method.
iv. Intermediate cover material will be laid on the first layer of landfill when it has extended as far as the divider.
v. A second layer of landfill will be laid on the intermediate cover material, extending to the divider.
vi. Final cover material will be laid on top of the second layer of landfill.
vii. A divider, gas removal facilities and leachate removal facilities will be constructed in the adjacent area for the following landfilling operations.

g. Landfill plan

This is summarized in the following.

i. Divider

The divider should be constructed on a small scale during the rainy season (July - Nov.) and on a large scale during the dry season (Dec. - June) following the increase and decrease of leachate. The divider should always be constructed directly adjacent to the soon-to-be completed landfill area.

ii. Construction work

Private contractors will perform the construction of the following.

- divider
- leachate collection facilities
- gas removal facilities
- on-site road
- ditch

iii. Configuration of completed landfill area

To insure the immediate discharge of rainwater on the completed area, the following work will be completed by the MPSP.

- leveling
- temporary drain construction
    * main ..... concrete lined
    * branch ..... unlined

iv. Procurement of cover material

The cover material will be procured by a bidding process involving selected suppliers.

(2) Facility Maintenance

a. On-site maintenance

i. On-site and approach roads

The on-site road is to be repaved with gravel and compacted and the approach road, with asphalt, to avoid any problems for vehicles.

ii. Fire prevention measures

Fire-fighting sand (covering materials will be applied for this purpose) and a water sprinkler truck with fire-fighting pump will be used to cope with any unexpected fire in the disposal site. Furthermore, daily covering operations will be carried out concurrently so as to prevent fire from occurring.

iii. Sanitation control

The most effective sanitation control is to carry out daily covering operations by the cell method, and it is important to prohibit solid wastes from being exposed and standing water from being produced. Only when absolutely needed should insecticides be used and only very sparsely.

iv. Waste scattering prevention

A fence will prevent waste from scattering outside the site, in addition, scattered waste within the site will be constantly checked and collected.

v. On-site maintenance (equipment)

The following is necessary equipment for effective on-site maintenance.

- disaster prevention ..... water sprinkler truck
- on-site patrol ..... inspection vehicle

b. Main facility maintenance

The main facilities must be maintained in top condition as one breakdown could affect all, resulting in mass damage.

i. The bund must be checked for any breaks or holes.

ii. The drainage system should be constantly checked and cleaned out as it can be stopped up by sand, leaves, weeds and other objects.

iii. The leachate volume should be checked daily. In case of sudden increase or decrease, the leachate collection facilities could become stopped up and cause leachate to discharge outside the landfill site. Also, the existence of springwater in the landfill site should be investigated.

c. Equipment maintenance

In order to perform proper maintenance for effective operations, if problems are discovered during periodic investigation, they should be analyzed and equipment should be repaired by only skilled mechanics. Necessary spare parts should be kept in stock.

d. Hygiene and safety control

i. Hygiene control

Periodic health check-up are performed and medicine is given for any possible accident. In addition, the staff will possess full knowledge of hospital location and access to go in case of any emergency.

ii. Safety control

In order to prevent fire caused by carelessly thrown cigarettes, a measure such as a no-smoking rule should be put into effect the landfill site. The staff will be well educated on disaster prevention.

(3) Environmental Monitoring

In the process of carrying out landfill work, the staff should prepare a monitoring (or supervision) plan, which includes water quality inspection and control of solid waste-scattering, in order to conserve the environmental conditions of the final disposal site.

a. Water quality monitoring

The following monitoring methods shall be effected for ample control.

i. monitoring of groundwater by the monitoring well,
ii. monitoring of surrounding drain surface water
iii. monitoring of retention and regulation pond leachate
iv. monitoring of leachate at the effluent pump and at the effluent outlet.

b. Waste monitoring

i. Monitoring of directly hauled waste by the generators themselves, in particular, checking of unacceptable industrial waste by referring to the scheduled waste inventory list from the DOE survey on industrial toxic waste,
ii. Monitoring of scattered waste outside the site,
iii. Monitoring of illegal dumping.

2.3.4 Ultimate Use

(1) Basic Conditions on Ultimate Use

Here are the following basic considerations concerning ultimate use of the completed landfill sites;

- problems related to settlement
- problems related to gas generation
- maintenance of completed landfill site

(2) Ultimate Use Plan

Due to settling and gas problems, construction of buildings on completed landfill site is not recommended for at least up to a certain amount of years (over 15 years). Thus, the following ultimate uses are recommended.

i. For the KMDS, a park for the surrounding inhabitants is recommended.

ii. For the PBDS, farmland use is recommended by alternating the completed landfill on the former site of Byram Forest Reserve with the farmland in Pulau Burong.

The reasons are:

i. for the KMDS

A park is:

- a great contribution to the surrounding residents,
- in harmony with the existing landscape,
- compatible with the surrounding land use,
- one of the lest expensive methods of land use.

ii. for the PBDS

This is:

- the provision of the alternative farmland
- compatible with the present land use
- the lowest cost method
- and because this area is farly separated from establishments of any kind.

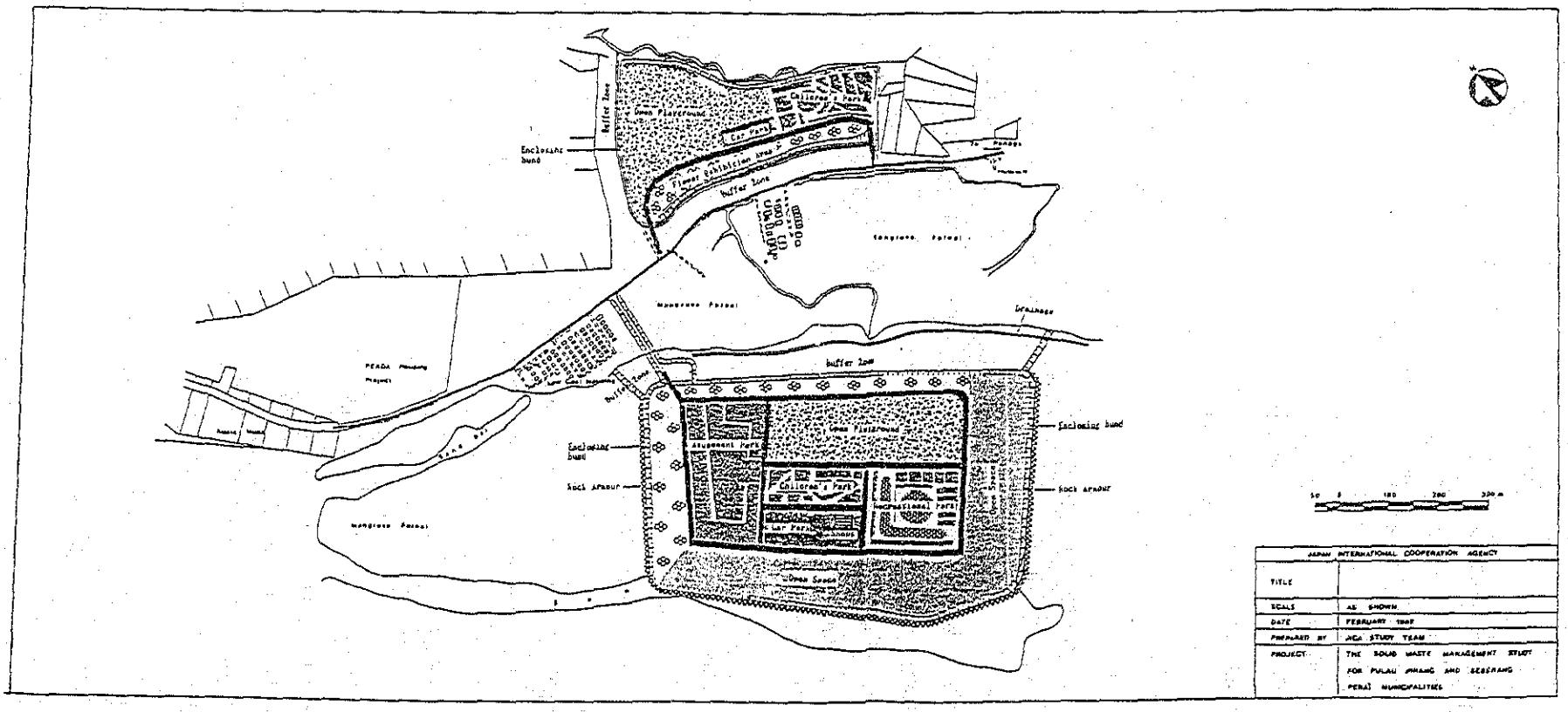


Fig. 2.3-21 Ultimate Use Plan of KMDS

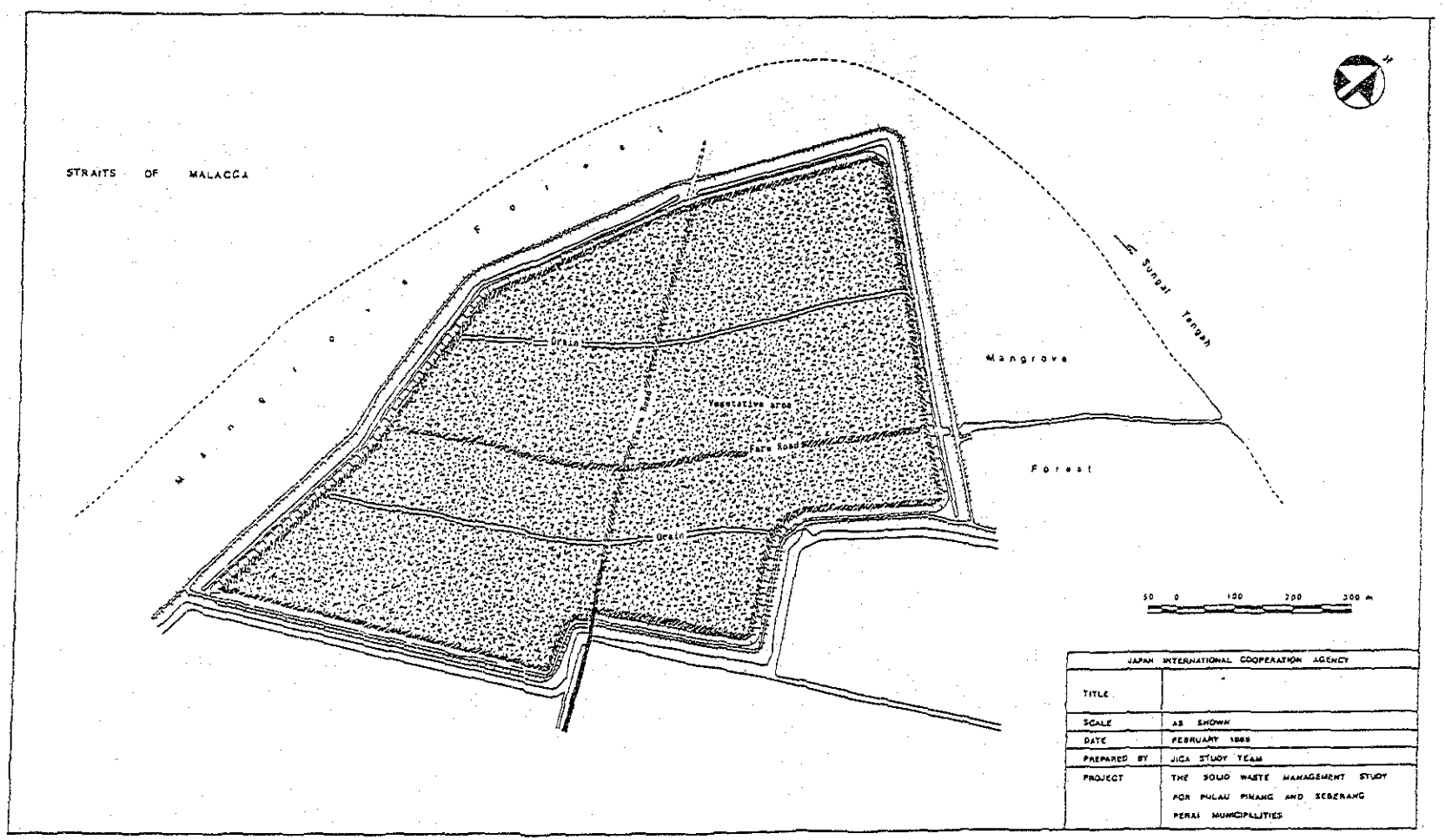


Fig. 2.3-22 Ultimate Use Plan of PBDS

3. Cost Estimate

The investment and operation costs were estimated on the basis of 1987 prices by adding the cost of each facility and equipment. The unit prices used in the cost estimation were obtained from following sources:

a. construction cost : Kerajaan Malaysia (JKR)
b. equipment/machinery cost : relevant studies

3.1 Investment Cost

(1) Collection and Haulage

Investment cost for collection and haulage covers the purchasing of the collection vehicles required for the Council's service in 1995, and amounts to M$5.3 million as shown in Table 3.1-1. As the vehicles have a life expectancy of 7 years, there will be no replacement demand prior to 1995.

Table 3.1-1 Investment Cost for Collection Improvement

(M$1,000 in 1987 price)

VEHICLE TYPE	NO.	INVESTMENT COST
Compactor	34	5,100
Tipper	3	240
Total	37	5,340

(2) Cleansing

Investment cost for cleansing improvements covers the purchasing of mechanical sweepers, trucks and grass cutting machines, and amounts to M$1.4 million as shown in Table 3.1-2. The replacement demand is not taken into account for the investment cost.

Table 3.1-2 Investment Cost for Cleansing

(M$1,000 in 1987 price)

ITEM	NO.	INVESTMENT COST
Truck	6	480
Mechanical Sweeper	3	750
Grass Cutting Machine	95	190
Total		1,420

(3) Disposal

Invesetment cost for disposal sites consists of the construction cost and equipment purchasing cost and is amounts to M$7.0 million as shown in Table 3.1-3.

Table 3.1-3 Investment Cost for Disposal Sites

(M$1,000 in 1987 price)

ITEM	KMDS	PBDS	TOTAL
Construction			
- Site Preparation	240	300	540
- Main Construction Work	1,391	1,655	3,046
- Pollution Control Facility	305	285	590
- Auxiliary Work	270	270	540
Sub-Total	2,206	2,510	4,716
Equipment Purchasing	1,137	1,137	2,274
Total	3,343	3,647	6,990

(4) Total Investment Cost

Total investment cost amounts to M$14.7 million including engineering fee, physical contingency and price contingency as shown in Table 3.1-4.

Table 3.1-4 Total Investment Cost

(M$1,000 in 1987 price)

ITEMS	INVESTMENT COST	REMARKS
Collection	5,340	
Cleansing	1,420	
Disposal		
- Construction Cost	4,716	
- Equipment Purchasing Cost	2,274	
Sub-Total	13,750	
Engineering Fee	236	4,716 x 0.05
Physical Contingency	472	4,716 x 0.1
Price Contingency	217	(13,750+236+472) x 0.015
Sub-Total	925	
Total	14,675	

3.2 Operation Cost

Operation cost consists of the depreciation cost and the operation/ maintenance cost which includes costs for fuel, personnel, contracting and management costs, etc.

The depreciation cost was calculated by dividing the facility and equipment by their lives, taking the residual value into consideration while the maintenance cost was calculated by multiplying the construction/procurement cost by specific rates. The fuel cost was calculated on the basis of a standard unit of consumption.

(1) Collection and Haulage

The annual operation cost of collection and haulage will be M$3.3 million in 1995 as shown in Table 3.2-1.

Table 3.2-1 Annual Operation Cost of Collection and Haulage (1995)

(M$1,000 in 1987 price)

ITEMS	ANNUAL OPERATION COST
Depreciation	629
Maintenance	587
Personnel	1,581
Fuel and Others	542
Total	3,339

(2) Cleansing

The annual operation cost of road sweeping and drain cleansing will be M$3.2 million in 1995 as shown in Table 3.2-2.

Table 3.2-2 Annual Operation Cost of Cleansing (1995)

(M$1,000 in 1987 price)

ITEMS	ANNUAL OPERATION COST
Depreciation	190
Personnel	2,769
Maintenance, Fuel and Others	277
Total	3,236

(3) Disposal Sites

The annual operation cost of the disposal sites is estimated to be M$2.2 million in 1995 as shown in Table 3.2-3.

Table 3.2-3 Annual Operation Cost of Disposal Sites (1995)

($1,000 in 1987 price)

ITEM	KMDS	PBDS	TOTAL
Depreciation			
- Disposal Site Facilities	372	423	795
- Equipment	146	146	292
Maintenance	124	129	253
Personnel	104	105	209
Fuel, etc.	293	354	647
Total	1,039	1,157	2,196

(4) Contracting to Private Sector

Private contractors are used for both collection and cleansing work in MPSP. The cost of contractors is estimated to be 10% lower than that of work managed by the Council. The estimated cost is M$5.5 million in 1995.

Solid Waste Collection : M$3,868,000
Cleansing : M$1,594,000
Total : M$5,462,000

(5) Administration Cost

The administration cost is expected to reach M$1.0 million in 1995.

(6) Total Operation Cost

The total operation cost in 1995 is shown in Table 3.2-4 based on the above estimation.

Table 3.2-4 Total Operation Cost in 1995

(M$1,000 in 1987 price)

ITEM	DEPRECIATION	MAINTENANCE	FUEL, ETC.	PERSONNEL	TOTAL
Collection	629	587	542	1,581	3,339
Cleansing	190	-	277	2,769	3,236
Disposal	1,087	253	647	209	2,196
Contractors	-	-	5,462	-	5,462
Administration	-	-	-	962	962
Total	1,906	840	6,928	5,521	15,195

4. Organization, Privatization and Fee Collection

4.1 Proposed Scheme for USD Responsible for SWM

(1) Organizational Scheme

An organization scheme as shown in Fig. 4.1-1 is proposed for the new Urban Service Department of MPSP. The organizational scheme of the USD proposed below is the one that can be the implemented immediately by deploying the existing cleansing personnel.

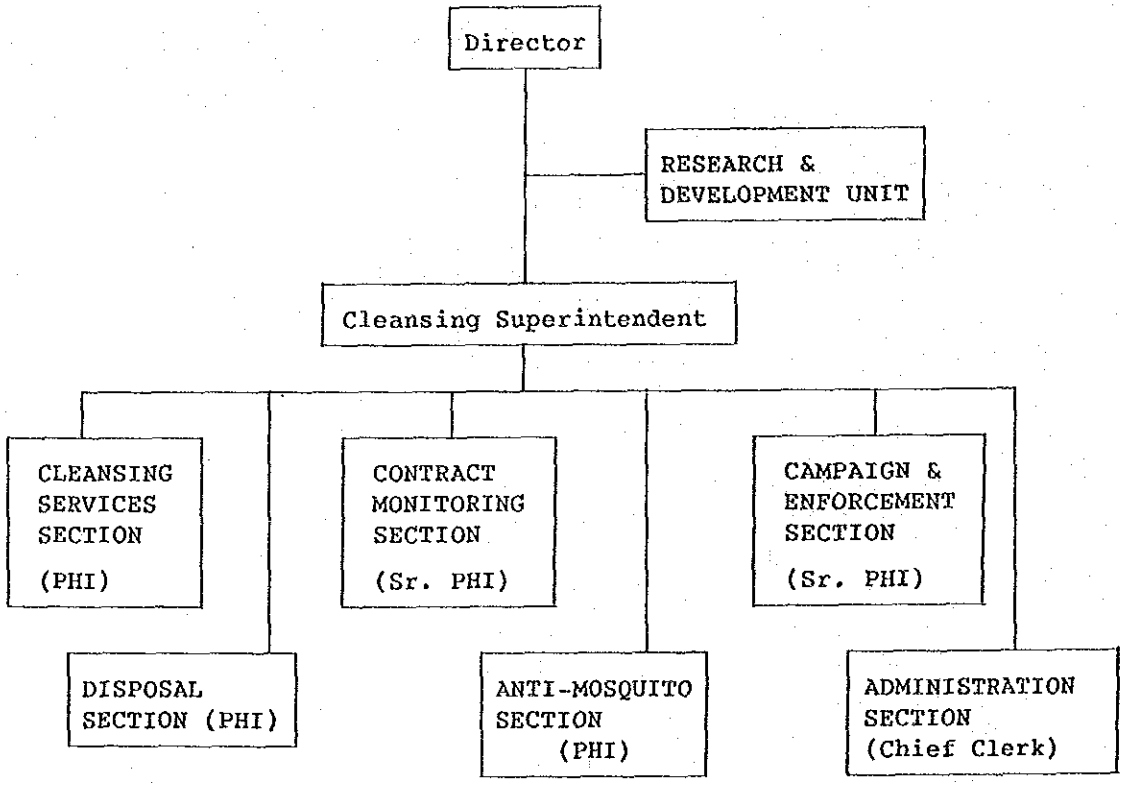


Fig. 4.1-1 Proposed Organization of the USD for MPSP

Notes:

1) Position shown below the names of sections indicate the heads of these sections proposed. Actual appointment, however should be made based upon the merits of individual persons.
2) The responsibility of Cleansing Services Section will include collection/haulage and street/drain cleansing.

(2) Manpower Scheme

Personnel requirements projected for 1995, according to section and position, are shown in the Table 4.1-1. In total 869 persons will be required which is about 80% of the present Manpower size.

Table 4.1-1 Proposed Number of Personnel According to Section and Position (1995)

NAME OF SECTION	PHI & ENG	TECH & Jr. CLE	OVER-SEER & Jr. TECH & CLE	DRIVER & OPE	MANDOR	LABORER	TOTAL
1. Cleansing Services	4*	-	24	43	39	624	734
2. Contract Monitoring	1	-	5	-	-	-	6
3. Campaign & Enforcement	1	-	4	-	-	-	5
4. Disposal	2	2	4	6	-	6	20
5. Research and Development	1	-	-	-	-	-	1
6. Anti-Mosquito	1	-	4	-	6	70	81
7. Administration	-	1	-	-	-	21	22
Total	10	3	41	49	45	721	869

* A director is included in this category.

Abbreviations:

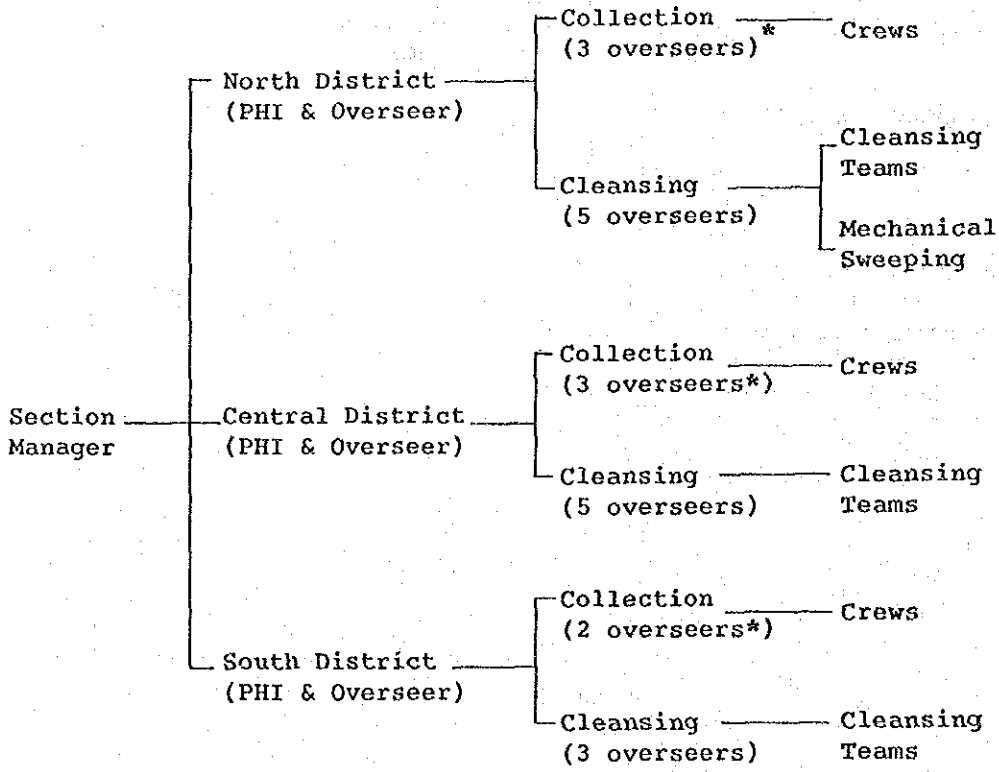
PHI : Public health inspector
ENG : Engineer
TECH : Technician
Jr. CLE: Junior Clerk
OPE : Operator

MPSP will have many redundant laborers in the future when it fully introduces 3 times/week collection and once-a-week cleansing system in residential area. Those redundant laborers need to be deployed for other kinds of services such as landscaping work, which is important in view of creating more beautiful city.

(3) Organizational Scheme for the Cleansing Services Section

The organizational scheme as shown in Fig. 4.1-2 is proposed for the cleansing services section of the USD.

It is proposed that both PHIs and Overseers would act as middle management who would generate more managerial and planning inputs rather than occupying themselves with daily routine.



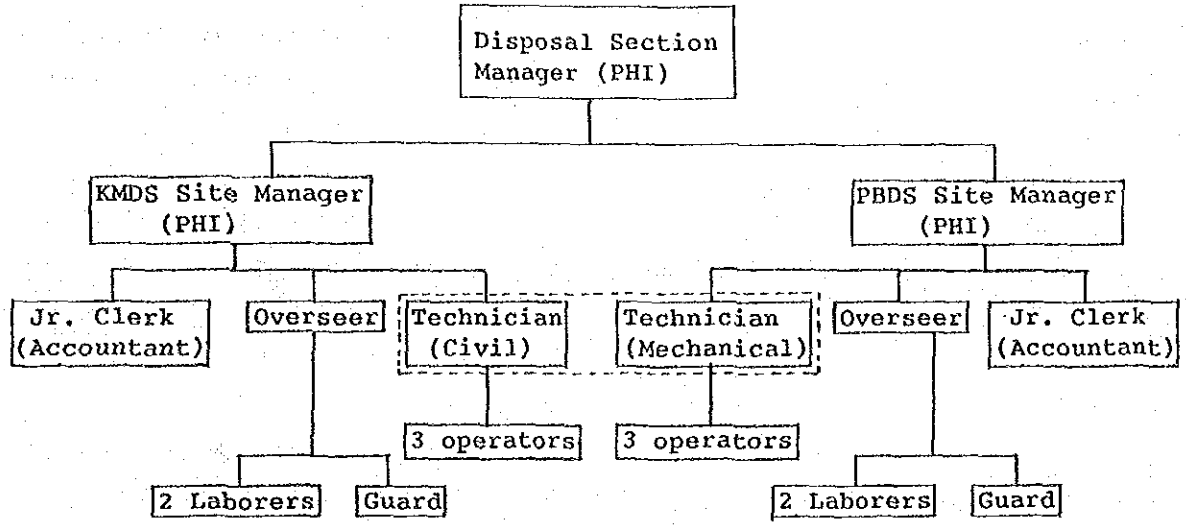
Note 1: North District managers (PHI) will assume the responsibility of the Section Manager.

2: One of the overseers marked with "*" will be responsible for the vehicle control.

Fig. 4.1-2 Organization Scheme for Cleansing Services Section in MPSP

(4) Disposal Section

The organization of disposal section is proposed as shown in Fig. 4.1-3.



Note: 1. One of the site managers will assume the responsibility of the Disposal Section Manager.

2. Two technicians will look after both sites though each technician has a principal site where he stations.

Fig. 4.1-3 Organization Scheme for Disposal Section

4.2 Privatization

(1) Rate of Privatization

It is proposed that MPSP will expand its privatization in view of the increasing demand for waste collection and cleansing services, which would arise from the increasing waste amount and necessity for expanding the service coverage.

It is proposed that MPSP in 1995, will privatize 50% of domestic waste collection and 100% of the large amount waste collection services, which would lead to an overall privatization rate of 56% in terms of waste collection amount.

Similarly, it is proposed that MPSP will increase the privatization of street/drain cleansing to 50% approximately in 1995 in terms of served population. Like the present system, a contractor should be responsible for both waste collection and street/drain cleansing services in its contract area.

(2) Contract Area

It is proposed that the contract area be urban area, while MPSP itself will provide services mainly in rural area.

4.3 Fee Collection

(1) Fee Collection System

It is proposed that MPSP introduce two kinds of fees: commercial waste collection fees and tipping fees to be charged on waste directly brought into the Council's disposal site by private firms.

It is also proposed that MPSP increase revenue from those fees by increasing both fee rates and number of the fee payers.

As a means of collecting the commercial waste collection fees, it is advisable that such fees be included in water bills, as practiced by MPPP.

As a means of collecting the disposal tipping fees, a pre-paid ticket system may be advisable.

(2) Measures to Strengthen Fee Collection System

The following measures are proposed for strengthening the fee collection system.

1) Revision of regulations related to the fees.
2) Introduction of licensing system for users of the Council's disposal site
3) Introduction of severer penalties on illegal dumping.

5. Project Evaluation

5.1 Technical Evaluation

(1) Improvement of Collection and Cleansing Works

From technical view point there is no problem in the introduction of 3-times/week collection system, plastic bag usage for discharge and once-a-week cleansing system.

It is considered that the introduction of those systems would be feasible in all residential area of MPSP by 1995 as proposed.

The MPPP's pilot project in Bayan Baru shows that these systems have following benefits:

a. Operation efficiency will be greatly improved, and environmental conditions in the area will not deteriorate through residents' cooperation.
b. Collection and cleansing zones are divided into smaller zones under the reduced frequency service system. The services are provided in a smaller zone in each day. This has made it easy to control the daily operation. It has been also found that the work control is easier under the group working system introduced in the pilot project area.
c. The usage of plastic bags greatly contributes to the increase of collection efficiency and to the upgrading of sanitary conditions.

Health Department of MPSP will have some redundant laborers through the expansion of area where these systems will be applied in the near future. Therefore, it is necessary to deploy these laborers to other public services.

(2) Introduction of compactor vehicle

It is proposed that compactor vehicles with 10 cu.m body be used for domestic waste collection also in future instead of tipper vehicles. It will not cause any problem to MPSP in terms of operation and maintenance because MPSP has been using the vehicles of this type and size already.

However, it is necessary to establish a strong preventive maintenance system.

(3) Cosntruction of level 3 sanitary disposal sites in Kuala Muda and Pulau Burong

From technical view point, level 3 sanitary disposal site which has daily soil cover and leachate circulation system to improve leachate quality does not have any difficulty in construction and operation.

5.2 Preliminary Environmental Impact Assessment

5.2.1 Introduction

As part of the solid waste disposal master plan for Seberang Perai, two sites were identified for the development of sanitary landfill that would receive the solid waste of MPSP area from 1992 to 2005.

Two sites were selected from a list of 9 potential sites based on a set of criteria that included environmental, economic, administrative and political considerations.

The Kuala Muda site is located near the fishing village of Kampung Kuala Muda. This site, in fact, consists of two sub-sites, one for each phase of the proposed development. The first sub-site is located on wasteland with very little natural vegetation. The second sub-site is a lagoon which is protected by a natural sand bund formed by the action of the waves.

The Pulau Burong site is situated in the Byram Forest Reserve adjoining Pulau Burong. The forest reserve is presently planted with exotic fast growing trees.

The sanitary landfill will be constructed in three phases. Because of financial considerations, the level of landfill development and operation will be designed at level 3 in the first and second phases.

The level of landfill development and operation proposed for the third phase will be at level 4, where the leachate from the sanitary landfill will be treated before discharge.

A preliminary Environmental Impact Assessment for the proposed solid waste disposal sites in accordance with the Environmental Quality Order 1987 was conducted by the University Sains Malaysia, and impacts on air quality, water quality and noise were evaluated by the JICA Study Team.

5.2.2 Existing Environment

(1) Physico-chemical Environment

Both sites are located near the sea and away from any water catchment area. The coastal waters at these two sites are relatively clean, but with high sediment loads.

Both areas are relatively quiet, with little noise generated by human activities as the population densities are low;

The air quality in the areas is within environmentally acceptable limits.

(2) Biological Environment

a. Kuala Muda

The first site at Kuala Muda consists of scrubland, with very little natural vegetation. The second site is the newly accretted mudflats with some colonization of the pioneer mangrove species, Avicennia (api-api).

There are a large number of bird species, about 103 species, because of the diversity of habitats that includes the estuary, coastal mudflats and scrubland. The bird fauna includes a number of rare species besides some migratory birds.

There is a certain amount of fishing activity and the collection of gravid females of prawns and fish. There are a number of aquaculture schemes for cage culture for fish as well as pond culture near the proposed sites.

b. Pulau Burong

The natural vegetation of Pulau Burong is mangrove, but this has been cleared recently except for the narrow coastal strip. The land has been cleared for agriculture, mainly the planting of vegetables.

There are also a large number of bird species (over 63) and two troops of monkeys, the long-tailed macaque.

The major sea-based activity is cockle culture in the adjoining mudflats and about 265 ha are used for cockle culture.

(3) Socio-economic Environment

a. Kuala Muda

The population of the Kuala Muda area is estimated to be about 2,500 in 1985. The population is predominantly Malay. The main occupations are agriculture and fishing, and Kampung Kuala Muda is a major fish landing site, being the fourth largest in the State. There are a number of cage culture activities in the estuary and the beginning of pond culture along the river banks in the mangrove areas. The mean income of the villagers is estimated at M$500 per month with a mean per capita income of M$94 per month. The surrounding land use is mixed agriculture with rice and a considerable amount of idle land around the Kuala Muda area.

b. Pulau Burong

There is no resident population in Pulau Burong. The surrounding land use is mainly oil palm plantations, with the beginnings of vegetable farming in Pulau Burong itself.

5.2.3 Environmental Impacts

(1) Construction Phase

a. Noise

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 the construction period is not too long at the same place and construction works shift.

b. Dust

In Kuala Muda, the predominant wind blows from the proposed site to the central district of Kuala Muda, but is not expected to have adverse impact to the residential area, because a five-meter high bund will be constructed with a 50 m wide green belt.

c. Traffic Volume

Increase of traffic volume in relation to the construction will not be expected.

(2) Operational Phase

a. Leachate

When the effluent is discharged at 800 ppm BOD, the effluent is diluted to less than 3 ppm in the outer sea area of 30 m radius centering around the discharge point. This low level is because of the extremely low volume of the effluent (for KMDS, 87 m^3/day in rainy season and 42 m^3/day in dry season, for PBDS, 101 m^3/day in rainy and 52 m^3/day in dry season).

When the effluent is discharged at 1,200 ppm COD, then it is diluted to less than 5 ppm in the outer area of 30 m 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.

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

b. Noise

Of the sanitary landfill equipments, the major noise sources are bulldozers. However, more than 10 dB(A) noise is expected to be attenuated because of a five-meter high bund around the disposal area, and areas around the site would not be exposed to the same noise level for a long term because the landfill area will shift after three or four months only.

In comparison with the existing average noise level of 72.1 dB(A) from 7:00 AM to 7:00 PM, which was measured at 106 places in Penang State in 1986, noise level from waste transportation vehicles is low.

c. Dust and Odor

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

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

d. Air Pollution

Though the most serious pollutant derived from vehicle exhaust gas in Penang is carbon monoxide (CO), estimated concentrations of CO are very low.

(3) Plant and Animal Communities

a. Kuala Muda

The Kuala Muda site differs from the two other sites, in which there is no removal of vegetation involved.

A number of aquaculture ponds have been dug near the river bunds and the point of water intake for the ponds is quite close to the proposed disposal site.

Although there are other fisheries activities, these are not likely to be seriously affected. By discharging the leachate directly into the sea and not into the river, the impact would not be significant.

b. Pulau Burong

There would be a remaining mangrove fringe for shore protection, which would be separated by a canal and a bund from the proposed sites.

The main biological effect would be the loss of habitats for the birds and mammals. As a mitigation measure to provide habitats for the birds, the mangrove fringe should be retained.

Though there is a lot of cockle farming in the mudflats, these would not be affected much by the leachate.

(4) Human Settlements

a. Kuala Muda

There is the problem of real estate values for the housing units situated in the proposed PERDA housing scheme. People intending to buy houses will not purchase one next to a waste disposal site.

The human settlements along the road are expected to be affected by haulage vehicles, because the number of trucks moving are very much and most of the roads are very narrow.

b. Pulau Burong

There are very few problems associated with human communities and activities in this site. The main problem is the trucking of waste through the narrow roads.

5.2.4 Mitigating and Abatement Measures

To reduce the impact of the removal of mangrove vegetation at Pulau Burong, the coastal strip of mangrove should be maintained for providing habitats for the birds and animal life as well as for shore protection.

To reduce the impact of the leachate on the surrounding coastal areas, no discharge should be made on land or into the waterways. The leachate should be pumped some distance to the sea where dilution can take place to within acceptable levels.

There should be regular monitoring on the areas surrounding the discharge points as well as seepage into the ground water around the disposal sites.

To reduce the noise levels during the operation of the sites, there should be an earth bund to attenuate the noise levels as well as a buffer zone between the sites and residences.

To minimise the odour problems, the sanitary landfill must be properly maintained.

There should also be green belt of trees and other plants between the disposal sites and public areas for aesthetic reasons.

5.2.5 Residual Impacts

Despite above measures, some residual impact on the surrounding area would nevertheless remain.

In order to examine impacts on surrounding environment by landfill operation, monitoring systems should be introduced.

It would also be crucial to educate vehicle drivers to be careful along rural roads. Courteous behaviour in these areas can go a long way to mitigate against prejudice by the local residents on such offensive activities.

Another important feature of the overall effort is to ensure that damaged rural roads are immediately repaired so as to anticipate criticisms against the local authorities.

As regards Kuala Muda, rerouting of the trucks from the proposed Penaga road to the Permatang Sintok road may be necessary.

5.3 Social Evaluation

(1) Collection and Cleansing Improvement in Residential Area

As for the introduction of 3 times/week collection system combined with plastic bag and once a week cleansing system, it is indispensable to obtain the resident's cooperation due to the reduction of the service frequency.

It is reasonably expected that those new systems may be socially acceptable in MPSP area in view of the successful implementation of the pilot project in Bayan Baru.

(2) Introduction of Compactor

The introduction of compactors will contribute to the reduction in workload and the improvement of sanitary conditions of workers.

(3) Level 3 Landfill Operation

An agreement is made between the parties concerned regarding the use of Kuala Muda and Pulau Burong areas as the sites for waste disposal. The Stage Government has started the control over the development of the areas surrounding these sites.

Furthermore, the existing dump site in question will possibly be closed upon the commencement of landfill operation at KMDS and PBDS.

5.4 Economic and Financial Evaluation

5.4.1 Evaluation Framework

(1) Basic Policies

In view of the non-productive nature of solid waste management, the following basic policies were adopted to evaluate the Project.

a. While the Project was evaluated from both economic and financial aspects, priority was given to the financial evaluation based on the financial strength of MPSP.

b. A minimum cost method was employed to compare and examine the project elements.

c. In the economic evaluation, indices relating to the environment, hygiene and landscape, etc. were qualitatively analyzed, and economic benefits were calculated in regard to collection and cleansing improvement.

(2) Economic Evaluation

Although economic evaluation is essential to determine the feasibility of a project, it is difficult to calculate the benefits of solid waste management. In addition, given the nature of the work, it is generally impossible to expect direct benefits to exceed the cost. The economic evaluation, therefore, was conducted as follows.

a. The effects of sanitary landfill were qualitatively evaluated.

b. The effects of collection and cleansing improvements were both qualitatively and quantitatively evaluated in view of the expected reductions in present cost to result from improvement measures.

c. The Project was considered feasible from the viewpoint of economic evaluation if the benefit-cost ratio of solid waste management was one or higher.

(3) Financial Evaluation

In general, there are two aspects of financial evaluation, i.e. financial evaluation of the project in question and analysis of the effects of project implementation on the Council's budget.

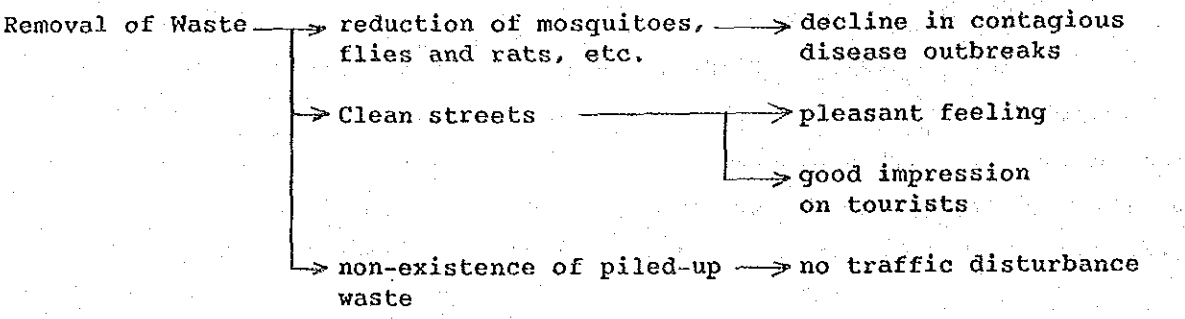
In regard to the former, a financial evaluation for a period of 15 years was conducted for MPSP based on the project cost and the expected income (including part of the assessment rate). As part of this evaluation, a sensitivity analysis was conducted to measure project cost, financial conditions and the effects of increased cost for personnel, etc.

While the willingness of the residents to pay a collection fee is not strong, various collection fees currently imposed in other municipalities were analyzed and preferable rates of commercial waste collection and tipping fees at disposal site were examined.

5.4.2 Economic Effects and Evaluation

(1) Collection Improvement

The purpose of solid waste management is the prompt collection/removal of solid waste generated by urban activities to maintain or improve the living environment and public hygiene. In general, regular collection services can achieve the following effects.



Taken together, these effects result in a good living environment.

An improved collection service is hoped for in MPSP to eradicate those areas with difficult access or those where regular collections are not provided despite the efforts of the Health Department in the past. The transfer to the 3 times/week collection system throughout almost all of MPSP will enable the expansion of the service area and the provision of regular collection services under limited financial capability, achieving the above effects.

While the collection frequency will decrease in those areas where a daily collection service is currently provided, regular and reliable collection will compensate for the decrease in the collection frequency. The problem of bad odour which may arise due to the less frequent collection service must be minimized by developing new indoor storage containers and enlisting the cooperation of the public in regard to discharging the waste just prior to collection.

Improvement of the service coverage will have a significant effect. However, the necessity of further improvement is shown by the fact that the service coverage rate in 1995 will be at 77%. It will be necessary for waste to be collected at least once a week with public cooperation in those areas where the regular collection service is not yet provided.

Implementation of carefully though-out measures will improve the understanding of the public of the importance of solid waste management, further assisting the effects of collection work.

The proposed improvement measures will also achieve a higher collection efficiency and will enable a considerable cost reduction as compared to the case where the present collection system is simply expanded. This means that the public services provided by the Council may be either improved or expanded by utilizing the Council's resources to be saved through the above SWM improvements.

(2) Cleansing Improvements

The purpose of cleansing work is the prompt collection/removal of waste and litter on streets and in drains in order to maintain and improve the living environment and public hygiene together with solid waste collection services.

The proposed main improvement point in cleansing work is the revision and reduction of the cleansing frequency according to road type. It is expected that the overall cleansing service quality can be maintained through the provision of the regular and reliable service though the service frequency would decrease.

As in the case of collection improvements, the implementation of carefully thought-out measures will enhance the citizens' understanding of the importance of maintaining environmental hygiene, further assisting the cleansing work efforts.

(3) Disposal Improvement

A major benefit resulting from the realization of the level 3 sanitary landfill with cell method is that the living environment and public hygiene standard would be greatly upgraded as compared to the case where the existing disposal systems continue.

The adverse environmental impact of the conventional controled tipping method on areas surrounding the disposal sites will be minimized with the adoption of the sanitary landfill method, paving the way for securing new disposal sites in the future.

While the sanitary landfill method (Level 4) which will be the model disposal method for Malaysia in the future cannot be immediately introduced at the KMDS and PBDS because of financial constraints, the establishment of appropriate technologies and technical transfers to other municipalities will be conducted where possible.

Moreover, the following positive effects can be achieved by adopting the landfill method.

a. Prevention of fires, scattering of waste, odours and the propagation of harmful insects and rats, etc.

b. Avoidance of adverse environmental effects on the surrounding areas by the erection of fences to prevent the scattering of waste.

c. Avoidance of adverse environmental effects on the surrounding areas by the treatment and sprinkling of leachate.

d. Improvement of environmental conservation and working conditions by the active implementation of the following measures:

- Prompt discharge of generated gas to ensure safety at the site;
- Control of the disposal of certain toxic substances;
- Introduction of a leachate effluent monitoring system;
- Prevention of scavengers and animals entering the site to secure safe landfill work;
- Improvement of staff working conditions.

(4) Economic Evaluation

Table 5.4-1 shows the cumulative SWM costs till 2005 estimated for the following two cases:

Case 1: Waste disposal system will be improved as proposed in the Master Plan. No improvements, however, will be made regarding waste collection/haulage and street/drain cleansing services.

Case 2: Improvements will be made not only for waste disposal system but also for collection/Haulage and street/drain cleansing services as proposed in the Master Plan. The improvements of collection/haulage and street/drain cleansing services include the reduction in the frequency of those services.

Table 5.4-1 Comparison of the Cumulative SWM Costs between the Two Cases

(M$ million in 1987 price)

Case 1	:	255.7 (a)
Case 2	:	239.2 (b)
Difference	:	16.5 (c)
Ratio of (b) to (a)	:	93%
Ratio of (c) to (a)	:	6%

The above table shows that the Case 2 which includes the improvements of collection/haulage and street/drain cleansing will bring about a considerable saving which would amount to M$16.5 million over the Master Plan period till 2005.

Therefore, the Case 2 which is recommended in the Master Plan, has proved to be feasible.

5.4.3 Financial Evaluation

(1) Conclusion

The results of the financial evaluation of collection, cleansing and disposal improvement are given below. The evaluation was based on the increase of budget by 4.8% annually for solid waste management and improved fee collections in the future.

Annual expenses of solid waste management in MPSP is to be some M$9.9 million in 1987 (as shown in Table 5.4-3). If MPSP introduces both tipping fee and commercial waste collection fee as proposed in the Master Plan, it is expected that the fee revenues would amount to M$1.2 million in 1995 and M$3.5 million in 2005.

With the implementation of collection, cleansing and disposal site improvements, the annual total operation cost of solid waste management is expected to amount to M$16.2 million by 1995 and M$24.9 million by 2005.

If solid waste management budget increases by 4.8% in real term annually and the fees are collected as proposed, the total debt will decrease to M$18.1 million in 2005, and will possibly be repaid completely in several years after 2005 as shown in Fig. 5.4-1.

Given the above financial evaluation results, the Project is considered financially feasible.

(2) Important Assumptions in Financial Evaluation

The following assumptions were made in the course of the financial evaluation, as in the case of the financial evaluation for the Master Plan.

a. Reduction of collection costs by the successful implementation of a 3 times/week collection system.
b. Reduction of cleansing cost by a decrease of the frequency.

c. Imposition of a collection fee on commercial waste and tipping fee on waste taken directly to the disposal site.

d. Acquisition of investment funds at an annual interest rate of 6.0% or lower.

e. Budget of the solid waste management will increase by 4.8% annually in real term up to year 2005.

f. Adoption of the Level 3 landfill method.

In the above items, a. and b. will be expanded to the whole area of MPSP by year 1995. In respect of item c., rate of fee collection will be raised as shown in Table 13.2-3 of Part I.

(3) Investment Cost and Annual Expenses

Tables 5.4-2 and 5.4-3 show the investment cost and annual expenses respectively necessary for successful implementation of the Project.

Table 5.4-2 Investment Cost

(M$ million in 1987 price)

	PHASE I	PHASE II	PHASE III	TOTAL
Collection	5.3	5.6	4.7	15.7
Disposal	7.2	10.0	19.0	36.2
Cleansing	1.4	1.6	1.2	4.2
Total	14.0	17.2	24.9	56.1

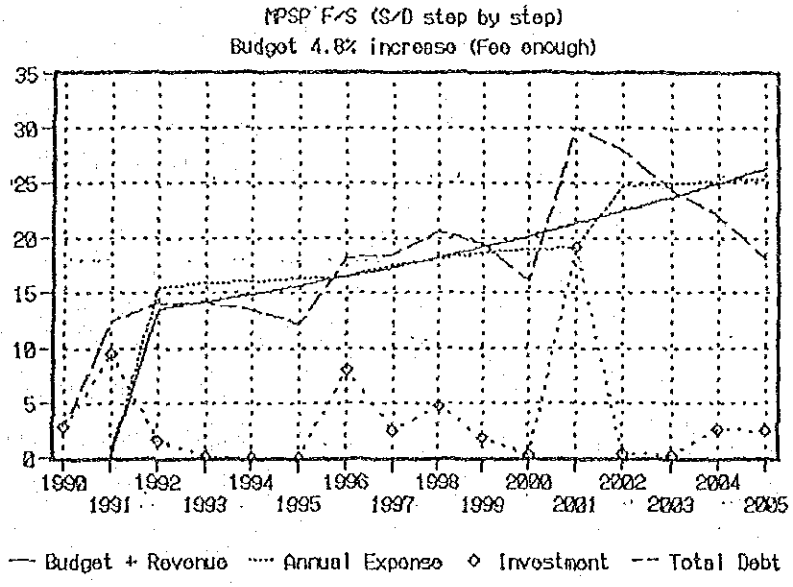


Fig. 5.4-1 Cash Flow in MPSP

Table 5.4-3 Annual Expenses and Income

(M$ million in 1987 price)

	1987	1992	1995	2005
Annual Expenses				
- Management	1.0	1.0	1.0	1.0
- Collection	5.3	7.1	7.2	9.7
- Disposal	0.1	2.0	2.2	6.0
- Cleansing	3.5	4.6	4.8	5.8
- Interest/Repayment and Others	-	0.9	1.0	2.4
Total (1)	9.9	15.5	16.2	24.9
Income (2)	-	1.1	1.2	3.5
Balance (1) - (2)	9.9	14.4	15.0	21.4

Note: Depreciation cost is included.

(4) Sensitivity Analysis

Sensitivity analysis is conducted by paying attention to three aspects i.e. increase of personnel cost, the change of the amount of fee collection and the change of construction cost.

In case the personnel cost would increase by 2% a year in the real term, the result shows the budget of SWM must be increased by at least 5.7% a year. In case the fee collection is not implemented as it is planned, 6% yearly increase of the SWM budget is required. In either case the increase rate of the SWM budget is predicted to be more than the economic growth rate, which would be a big burden to MPSP.

On the other hand, total debt will reach M$34.1 million in year 2005, if the construction cost of sanitary landfill sites would increase by 10%.

It can be said that the project will be hardly materialized without any financial subsidies from State Government of Penang or Federal Government.

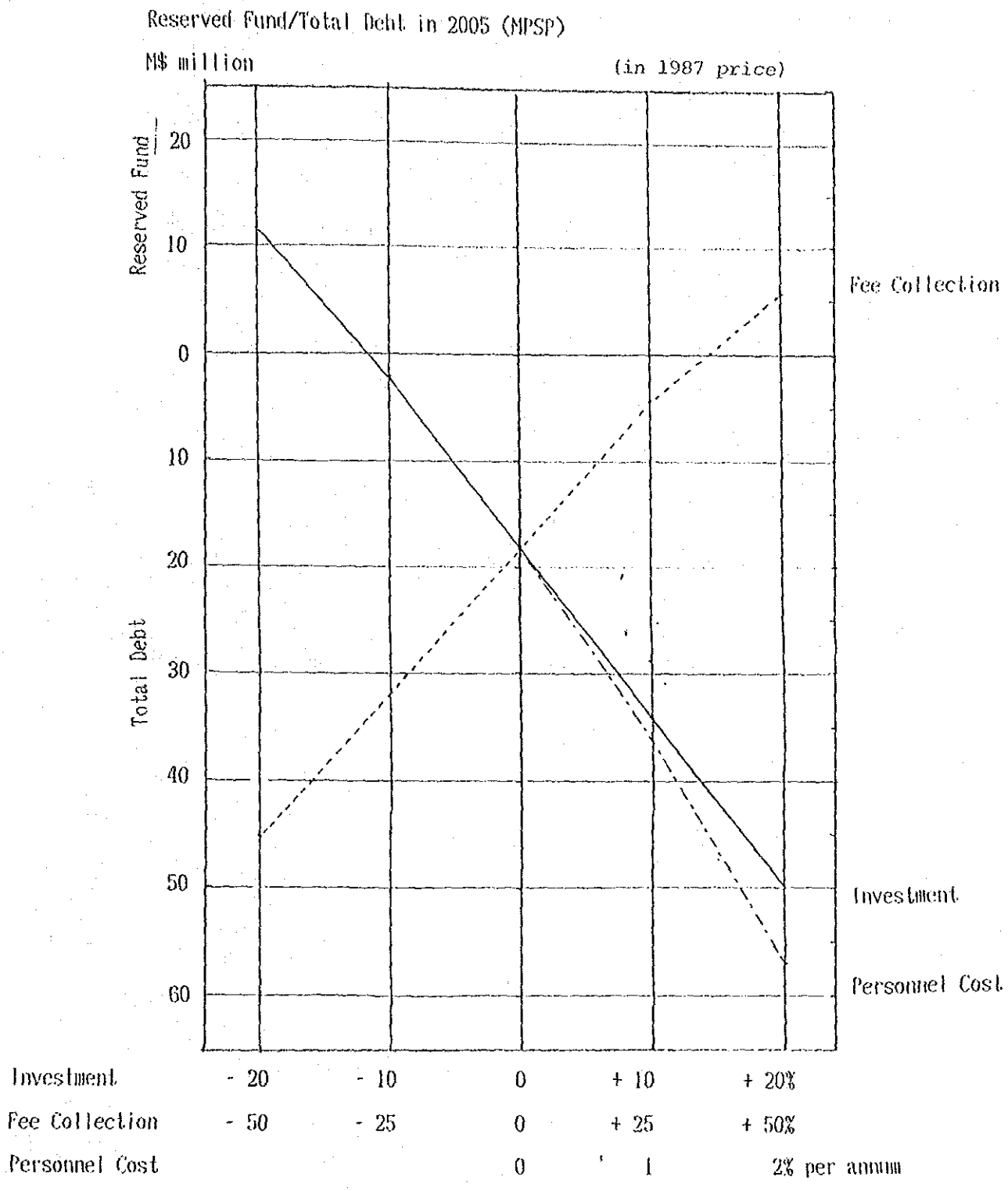


Fig. 5.4-2 Sensitivity Analysis

6. Implementation Plan

6.1 Project Implementation Body and Schedule

6.1.1 Project Implementation Body

Solid waste management is currently conducted by the Health Department and which are responsible for collection/cleansing and disposal. For the successful project implementation, the Urban Service Department should be established. In view of the fact that the financial assistance of the Federal Government is expected to support the Project implementation, the Ministry of Housing and Local Government will provide the necessary funds and will supervise the implementation of the Project.

6.1.2 Implementation Schedule

(1) Implementation Conditions

The implementation conditions for the Phase I Improvement Project are as follows:

- Design Target Year : 1995
- Service Commencement Year : 1992
- Subject Area : Entire MPSP

(2) Preparatory Period

The following must be conducted in the preparatory period of some 18 months from the completion of the Feasibility Study to the commencement of the construction work.

- Provision of investment funds and preparation of repayment plan
- Confirmation of facility construction sites
- Preparation of detailed design and construction, as well as equipment/material, specifications
- Selection of contractor (tender, evaluation and contract)

(3) Construction Schedule

The Project is mainly divided into equipment procurement work and facility construction work to be completed in the periods specified below:

- Equipment/material procurement: 6 months after completion of contract
- Disposal sites construction : 12 months after commencement of the work

6.2 Financial Plan

Based on the results of the financial evaluation, the financial plan for the implementation of this project will be set as follows:

(1) Required Fund

The investment cost and annual expenditure shown in Table 6.2-1 have been estimated based upon Table 3.1-4 and 3.2-4 making the additional assumptions:

a. An additional budget amounting to 15% of the original construction cost may be required for engineering services and allowance for contingency.

b. Operation cost except emolument will increase at the rate of 1.5% per year. Emolument will increase at the rate of 2.5% per year.

c. Rates of interest on long term, middle term and short term loans will be 7%, 9% and 13.5% respectively instead of 6%, 8% and 12%.

Table 6.2-1 Investment Cost and Annual Expenditure for MPSP

(M$ million)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
1. Investment cost																		
- Vehicle	0.0	2.7	1.7	1.1	0.2	0.0	0.0	6.6					6.1					18.4
- Cleansing	0.0	0.0	0.8	0.6	0.0	0.1	0.1	1.9					1.5					4.9
- Sanitary D/S	0.1 (0.1)	0.3	8.2	0.0	0.0	0.0	0.0	12.8					26.8					48.2
- Total	0.1 (0.1)	3.0	10.7	1.7	0.2	0.1	0.1	21.4					34.4					71.5
2. Annual Expenditure																		
- Administration	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	18.0
- Collection	4.0	4.0	4.0	3.2	3.2	3.2	3.2	3.3	3.3	3.4	3.5	3.5	3.6	3.7	3.7	3.8	3.9	48.4
- Street/Drain	3.5	3.5	3.5	3.3	3.4	3.5	3.7	3.8	4.0	4.1	4.3	4.4	4.6	4.9	5.1	5.3	5.5	60.0
- Contract-out	2.1	2.5	3.1	5.4	5.6	5.9	6.2	6.6	7.0	7.4	7.8	8.2	8.7	9.2	9.7	10.1	10.6	108.4
- Disposal	0.3	0.3	0.3	1.2	1.2	1.2	1.3	1.3	0.9	0.9	0.9	1.0	1.0	2.7	2.8	2.9	2.9	22.1
- Interest	0.0	0.0	0.3	1.1	1.4	1.4	1.5	1.4	2.5	2.8	3.3	3.3	3.1	4.3	4.1	3.7	3.6	37.8
Sub-total	10.9	11.3	12.5	15.2	15.9	16.4	16.9	17.6	18.9	19.8	21.1	21.9	22.4	26.1	26.8	27.3	28.1	294.7
- Repayment	0.0	0.0	0.0	0.0	0.2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6	0.5	0.5	0.5	0.5	8.5
Total	10.9	11.3	12.5	15.2	16.1	17.2	17.7	18.4	19.7	20.7	21.9	22.7	23.0	26.6	27.3	27.8	28.6	303.2

(2) Financial Resources

Financial resources for the investment are to be prepared through Federal Government loans and the MPSP development fund. Federal Government loans will be a combination of long term and mid term loans as shown in Table 6.2-2.

Table 6.2-2 Financial Resources for Investment

(M$ million)

	1990	1991	1992	1993	1994	1995	Total
Long Term Loans	0.3	8.2	-	-	-	-	8.5
Middle Term Loans	2.3	1.5	1.0	-	-	-	4.8
MPSP Fund	0.4	1.0	0.7	0.2	0.1	0.1	2.4
Total	3.0	10.7	1.7	0.2	0.1	0.1	15.6

Loan conditions are assumed as shown in Table 6.2-3.

Table 6.2-3 Loan Conditions

	REPAYMENT SCHEDULE	INTEREST RATE REAL	NOMINAL
Long Term Loans	Repayment over 20 years with a 3 year grace period	6%	7.0%
Middle Term Loans	Repayment over 10 years with a 2 year grace period	8%	9.0%
Short Term Loans	Repayment in the following year	12%	13.5%

Annual expenditure for the solid waste management is to be born by a portion of the assessment (property), fees for commercial waste collection and tipping fees for landfill as shown in Table 6.2-4.

Table 6.2-4 Resources of Revenue

(M$ million)

	1992	1993	1994	1995	TOTAL
Assessment	13.4	14.3	15.2	16.2	59.1
Fee Collection					
- Commercial Fee	0.8	0.8	0.8	0.9	3.3
- Tipping Fee	0.5	0.5	0.5	0.5	2.1
Total	14.7	15.6	16.6	17.6	64.5

Note: All the amounts shown in Table 6.2-4 are greater than the corresponding figures shown in the previous sections as a result of the reflection of an inflation which is assumed at 1.5% per year.

The SWM budget to be allocated from general budget of the MPSP is estimated to increase by 6.37% annually against 1987 SWM budget considering yearly increase rates 4.8% of real term and 1.5% inflation.

Commercial waste collection fee and tipping fee are estimated to be collected at the rates of M$65.8/t and M$15.3/t respectively in 1992. Those rates will increase to M$70.9/t and M$18.9/t in 1996, and M$79.5/t and M$21.0/t in 2001 respectively.

(3) Balance of Expenditure and Revenue

Basically the balance in Phase I will show a deficit, though it is expected that the balance will turn to the black in 2001.

In Phase III, the balance will show a deficit due to an increase in the operation cost of the level 4 sanitary landfill in 2002. However, it is expected that the deficit will decrease rapidly from M$4.8 million at 2002 to M$1.5 million at 2005.

(4) Proposed Financial Plan

Money flow of the project is shown in Table 6.2-5.

In view of the tight financial conditions arising in the future, the importance of the fee collection and the proposed service efficiency improvements cannot be overemphasized.

The construction of the level 4 sanitary landfill in Phase III will require much more fund than the level 3 landfill does. Judging from the future financial situation of MPSP, a grant from the Federal Government will be indispensable for MPSP to construct the level 4 sanitary landfill. The amount of the grant needs to be at least 50% (M$13.4 million) of the construction cost.

Table 6.2-5 Money Flow of the Project

(MPSP) F/S D/S step by step
unit: M$ thousand (1M$=¥50)) (considering inflation & personnel increase)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
Revenue																	
- SWM Budget			13,430	14,283	15,203	16,161	17,193	18,302	19,462	20,708	22,028	23,428	24,910	26,503	28,190	29,980	289,781
- Commercial Fee			768	799	830	864	1,051	1,183	1,333	1,501	1,690	2,132	2,402	2,706	3,048	3,434	23,741
- Tipping Fee			499	511	523	534	687	715	743	774	805	928	962	998	1,036	1,075	10,788
- Electrical Sale			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal (A)	0	0	14,697	15,593	16,556	17,559	18,931	20,199	215,38	22,982	24,522	26,487	28,274	30,208	32,275	34,489	324,310
Expense																	
- Depreciation			2,076	2,120	2,167	2,218	2,336	2,940	3,052	3,168	3,288	3,407	7,030	7,303	7,586	7,879	56,569
- Personnel			6,158	6,345	6,534	6,725	6,914	7,103	7,299	7,502	7,712	7,922	8,209	8,440	8,672	8,911	104,446
- Maintenance			963	957	952	946	978	874	906	940	973	1,008	1,278	1,318	1,358	1,400	14,851
- Fuel & Other			1,554	1,584	1,617	1,650	1,705	1,409	1,462	1,518	1,576	1,676	3,165	3,294	3,427	3,563	29,199
- Interest 1		223	931	1,022	1,004	941	878	814	751	688	625	562	515	481	446	411	10,292
- Interest 2		55	229	393	493	602	646	1,995	2,351	3,042	3,249	3,103	4,536	4,492	4,269	4,255	33,710
- Contract 1			3,812	3,992.7	4,174.0	4,355	4,698.7	5,042.1	5,385.6	5,729.0	6,072	6,462.1	6,851.8	7,241.6	7,631.3	8,021	79,470
- Contract 2			1,586	1,655.8	1,725.3	1,795	1,870.0	1,945.1	2,020.3	2,095.4	2,171	2,254.3	2,338.0	2,421.7	2,505.4	2,589	28,973
Subtotal (B)		278	17,308	18,070	18,667	19,231	20,025	22,123	23,228	24,682	25,666	26,395	33,923	34,991	35,895	37,028	357,510
Balance (A-B)		-278	-2,611	-2,477	-2,111	-1,672	-1,094	-1,924	-1,690	-1,700	-1,143	92	-5,649	-4,784	-3,620	-2,539	-33,200
Investment	2,951	10,688	1,697	175	53	56	10,421	2,844	5,661	2,189	255	26,906	563	371	3,359	3,241	71,431
- Fund	408	1,012	680	175	53	56	10,421	2,844	5,661	2,189	255	13,486	563	371	3,359	3,241	44,774
- Budget	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Grant	0	0	0	0	0	0	0	0	0	0	0	13,420	0	0	0	0	13,420
- Contractor																	
- Loan																	
Foreign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local 1	284	8,167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,451
Local 2	2,259	1,509	1,018	0	0	0	0	0	0	0	0	0	0	0	0	0	4,786
Repayment		0	0	205	813	813	813	813	813	813	813	624	497	497	497	497	8,508
Remain of Lo	2,543	12,219	13,237	13,031	12,218	11,406	10,593	9,780	8,967	8,154	7,341	6,717	6,220	5,722	5,225	4,728	
Money Demand	408	1,290	1,215	737	810	323	9,992	2,641	5,113	1,534	-1,077	10,611	-322	-1,652	-110	-1,602	
Short Term L	408	1,290	1,215	737	810	323	9,992	2,641	5,113	1,534	-1,077	10,611	-322	-1,652	-110	-1,602	29,913
Accumulated	408	1,6(8	2,913	3,650	4,460	4,784	14,776	17,417	22,530	24,064	22,987	33,599	33,277	31,625	31,515	29,913	
Total of Deb	2,951	13,917	16,150	16,682	16,679	16,190	25,369	27,197	31,497	32,218	30,328	40,315	39,497	37,347	36,740	34,642	

6.3 Establishment of a Monitoring System

(1) Necessity for the Establishment of a Monitoring System

Once the Council decides to commit itself to achieving Master Plan targets, it is important to establish a system within the Council to monitor closely the progress on the improvements. Data obtained through such monitoring will be used to make self-evaluation of the Council's performance, without which the Council will not know where they are.

(2) Personnel Responsible for Monitoring

Within the proposed USD responsible for SWM, the following personnel should be involved in the monitoring-operation.

Personnel to be Involved in Monitoring Operations

Action Required	Personnel Responsible
Identification of useful indicators	PHIs and Senior PHIs
Data-collection & compilation	PHIs and Senior PHIs
Data-analysis, Evaluation of performance and Formulation of action plans	PHIs/Senior PHI's and Cleansing Superintendent
Review of Master Plan Targets based upon the performance evaluation	Cleansing Superintendent and Director

(3) Indicators to be Used

a. Selection of Indicators

Selection of indicators are related to the Master Plan targets. Useful indicators include the following:

Principal and Supporting Indicators

Master Plan Targets	Principal Indicators	Supporting Indicators
Improvements in cost-effectiveness in services	Unit cost of service per ton	Daily waste amount collected per worker and vehicle Unit cost spent per service recipient
Expansion of service coverage	Percentage in terms of population	Percentage in terms of area
Improvement of service quality (regularity and punctuality) - residents' satisfaction	Number of complaints by residents	Number of days service was delayed or was not provided
Upgrading of the disposal standard	Standard of sanitary landfill	Leachate-quality

The above table shows some useful indicators. There may be other indicators. It is important to distinguish principal indicators from supporting indicators, as shown in the above table. Whether a particular indicator should be treated as a principal or supporting indicator depends on the purpose of the evaluation.

b. Definitions of Indicators

One of the most serious problems with respect to performance-indicators arises in the way to measure the performance, i.e. the definitions of indicators. For example, the unit-collection-cost differs greatly depending on whether or not to include certain indirect costs such as administration-costs, assumed office-rent, cost of stand-by vehicles and insurance premium paid, etc.

In view of the above, it is important for the Council to establish the precise definitions of indicators, and use indicators of the same definitions over the long period to enable the Council to compare the past performance to the present one on same grounds.

It will be very useful for SWM to develop definitions of indicators to be used by all Local Authorities. The development of such definitions will enable inter-municipal comparisons on same grounds. The initiative for such development may most suitably be taken by the Technical Section, Local Government Division, Ministry of Housing and Local Government.