JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF HOUSING AND LOCAL GOVERNMENT, MALAYSIA

THE STUDY ON THE SAFE CLOSURE AND REHABILITATION OF LANDFILL SITES IN MALAYSIA

FINAL REPORT

Volume 1

Summary

NOVEMBER 2004

YACHIYO ENGINEERING CO., LTD.

EX CORPORATION

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF HOUSING AND LOCAL GOVERNMENT, MALAYSIA

THE STUDY ON THE SAFE CLOSURE AND REHABILITATION OF LANDFILL SITES IN MALAYSIA

FINAL REPORT

Volume 1

Summary

NOVEMBER 2004

YACHIYO ENGINEERING CO., LTD.

EX CORPORATION

EXCHANGE RATE

US$1.00 = RM 3.770 (September 2004)

US$1.00 = Yen 110.88 (September 2004)

The Final Report of "The Study on The Safe Closure and Rehabilitation of Landfill Sites in Malaysia" is composed of seven Volumes as shown below:

Volume 1	**Summary**
Volume 2	**Main Report**
Volume 3	**Guideline for Safe Closure and Rehabilitation of MSW Landfill Sites**
Volume 4	**Pilot Projects on Safe Closure and Rehabilitation of Landfill Sites**
Volume 5	**Technical Guideline for Sanitary Landfill, Design and Operation (Revised Draft, 2004)**
Volume 6	**User Manual of LACMIS (Landfill Closure Management Information System)**
Volume 7	**Data Book**

This Report is "**Volume 1 Summary**".

PREFACE

In response to a request from the Government of Malaysia, the Government of Japan decided to conduct "The Study on The Safe Closure and Rehabilitation of Landfill Sites in Malaysia " and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA dispatched the study team headed by Mr. Hisashi YAMAUCHI of YACHIYO ENGINEERING Co., Ltd. and consisted of experts from YACHIYO ENGINEERING Co., Ltd. and EX Corporation to Malaysia, 5 times between February 2003 and November 2004. In addition, JICA set up the advisory committee headed by Yasushi MATSUFUJI, Professor at Faculty of Engineering, Fukuoka University in Japan.

The team had a series of discussions with the officials from Ministry of Housing and Local Development in Malaysia, and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of the practice of safe closure of the landfill sites and to the enhancement of friendly relationship between Malaysia and JAPAN.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

November 2004

Etsuo KITAHARA
Vice-President
Japan International Cooperation Agency

November 2004

Mr. Etsuo KITAHARA
Vice-President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

We are pleased to submit to you the final report of the Study on The Safe Closure and Rehabilitation of Landfill Sites in Malaysia. The report includes the advise and suggestions of the authorities concerned of the Government of Japan and your Agency. Also included are comments made by the Ministry of Housing and Local Government and related authorities in Malaysia.

The report deals with the present conditions of solid waste management and landfill sites in Malaysia and presents the landfill safe closure guideline as well as action plan with the target year of 2010.

In accordance with the contract with your Agency, we Yachiyo Engineering Co., Ltd. and EX Corporation implemented this study during the period of January 24, 2003 to November 30, 2004. Based on a deep understanding of the existing conditions in Malaysia we have prepared a plan that is feasible and can be implemented.

Finally we sincerely hope that this report will be effectively used for the realization of the plan. We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affaires and Ministry of the Environment. We also wish to express our deep gratitude to the Ministry of Housing and Local Government and the relating organizations in Malaysia for the close cooperation and assistance extended to us during the Study.

Very truly yours,

Hisashi YAMAUCHI
Team Leader
The Study on The Safe Closure and Rehabilitation of Landfill Sites
in Malaysia

EXECUTIVE SUMMARY

1 INTRODUCTION

1.1 Background of the Study

Approximately 170 landfill sites are operated in Malaysia where only about 10% of them are classified as sanitary landfill, in which environmental protection measures are considered for their facilities and operation. Most of the landfill sites are operated as so called open dumping sites and there are concerns that these sites are sources of environmental pollution; such includes waste scattering, offensive odour, insect infestation, surface and groundwater pollution, leachate problems, etc.

During the last 15 years about 60 landfill sites were closed without proper environmental countermeasures. Therefore, in Malaysia, environmental pollution surroundings the closed landfill sites are wide spread. Furthermore, it is reported that about 46% of the existing landfill sites will be closed within the next 5 years.

In order to prevent the environmental pollution and maintain a healthy environment and introduce the proper post-closure utilisation of landfill sites, the safe closure of existing landfill sites and rehabilitation of closed landfill sites are main issues in Malaysia that need to be urgently addressed.

Solid waste management (SWM) in Malaysia is in a transition period for privatisation, which has yet to be fully implemented. Therefore, it is strongly recommended that the Federal Government and/or States and Local Authorities should lead/control the private sector in both technical and administrative matters. Accordingly, human resource development on the management of landfill sites is also necessary.

Based on this understanding, in response to the request of the Government of Malaysia (GOM), the Japan International Cooperation Agency (JICA) conducted the Study on the Safe Closure and Rehabilitation of Landfill Sites in Malaysia.

The Study has been implemented in two phases:

(1) Phase 1 - Basic Survey and Preparation of Pilot Projects
(2) Phase 2 - Preparation of Guideline & Action Plan and Implementation of Pilot Projects

Phase 1 of the Study has commenced in February 2003 and completed by the end of June 2003 and Phase 2 has started from July 2003 and ended in November 2004. The entire Study period is about 22 months.

1.2 Objectives and Output of the Study

The objective of the Study is to reduce a health hazard and/or environmental pollution caused by the waste landfill sites, in the medium and long-term.

The major outputs of the Study are as follows:

(1) Development of Guidelines
   a. Guideline on the Safe closure of Landfill Sites covering institutional, financial, environment and technical issues
   b. Review of "Technical Guideline on Sanitary Landfills, Design and Operation (1990)"

(2) Developing an Action Plan for Safe Closure Implementation

(3) Implementation of Three Pilot Projects

(4) Preparation of Database of Landfill Sites

(5) Technology Transfer and Enhancing Management/Awareness on Landfill Safe Closure

2 GUIDELINE FOR SAFE CLOSURE AND REHABILITATION OF MSW LANDFILL SITES

2.1 Outline

The Guideline is divided into two sections, viz. Section I and Section II. Section I addresses the issues with regards to the general procedures for safe closure, and the legislation, institutional and financial aspects. Section II explains the technical requirements in more details.

The Guideline recommends that for all landfills, that accept municipal solid waste, including abandoned sites, where waste-filling work has been completed should be closed properly for the safe storage of the wastes and to prevent pollution to the surrounding environment. The "Safe closure plan" should be formulated to include the physical closure (PC) and the post-closure management (PCM) activities. The safe closure plan should be prepared based on the priority and the closure level of the landfill site.

The "Post-closure Land Use" is also addressed and it recommends that all future post-closure land use of closed landfill sites should be carefully considered based on the clear understanding of the landfill during its term of operation and closure as well as the impacts it has had on the surroundings. The proposed land use should not endanger the lives of the public and the users.

2.2 Purpose of the Guideline

The purpose of the landfill safe closure is as follows.

(1) Protecting public health and the environment by proper management of landfill safe closure and post closure land use,

(2) Prevention of environmental pollution and risks from the closed landfill sites,

(3) Prevention of environmental pollution and risks from the uncontrolled development of closed landfill sites.

This guideline provides the recommended steps necessary to close the landfill in a safe manner, including steps to rehabilitate the closed landfills and on how to manage the closed landfill site properly. This guideline also provides the recommendations for the post closure land use of closed landfill sites.

This guideline is to be used in conjunction with the "Technical Guideline on Sanitary Landfill, Design and Operation (Revised draft, 2004)", and should cover the entire lifespan of the landfill site.

2.3 Basic Concept of the Guideline

(1) "Safe Closure"

1) A landfill where waste-filling activities have been completed shall be closed properly for safe storage of the waste and prevention of pollution to the surrounding environment.
2) When a landfill is being closed, appropriate measures shall be taken to prevent environmental pollution caused by leachate or landfill gas resulting from the decomposition and degradation of the waste. Even long after closure of the landfill, post-closure management (including environmental monitoring) should be carried out continuously.
   Parameters that indicate the stability of the landfill site and may lead the termination of the post-closure management are shown in **Table 2.3.1.**

Table 2.3.1 Parameters to Measure the Landfill Stabilization

Parameter	Target value
Leachate	Below DOE Standard A or B (depend on location of the landfill) <Mainly for BOD, COD, SS and Heavy Metals>
Landfill	Methane (CH_4) : Below 1.0%
Subsidence rate	Below 2 cm per year

3) When a landfill site ceases in operation and closed, it is necessary to formulate a "safe closure plan" that which comprises of the physical closure (PC) and the post-closure management (PCM) for submission to the relevant authorities for approval. This also applies to the abandoned sites.
4) In order to minimize the risks of pollution and hazards caused by the landfill, *the Appropriate Technology* ranging from the basic level (C1) to the advanced level (C4) should be applied to close the site safely and to manage the closed site.

5) In order to determine the "safe closure" requirements, the conditions of each individual site shall be investigated based on the site-specific conditions.

(2) "Post-closure Land Use"

1) The type of post-closure land use of closed landfills should be carefully considered based on the clear understanding of the landfill conditions during operations, closure, and together with impacts it may have had on the surroundings.
2) The "Post-closure land use plan" will have to be formulated and submitted to the relevant authorities for approval.
3) Operation and maintenance of the landfill facilities should be continued throughout the post closure land use redevelopment. Those facilities that may have been affected by the redevelopment works, such as the gas ventilation pipes and surface drainage, must be re-installed at suitable locations in order to preserve their functions.
4) The stabilization period of landfill site after waste filling has completed is expected to be minimum 10 years. Therefore, post-closure land use shall be considered and can be preceded after this period. This is to minimize the effects of land subsidence and landfill gas generation on the development site.

   However, for the landfill sites 5 years has past after waste filling has completed, provisional land-use might be applied under the following conditions.

   1. Utilization of only surface layers of the closed landfill site and access of the people to the site shall be very limited; such as green space, parking etc.
   2. Prior to the utilization, monitoring of environment and landfill stabilization shall be carried out and then the landfill condition shall be clarified.

(3) Legal Framework and Role of Stakeholder

In order to implement and manage the sustainable landfill safe closure efficiently and effectively, institutional and legal systems will have been set up in accordance with the following principles.

1) The registration system of landfill sites will have been established to ensure better enforcement of the required measures and long-term operation and maintenance of the closed landfills in accordance with the appropriate safe closure measures.
2) The State Governments will be responsible for registration of the landfills, management/monitoring of landfill safe closure and post-closure land use.

3) The Federal Government will set up a new funding system to subsidize the additional financial expenditure necessary to implement the safe closure of landfills.

4) The landfill management activities will have to be managed by the State Governments and Local Authorities complying with the relevant regulations and laws. The Federal Government will provide the necessary technical advice and assistance with the human resources development.

(4) Financial Resources and Funding

The strategic funding system will be set up at the Federal Governmental level for implementing the sustainable landfill safe closure. The general concepts for the funding system are as follows.

1) The setting up of a specific *Fund* for implementing the safe closure of the landfill sites.
2) During landfill operation, a necessary fee should be added to the tipping fee to allow for contributions towards the *Fund*.
3) The Federal Government will manage the *Fund* and apportion the funds accordingly upon the requests from the State Governments and by taking into account of the landfill closure priorities.

2.4 Process of Landfill Safe Closure

The processes of landfill safe closure are as follows.

(1) The operator/owner of landfills should assess their respective sites in order to clarify the environmental pollution potential and land use potential.

(2) Based on the assessment, the operator/owner should setup a closure level of the landfill site.

(3) The operator/owner of landfills should prepare the "Safe Closure (SC) Plan" for submission to the State government for approval. The SC plan should be submitted one year before closure of the landfill site.

(4) After the approval, the operator/owner of landfills will implement the physical closure works and post closure management activities. These activities should be informed to the related authorities periodically.

(5) State government should examine the SC plan and approve if it meet the requirement. Safe closure activities (PC and PCM) carried out by the operator/ owner should be managed and monitored by the State government.

(6) The developer should prepare the "Post-closure Land Use Plan" and submit to the relevant authority in the State government for approval.

(7) The developer can implement the post-closure land use after obtaining the approval. Implementation activities including PCM shall be informed to the related authorities periodically.

2.5 Technical requirements

The technical requirements for safe closure of landfill sites are as follows.

(1) Landfill sites should be closed safely and the post-closure management should be carried out properly.

(2) Measures for safe closure of landfill sites.

a. To prevent wastes from littering or overflowing from the landfill site
b. To prevent fire or explosion that may be caused by landfill gases
c. To minimize offensive odours emitting from landfill site
d. To provide storm water run-off and drainage facilities
e. To minimize environmental pollution caused by leachate from landfill site
f. To prevent groundwater contamination
g. To take measures for wastes stabilization

(3) Measures for post-closure management of landfill sites.

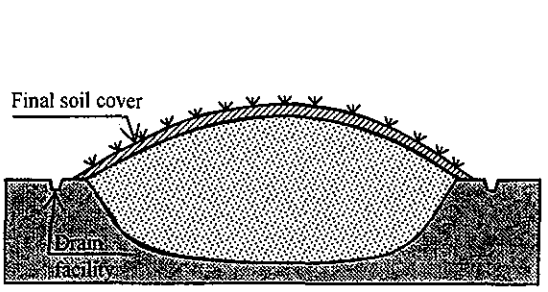
a. To implement appropriate operation and maintenance activities of landfill facilities such as providing the final cover soil
b. To continuously operate the landfill facilities such as the leachate treatment plant
c. To continue with the environmental monitoring work
d. To continue with the waste stabilisation monitoring

(4) Appropriate measures and activities required to achieve safe closure should be determined based on the conditions of the site including operation level, existing facilities, surrounding environment and post closure land use.

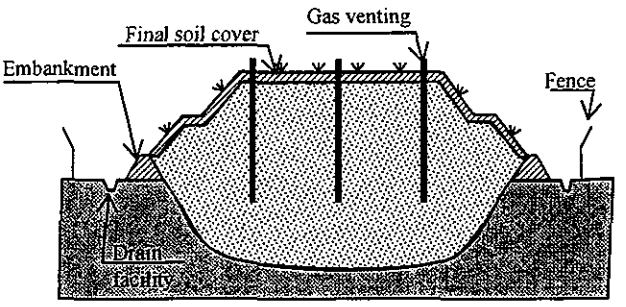
2.6 Landfill Closure Level

The closure levels are classified into 4 categories as follows, and schematic drawing of each level is shown in **Figure 2.6.1**.

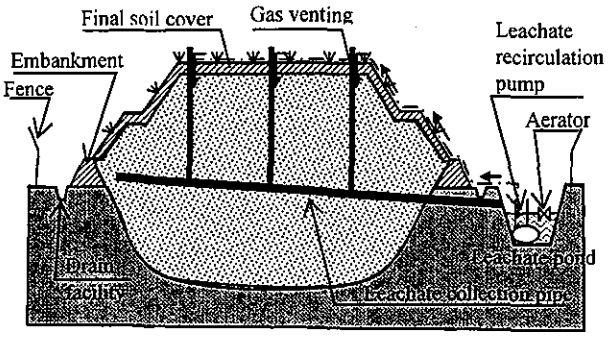
Level C1: Minimal closure level
Level C2: Low closure level
Level C3: Middle closure level
Level C4: High closure level



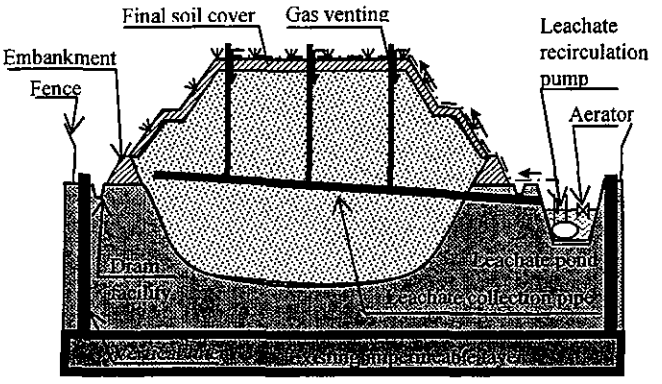
Landfill safe closure level: C1



Landfill safe closure level: C2



Landfill safe closure level: C3



Landfill safe closure level: C4

Note: For C3 & C4, aerobic area of existing landfill site will be expanded by safe closure measures.

Figure 2.6.1 Landfill Safe Closure Level

The measures necessary to be taken for each of the closure levels are tabulated in **Table 2.6.1**.

Table 2.6.1 Closure Levels and Required Measures/Facilities

Measures	Safe closure Level			
	C1	C2	C3	C4
Final cover soil	++	+++	+++	+++
Storm-water drainage	+	++	+++	+++
Safely storage	+	++	+++	+++
Gas vent		++	+++	+++
Leachate		+	+++	+++
Groundwater			++	+++
Early stabilization		+	+++	+++
Post closure measures		+	+++	+++
Monitoring	+	++	+++	+++
Landfill system			Semi-aerobic System	

Notes: 1. The methodology of closure level set-up is described at the Appendix, Chapter 5, Volume 2.
(Refer to article 3.1 of chapter 3.)
2. +: minimum equipped/ operated, ++: fair, +++: Fully equipped/ operated

3 ACTION PLAN ON SAFE CLOSURE OF LANDFILL SITES

3.1 Objective of Action Plan

(1) Outline

The Action Plan aims to set the proceedings and schedule to implement the safe closure for all the priority sites and to establish the required institutional mechanism and financial support by the year 2010. The major "Action" activities are as follows:

Action 1: To authorise the safe closure guideline

Action 2: To implement the physical closure and post closure management including the social considerations

Action 3: To establish the landfill registration system

Action 4: To arrange the Federal and State Organisation (Committee)

Action 5: To establish a funding system for safe closure

Action 6: To develop human resources for capacity building

(2) Target Year and Target Sites

a. Target year : 2010

b. Target sites : 72 landfill sites in Groups A, B and C

The breakdown of the number of sites in their respective groups is shown in

Table 3.1.1 Target Sites for Action Plan

Item	Target sites				Group D	Total
	Group A	Group B	Group C	Total		
Closed site	7	9	17	33	22	55
Operating site	13	18	8	39	17	56
Total	20	27	25	72	39	111

Note: It is noted that, among 111 landfill sites which will be closed up to 2010, 72 landfills identified as the priority sites in terms of their environmental risk potential and land use potential will be considered for the action plan.

3.2 Action 1: To Authorise the Safe Closure Guideline

In order to achieve a safe closure of the landfill, it is important that the various measures for safe closure have been considered even at the initial stages, from planning through to design and construction, and eventually throughout the operations. The safe closure guideline provides the recommended steps necessary to close the landfill in a safe manner, including steps to rehabilitate the closed landfills and on how to manage the closed landfill site properly. This guideline also provides the recommendations for the post closure land use of closed landfill sites. Thus it is important that the safe closure guideline is authorised by the relevant Governmental authorities and adopted as the official guideline for all future landfill safe closure requirements.

3.3 Action 2: To Implement the Physical Closure and Post Closure Management Including the Social Considerations

The Study has identified a total of 72 sites that require safe closure by the year 2010, and have been categorised into Groups A, B and C. The proposed implementation schedule should only commence from the year 2005, after the finalisation of the guideline and the necessary mechanisms.

The implementation schedule for the landfill safe closure is shown in **Table 3.3.1**. The table shows the annual breakdown of the number of sites, the closure levels and priority groups, which are to be closed from 2005 to 2010. The estimated CAPEX and OPEX have also been summarised in the table.

The social aspects/issues on scavengers and/or nearby households should be taken into consideration for each of the pre-closure, closing and post-closure stages of the landfill sites.

3.4 Action 3: To Establish the Landfill Registration System

The landfill registration system should be carried out by and managed by the State Government under the guidance of the Federal Government. The Local Authorities should be responsible for providing the updated information to the State, together with reporting of any infringements or irregularities that may occur. The introduction of the landfill registration system will be the first step towards preventing illegal waste dumping.

In addition, the registration system should be used to check and monitor the post-closure utilisation of the sites and to prevent any over exploitation of the site for purposes not suitable for the area.

3.5 Action 4: To Arrange the Federal and State Organisations

Since all land matters are under the control of the State Government, it is appropriate that the related authorities of the State Government should be responsible for implementing and maintaining the Landfill Registration System. It is understood that, even after the proposed privatisation of landfill sites, no specific agency will be responsible for the closed landfill sites or illegal dumping grounds, as the State Government should continue to be responsible for such sites.

It is proposed that the Landfill Sites Management Committee (LSMC) should be set up at the State Government level, as the main player in the management/monitoring of the safe closure of landfill sites.

It is also recommended that the Technical Committee for Management of Landfill (TCMLS) should be set up at the Federal level and to provide technical support to the State Government.

Table 3.3.1 Implementation Schedule for Landfill Safe Closure

(Unit of CAPEX & OPEX : RM)

1. CAPEX (Capital expenditure)	2005					2006					2007					2008					2009					2010					Total
	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	
A. Closed Sites																														
a) Group A			4	3	7																									
b) Group B							1	4	4	9																				
c) Group C											1	12	4		17															
A. Sub-total sites number					*7*					*9*					*17*					*0*					*0*				*0*	*33*
A. Sub-total CAPEX					*16,750,000*					*19,541,000*					*36,200,000*					*0*					*0*				*0*	*72,491,000*
A. Area of sites (ha)					*28.3*					*40.0*					*195.8*					*0*					*0*				*0*	*264.1*
B. Operating Sites																														
a) Group A			7	1	8				1	1			1		1			1		1			1	1	2					0
b) Group B			4	1	5			3		3				3	3			1	1	2			2	1	3			1	1	2
c) Group C			2		2			2		2		3			3					0			1		1					0
B. Sub-total sites number					*15*					*6*					*7*					*3*					*6*				*2*	*39*
B. Sub-total CAPEX					*52,913,000*					*16,154,000*					*20,692,000*					*14,409,000*					*23,122,000*				*9,167,000*	*136,457,000*
B. Area of sites (ha)					*171.4*					*56.1*					*49.9*					*56.5*					*48.7*				*19.7*	*402.3*
Total Sites Number					*22*					*15*					*24*					*3*					*6*				*2*	*72*
Total CAPEX					*69,663,000*					*35,695,000*					*56,892,000*					*14,409,000*					*23,122,000*				*9,167,000*	*208,948,000*
Total Area (ha)					*199.7*					*96.1*					*245.7*					*56.5*					*48.7*				*19.7*	*666.4*
2. OPEX (Operational expenditure)	**2005**					**2006**					**2007**					**2008**					**2009**					**2010**					**Total**
	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	C1	C2	C3	C4	Total	
A. Closed Sites																														
a) Group A						0	0	4	3	7	0	0	4	3	7	0	0	4	3	7	0	0	4	3	7	0	0	4	3	7	
b) Group B						0	0	0	0	0	0	1	4	4	9	0	1	4	4	9	0	1	4	4	9	0	1	4	4	9	
c) Group C						0	0	0	0	0	0	0	0	0	0	1	12	4	0	17	1	12	4	0	17	1	12	4	0	17	
A. Sub-total sites number										*7*					*16*					*33*					*33*					*33*	
A. Sub-total OPEX										*1,278,000*					*2,904,000*					*6,478,000*					*6,478,000*					*6,478,000*	*23,616,000*
A. Area of sites (ha)										*28.31*					*68.29*					*264.11*					*264.11*					*264.11*	*264.11*
B. Operating Sites															0					0					0					0	
a) Group A						0	0	7	1	8	0	0	7	2	9	0	0	8	2	10	0	0	9	2	11	0	0	10	3	13	
b) Group B						0	0	4	1	5	0	0	7	1	8	0	0	7	4	11	0	0	8	5	13	0	0	10	6	16	
c) Group C						0	0	2	0	2	0	0	4	0	4	0	3	4	0	7	0	3	4	0	7	0	3	5	0	8	
B. Sub-total sites number					*0*					*15*					*21*					*28*					*31*					*37*	
B. Sub-total OPEX					*-*					*5,277,000*					*7,044,000*					*8,671,000*					*10,059,000*					*11,868,000*	*42,919,000*
Total Sites Number					*0*					*22*					*37*					*61*					*64*					*70*	
Total OPEX					*-*					*6,555,000*					*9,948,000*					*15,149,000*					*16,537,000*					*18,346,000*	*66,535,000*

3.6 Action 5: To Establish a Funding System for Safe Closure

To secure availability of the fund, the Study recommends creation of the national fund for landfill closure in Malaysia. The fund mainly consists of:

- Additional allocation of national budget specifically used for landfill closure,
- Additional tipping fees collected from those who bring waste into the landfills including public and private SW haulers.

The schedule for the additional tipping fee collection is proposed as shown in **Table 3.6.1**.

Table 3.6.1 Schedule of Additional Fee Collection

2005-2006	2007-2009	2010-
Additional fee collection will be carried out in Kuala Lumpur	Additional fee collection will be gradually extended to other urbanised areas	Additional fee collection will be extended for the whole of the Peninsular Malaysia.

- The shortage of the fund for implementing the action plan during 2005-2010 will be covered by additional allocation from the national budget.
- From 2010 onward, the fund for safe closure will be mostly covered by additional fee collection.

Table 3.6.2 below estimates the amount of the fund that could be raised from the additional fee collection and additional National budget allocation required for safe closure of the landfill sites in accordance with the action plan.

Table 3.6.2 Estimated Amount of Fund with the Required Fund for Safe Closure of Landfill Sites during 2005-2010 (72 sites)

(Unit: RM)

Item	2005	2006	2007	2008	2009	2010
National budget required	55,750,000	55,750,000	29,610,000	29,610,000	NIL	NIL
Collection of tipping fees	3,602,000	3,795,000	12,199,000	24,988,000	39,348,000	40,760,000
Required fund for closure	69,663,000	42,250,000	66,840,000	29,558,000	39,659,000	27,513,000
Balance	-10,311,000	17,295,000	-25,031,000	25,040,000	-311,000	13,247,000

Figure 3.6.1 shows the estimated trend of CAPEX and OPEX in accordance with the action plan for safe closure of landfill sites (72 numbers).

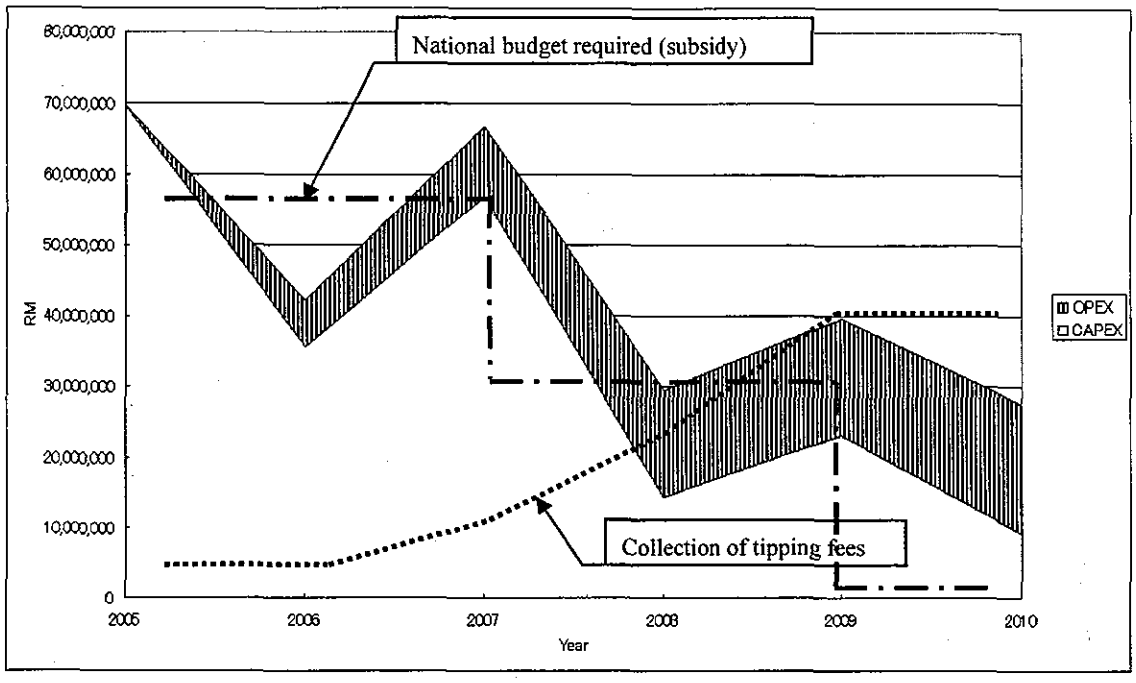


Figure 3.2.1 Trend of CAPEX and OPEX for Action Plan (2005 - 2010)

3.7 Action 6: To Develop Human Resource for Capacity Building

In order for the proper implementation of safe closure of landfill sites, it is necessary to identify the responsible organisations, operators and managers who will handle the management and/or carry out the actual safe closure works. However, due to the lack of suitably trained managers or operators in this field in Malaysia at present, the Federal Government must ensure that proper training and technical assistance must be provided.

The proposed contents of the training course are shown in **Table 3.7.1**.

Table 3.7.1 Proposed content of training courses for safe closure of landfill sites

	Training courses	State officials	LAs	Operator/ owner
1	Administration, management and finance	+++	+	+
2	Guideline	+++	+++	+++
3	Laws and enforcement	+++	++	+
4	Registration of landfill sites	+++	+	+
5	Inventory survey/priority and closure level set-up	+++	++	+
6	Physical closure and post-closure management	++	++	+++
7	Environmental risk and monitoring	++	+	+++
8	Re-development of closed landfill site	++	+	+++

Note: (+: Recommended, ++: Should Attend, +++: Compulsory)

3.8 Implementation Schedule

The implementation schedule for the Action Plan is shown in **Table 3.8.1.**

Table 3.8.1 Implementation Schedule of Action Plan

	Item	2004	2005	2006	2007	2008	2009	2010
	JICA Study on landfill safe closure	++++						
I	Landfill safe closure implementation		++++	++++	++++	++++	++++	++++
	- Closed sites (High Priority: 7 sites)		++++					
	- Closed sites (Medium Priority: 9 sites)			++++				
	- Closed sites (Medium-Low Priority: 17 sites)				++++			
	- Operation sites (High-Med-Low Priority: 39 sites)			++++	++++	++++	++++	++++
II	Guideline for landfill safe closure	++++						
III	Landfill registration (set-up committee in State Gov.)	++++						
IV	Landfill sites list	++++						
V	Funding system set-up	++++	++++					
VI	Human resource development	++++	++++	++++	++++	++++	++++	++++

4 PILOT PROJECTS

4.1 Purpose

The three Pilot Projects (PP) as shown below have been implemented in order to examine the standards for the Safe Closure Guideline and demonstrate the method and effect of the safe closure and rehabilitation.

- Ampang Jajar landfill site (Pulau Pinang State)
- Pekan Nenasi landfill site (Pahang State)
- Ampang Jaya closed landfill site (Selangor State).

4.2 Outline of the Pilot Projects

An outline of the pilot projects is shown in **Table 4.2.1.**

Table 4.2.1 Brief Description of the Pilot Projects

Item	Pilot Projects		
	Ampang Jajar Landfill	Pekan Nenasi Landfill	Ampang Jaya Closed Landfill
Status of landfill	Closed (2003)	In Operations	Closed (1998)
Key points in safe closure consideration	Safety closure of landfill that has been operated under improved conditions	Model for rehabilitation of landfill located on wetlands	Safety closure of landfill previously operated as an open dump site and poorly located
Targeted safe closure levels	Landscaping and safety closure to Level C3	Safety closure to Level C3	Safety closure to Level C2

Brief description of the pilot projects	Improvement of the slopes and installation of storm water drains, leachate collection pipes and gas vents	Upgrading to semi-aerobic landfill with leachate collection pipes, recirculation system and gas vents	Provision of leachate collection pipes and gas vents. Installation of surface storm water drainage system
Major works carried out	• Topographic and geological survey	• Topographic and geological survey	• Topographic and geological survey
	• Re-forming 250m stretch of slopes from 3.2m to 7m high • Applying 8,000m^2 cover soil (150mm thick) • Plant 11,400m^2 turfing & 240 trees • Installing 275m of 450mm dia. leachate collection pipes • Installing 600m of 150mm dia. Leachate/gas pipes • Installing 900m of pre-cast surface/ stormwater drains	• Install 84m of 450mm dia leachate collection pipe • Install 330m of 225mm dia branch pipes • Excavation of 100m x 10m x 2m(deep) leachate collection pond • Installation of one 7.5kw surface aerator c/w control systems • Installation of one 5kw recirculation pump c/w piping and control panel	• Construct 1km, 7m wide access road • Install 1km stormwater drains alongside access road • Install 126m of 450mm dia HDPE leachate collection pipe • Install 500m of 100mm dia leachate / gas collection pipes • Install 500m stormwater drains • Excavation of wetland area for leachate pond
Environmental monitoring	Before and after PP • Surface & groundwater • Leachate • *Landfill gas*	Before and after PP • Surface & groundwater • Leachate • *Landfill gas*	Before and after PP • Surface & groundwater • Leachate • *Landfill gas*

Evaluation of the Pilot Project is summarized in **Table 4.2.2.**

Table 4.2.2 Evaluation of Pilot Projects

Item	A*	B*	C*	Comment
1. Malaysian technical capability				
(1) Detailed design	O			Detailed design was prepared by Local consultants appropriately based on the instruction of the JICA Study Team.
(2) Construction	O			Contractors implemented the construction woks well.
2. Construction Implementation				
(1) Construction period	O	O		Ampang Jaya PP completed on time, but Ampang Jajar and Pekan Nenasi PP faced some delays due to rainy season.
(2) Budget maintenance	O			All PPs completed within the budgets.
(3) Equipment and materials		O		All the equipment and materials for the works procured in Malaysia.
(4) Workmanship		O		Contractors implemented the construction woks as it was designed.
3. Applicability of Guidelines				
(1) Ampang Jajar PP	O			Re-formation of slope and application of C3 level (leachate collection, drainage system, gas vents, etc).
(2) Pekan Nenasi PP	O			Application of C3 level (semi-aerobic landfill system including leachate re-circulation system).

(3) Ampang Jaya PP		O		Installation of leachate collection and drainage system.
4. Deepening understanding of safe closure				
(1) MHLG		O		Arrangement of C/P personnel for each pilot site for supervise works. Implementation of training workshops.
(2) Local Authorities	O		O	Active participation of Las in Ampang Jajar and Pekan Nenasi PP. Inadequate participation in the case of Ampang Jaya PP.
(3) Site operators	O			Understanding and Cooperation of landfill operators during implementation. Adjacent cell was developed by LA's initiative in Pekan Nenasi.
(4) Public	O			Based on the public hearing to Ampang Jajar residents (about 200 attendees), PP was totally accepted by the public.
(5) 1st Training Workshop	O			Topic: Evaluation of landfill sites and planning of pilot projects. Attendees: federal/state government and local authorities.
(6) 2nd Training Workshop	O			Topic: Detail design, construction work and monitoring of PP. Attendees: Federal/state government, LAs, and concessionaires.
5. Environmental improvement				
(1) Ampang Jajar	O			Surface water & Leachate improved. Landscaping improved.
(2) Pekan Nenasi		O		Leachete improved. Continuous monitoring is required.
(3) Ampang Jaya		O	O	Leachate can be controlled. Leachate treatment is urgently required.

Note: * Key: A = Excellent, B = Satisfactory, C = Inadequate

5 FORMULATION OF LANDFILL DATABASE

Landfill inventory survey composed of two survey exercises were carried out, one was the actual site visit and inspection survey and the other was the desk-top questionnaire survey whereby proforma questionnaires were sent to the Local Authorities for them to provide as much information and details about their respective landfills.

From the results of the surveys and information collated in the inventory list, the database of landfills in Malaysia for 147 landfill sites was created. This leads to the formation of the Landfill Closure Management Information System (LACMIS).

The LACMIS database is based upon the Geographical Information System (GIS) that comprises of a series of spatial data and non-spatial attribute data. The Spatial Data include geographical information on the Administration boundaries, the landfill site location, the location of water intake points, hydrological map and the transportation network. The non-spatial attribute data include information on the administrative database, the environmental database, the land utilisation database and the rating database.

Figure 5.1.1 shows the example page of the LACMIS visual display with the map of the Peninsular Malaysia, indicating the locations of the major cities/town, roads, rivers, and the locations of the landfill sites.

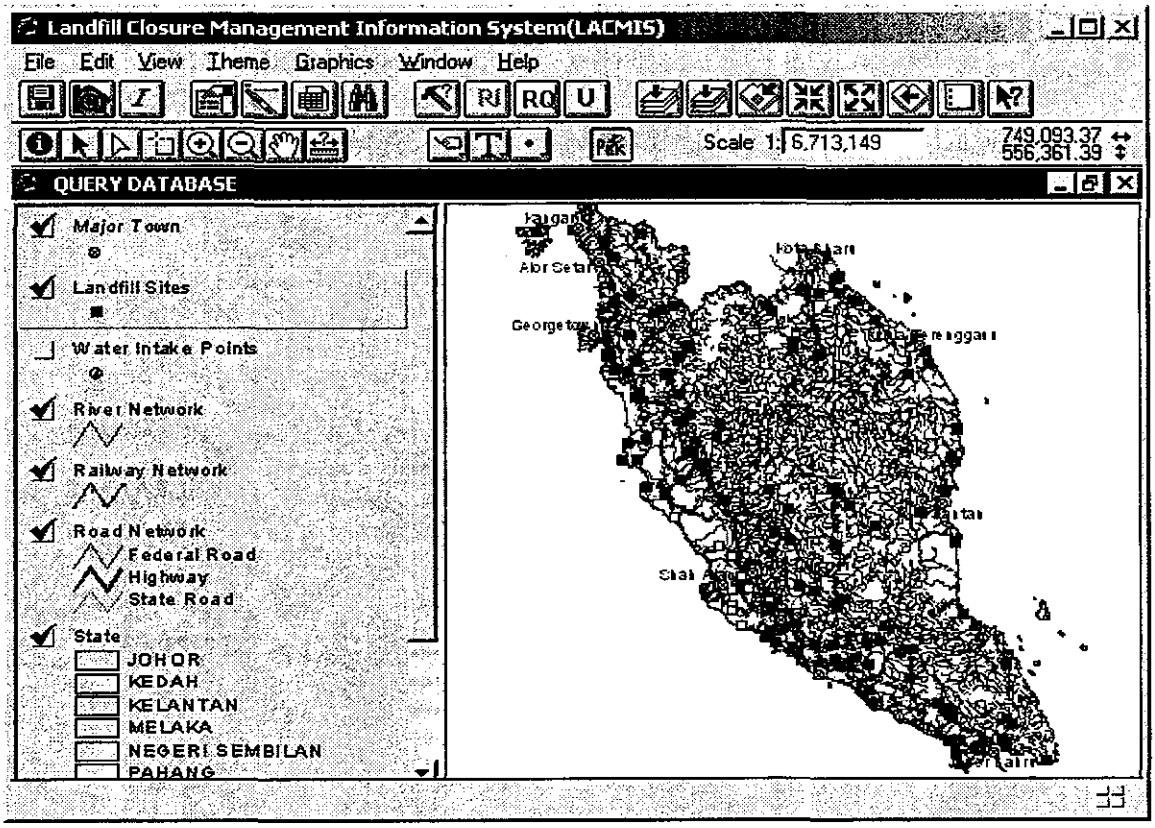


Figure 5.1.1 Example of LACMIS Visual Display

6 REVIEW OF TECHNICAL GUIDELINE ON SANITARY LANDFILL

The "Technical Guideline on Sanitary Landfill, Design and Operation (draft)" was prepared by the JICA expert in October 1990. In order to meet the present conditions of solid waste management activities in Malaysia, the technical guideline (draft) were reviewed considering the following key items, and "Revised draft, 2004" has been prepared by the study.

- Recommendation for Semi-aerobic landfill system
- Sanitary landfill levels
- Function of the landfill
- Necessity of the cover soil
- Environmental monitoring
- Countermeasures for heavy rainfalls
- Sectional land filling

- Design requirements for leachate control system
- Treatment method of leachate
- Occupational health and safety
- Landfill operation and maintenance control
- Rehabilitation of existing landfill site
- Cost for landfill construction and operation
- Explanation of intermediate treatment
- Updating of data
- Revision of the contents

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABBREVIATIONS

Note: Abbreviations used in this Report

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DOE	Department of Environment, Malaysia
DANCED	Danish Cooperation for Environment and Development
EIA	Environmental Impact Assessment
EMP	Eight Malaysian Plan 2001 – 2005
EPU	Economic Planning Unit
EQA	Environmental Quality Act
FTKL	Federal Territory of Kuala Lumpur
GIS	Geographical Information System
GPS	Global Positioning System
HA (ha)	Hectare (=10,000 m^2 = 2.4711 acres)
IEE	Initial Environmental Evaluation
JICA	Japan International Cooperation Agency
MD	Majlis Daerah (District Council)
MHLG	Ministry of Housing & Local Government, Malaysia
MOH	Ministry of Health, Malaysia
MP	Majlis Perbandaran (Town Council)
NREB	Natural Resources and Environment Board
NSP	National Strategic Plan for Solid Waste Management 2003
OPP3	Third Outline Perspective Plan for 2001 - 2010
PJ	Petaling Jaya, Selangor
PPM (ppm)	Parts Per Million
SWM	Solid Waste Management
Ton	Metric Ton (Tonne)
TWG	Technical Working Group
UPM	University Putra Malaysia
WHO	World Health Organisation

DIFINITION OF TERMS

Landfill site: The site where municipal wastes are disposed off by land filling. Such sites may be provided with various landfill facilities. In accordance with the "Technical Guideline on Sanitary Landfill, Design and Operation (Revised draft)", the landfill sites can be categorised into 4 types; i.e. from Level 1 (L1) to Level 4 (L4). Open Dumpsite is categorised as Level Zero (L0.)

Closed landfill site: The landfill site where the waste filling activities have been completed.

Abandoned site: The landfill site where the owners/operators could not be identified "Illegal dump site" will be included in this category.

Safe closure (SC): "Safe closure" consists of the activities of "Physical closure (PC)" and "Post-closure management (PCM)".

Physical closure (PC): The action by which the necessary measures for safe closure has been applied to the entire landfill area.

Closure levels (C1, C2, C3, C4): There are 4 closure levels, i.e. from C1 to C4. These closure levels indicate the countermeasures necessary to control the environmental pollution and hazards from the landfill sites. Each landfill site should be assigned with a targeted closure level at the initial stages of the safe closure process.

Post-closure management (PCM): The management activities necessary to operate, maintain and monitor the landfill facilities such as the leachate treatment, landfill gas treatment, cover soil etc. The activities also include the environmental monitoring, landfill stabilization monitoring and management of information/ records of the closed landfills.

Post-closure land use: The re-utilization of closed landfill sites for purposes other than for waste filling. The PCM activities should be continued through out the post-closure land use.

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Approximately 170 landfill sites are operated in Malaysia where only about 10% of them are classified as sanitary landfill, in which environmental protection measures are considered for their facilities and operation. Most of the landfill sites are operated as so called open dumping sites and there are concerns that these sites are sources of environmental pollution; such includes waste scattering, offensive odour, insect infestation, surface and groundwater pollution, leachate problems, etc.

During the last 15 years about 60 landfill sites were closed without proper environmental countermeasures. Therefore, in Malaysia, environmental pollution surroundings the closed landfill sites are wide spread. Furthermore, it is reported that about 46% of the existing landfill sites will be closed within the next 5 years.

In order to prevent the environmental pollution and maintain a healthy environment and introduce the proper post-closure utilisation of landfill sites, the safe closure of existing landfill sites and rehabilitation of closed landfill sites are main issues in Malaysia that need to be urgently addressed.

Solid waste management (SWM) in Malaysia is in a transition period for privatisation, which has yet to be fully implemented. Therefore, it is strongly recommended that the Federal Government and/or States and Local Authorities should lead/ control the private sector in both technical and administrative matters. Accordingly, human resource development on the management of landfill sites is also necessary.

Based on this understanding, in response to the request of the Government of Malaysia (GOM), the Japan International Cooperation Agency (JICA) conducted the Study on Safe closure and Rehabilitation of Landfill Sites in Malaysia.

1.2 OBJECTIVE AND OUTPUT OF THE STUDY

The objective of the Study is to reduce a health hazard and/or environmental pollution caused by the waste landfill sites, in the medium and long-term.

The major outputs of the Study are as follows:

(1) Development of Guidelines

   a. Guideline on the Safe closure of Landfill Sites covering institutional, financial, environment and technical issues

   b. Review of "Technical Guideline on the Design, Construction and Operation of Sanitary Landfills, Design and Operation (1990)"

(2) Developing an Action Plan for Safe closure implementation

a. Determination of priority and safe closure levels for 147 landfill sites listed in the Landfill Inventory based on evaluation of environmental risks and value of land use for each site

b. Preparation of Action Plan for safe closure of 72 landfills by the year 2010 covering technical requirements and associated costs

c. Institutional modifications recommendations to effectively implement safe closure of the landfills

d. Developing a landfill registration system

(3) Pilot Projects Implementation

a. Ampang Jaya Landfill Site

b. Pekan Nenasi Landfill Site

c. Ampang Jajar Landfill Site

(4) Preparation of Database

a. Field reconnaissance and data collection to supplement and update existing information

b. Preparation of Landfill Inventory

c. Preparation of data maintenance system for inputting and analysing data related to landfills

(5) Technology Transfer and Enhancing Awareness on Safe closure

a. Implementation, monitoring and evaluation of the 3 Pilot Projects to study effective technical measures, related costs and serve as models for GOM officials

b. Seminars and workshops to discuss technical issues related to safe closure and enhance awareness on this subject

c. Implementation of field visits together with GOM officials to develop mutual understanding of issues associated with sanitary landfill design, construction, operation and safe closure

d. Training of GOM officials on maintenance of data base and analysis

1.3 STUDY IMPLEMENTATION PROCESS

The Study has been implemented in two phases:

(1) Phase 1 - Basic Survey and Preparation of Pilot Projects

(2) Phase 2 - Preparation of Guideline & Action Plan and Implementation of Pilot Projects

Phase 1 of the Study has commended in February 2003 and completed by the end of June 2003 and Phase 2 has started from July 2003 and ended in November 2004. The entire Study period is about 22 months and the schedule for implementation of each study task is shown in **Figure 1.3.1**.

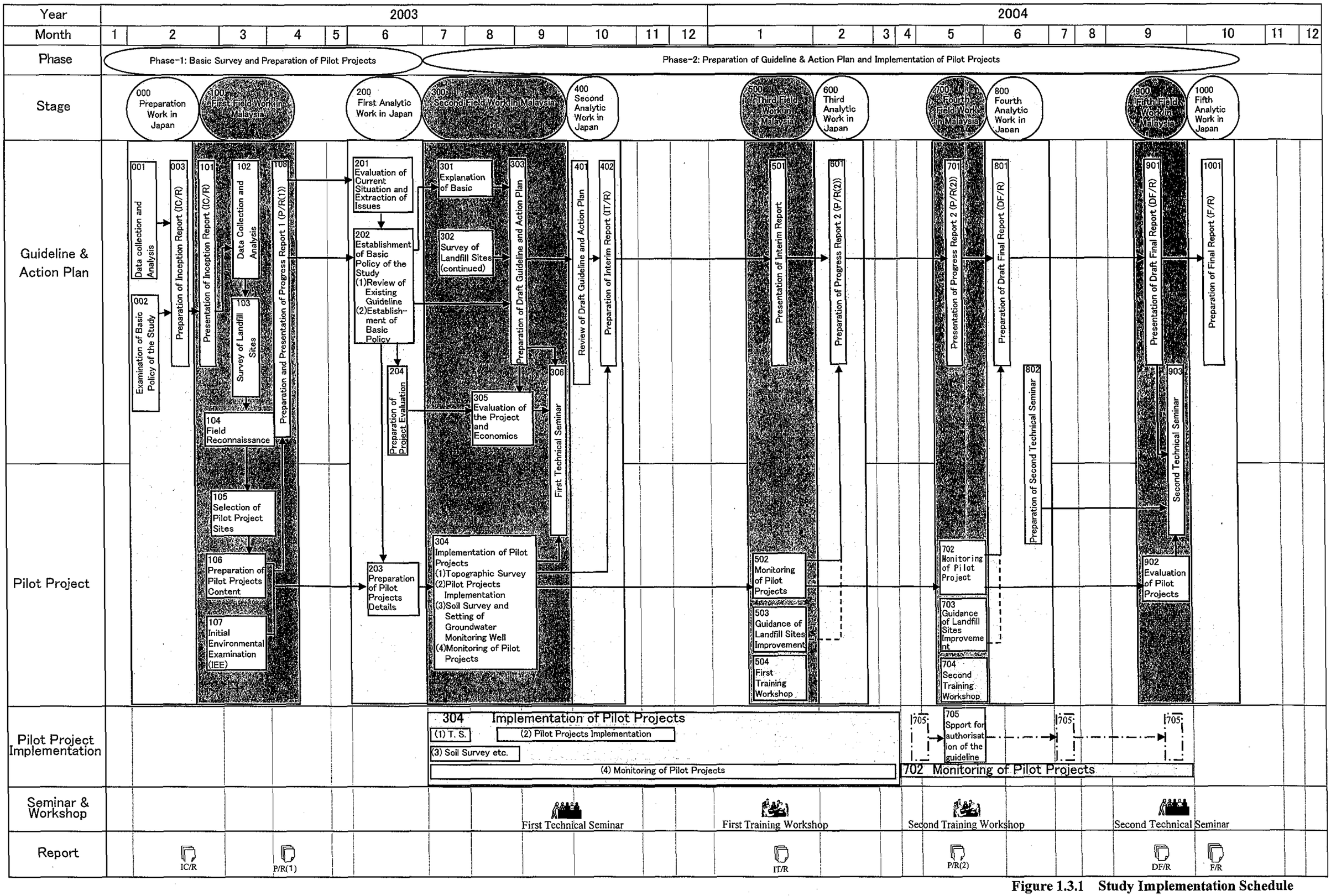


Figure 1.3.1 Study Implementation Schedule

1.4 STUDY MEMBERS

(1) JICA Side

1) JICA Advisory Committee

Dr. Yasushi Matsufuji	Advisory Committee Chairman Professor, Faculty of Engineering, Fukuoka University
Mr. Koichi Kubokura	Acting Advisory Committee Chairman Researcher, Water Research Centre, Fukuoka City Environmental Bureau

2) JICA Study Team

Mr. Hisashi Yamauchi	Team Leader/Solid Waste Management Plan
Mr. Hiroshi Abe	Sanitary Landfill
Mr. Hideo Furuta	Facility Design/Cost Estimation/Construction Supervision (Phase-1)
Mr. Mahmoud Riad	Facility Design/Cost Estimation/Construction Supervision (Phase-2)
Mr. Munehiro Fukuda	Environmental Consideration/Environmental Monitoring
Mr. Koshi Takahata	Organization and Institution
Mr. Kenji Igarashi	Social Consideration
Mr. Satoshi Sugimoto	Project Evaluation
Mr. Naohisa Yamaguchi	Post Closure Management/Countermeasure
Mr. Nobuyoshi Furukori	Coordinator/ Waste Treatment
Mr. Takuro Nukazawa	Pilot Projects
Mr. Akihiro Shimomura	Team Member
Mr. Zainuddin Arshad, A.M.N.	Local Engineer of the JICA Study Team
Mr. Ng Han Kok	Local Engineer of the JICA Study Team

3) JICA Headquarters

Mr. Takuya Murata	Envoronmental Management Team II, Group II (Environmental Management), Glocal Environment Department, JICA

4) JICA Malaysia Office

Mr. Hitoshi Ara	Assistant Resident Representative, JICA Malaysia Office

(2) Malaysian Side

1) MHLG

Mr. Dato' Mohamad Bin Saib	Director General, Local Government Dept. MHLG
Ir. Fong Tian Yong	Deputy Director General, Local Government Dept. MHLG
Mr. Abdul Halim Bin Abdul Hamid	Director, Technical Division, Local Government Dept. MHLG (move to MOH in 2004)
Mr. Huszian Bin Husin	Director, Environmental Health Engineering Division, MHLG
Y.M. Engku Azman Tuan Mat	Director/ PIU, Local Government Dept. MHLG
Ms. Zainah Bt Hj. Mohamed	Director of Policy Planning & Development Div.

	MHLG
Mr. Mohd Nazeri Bin Salleh	Chief Assistant Director/ PIU, Local Government Dept. MHLG
Mr. Ismail Bin Hassan	Chief Assistant Director, Local Government Dept. MHLG
Mr. Koh Chee Yong	Assistant Director, Technical Div., Local Government Dept., MHLG (move to SWM Sdn. Bhd. in 2004)
Mr. Mohd Zaki Bin Othman	Technical Division, Environmental Health Engineering Division, MHLG
Cik. Raihani Bte Che Mamat	Technical Division, Environmental Health Engineering Division, MHLG
2) EPU	
En. Dziauddin Bin Mohamed	Principal Assistant Director, Social Service Section, Economic Planning Unit
Cik Salwani Ismail	Assistant Director, Social Service Section, Economic Planning Unit
Mr. Ooi Gin Hoay	Technical Service Section, Economic Planning Unit
Mr. Mohd Hadzin Bin Ahmad	Assistant Director, Technical Service Section, Economic Planning Unit
En. Mohd Radzi Abd Hamid	Technical Service Section, Economic Planning Unit
3) MOH	
En. Mohd Azizi Bin Ibrahim	Principal Assistant Director, Engineering Services Division, MOH
En. Norhafizan Bin Daud	Assistant Director, Engineering Services Division, MOH
En. Dzulkifli Bin Mohamad	Engineering Services Division, Ministry of Health
4) DOE	
Ms. Nor Aziah Bt. Jaafar	Environmental Control Officer, DOE
En. Abd. Aziz Abd Rasol	DOE
5) MOF	
Cik. Fadzillah Bte Mohd Saaid	Principal Assistant Secretary, MOF(Inc) Companies, Privatisation and Public Enterprise Division, Ministry of Finance
6) UPM	
Prof. Madya Dr. Mohd Nasir Bin Hassan	Faculty of Environment, University Putra Malaysia
Mr. Theng Lee Chong	University of Putra Malaysia
7) LAs	
Dr. Hj Romli Hj Amin	Majlis Perbandaran Seberang Perai
En. Abd. Wahab Bin Jaafar	Majlis Perbandaran Seberang Perai
Mr. M.Raju	Majlis Perbandaran Seberang Perai
Tuan Haji Arshad Bin Salleh	Majlis Perbandaran Kajang
Puan Cheam Shiew Kan	Majlis Daerah Pekan
En. Mohd Nor Hashim	Setiausaha, Majlis Daerah Pekan
Mr. Mohd Zainuddin B. Idris	Kuantan Municipal Council

CHAPTER 2 OUTLINE OF SOLID WASTE MANAGEMENT IN MALAYSIA

2.1 REVIEW OF EXISTING LEGISLATION

With the exception of the Environmental Quality Act (EQA), there is at present, no Federal Legislation that deals with any aspect of Solid Waste Management (SWM). Consistent with the current constitutional position whereby State Governments appear to have jurisdiction over SWM, management of solid waste is covered by several State laws.

2.1.1 Local Government Act, 1976 (LGA)

In essence municipal administration is about providing essential services to the public and in return, the public pay rates to fund the activities of the authorities. The provision of such services and the collection of rates are governed by various laws. The principal legislation is the Local Government Act, 1976 (LGA), and applies throughout the Peninsular Malaysia. It provides for the formation of Local Authorities and governs their administration, operations, areas of control and regulation and financing. It also allows detailed regulations to be enacted by the Local Authorities to regulate specific matters such as to establish, maintain and compel the use of services set up for solid waste removal and public cleansing.

2.1.2 Street, Drainage and Building Act, 1974 (SDBA)

The carrying out of any works for streets, buildings or drains is controlled under the Street, Drainage and Building Act, 1974 (SDBA). The SDBA provides power to Local Authorities to effect control on the deposition of any refuse, wastes or unwanted material onto any street, building or drains.

2.1.3 Environmental Quality Act, 1974 (EQA)

The EQA, a Federal law, is the principal legislation pertaining to environmental protection. Various sections of the EQA provide controls over air, water, soil and noise pollution. In addition the DOE has issued a Guideline for the disposal of solid waste on land namely the "Recommended Code of Practice for the Disposal of Solid Waste on Land".

2.2 INSTITUTIONAL STRUCTURE FOR SWM

2.2.1 Introduction

The present management of solid waste may appropriately be divided according to the major players involved at various levels and their degree of involvement. The major players are the Federal, State and Local Authorities and the private/commercial operators.

At the operating level there would be numerous stakeholders. This would include the concessionaires or privatised main service providers (i.e. Alam Flora Sdn Bhd, Southern Waste Management Sdn Bhd and Environment Idaman Sdn Bhd), subcontractors, transport operators, disposal and or landfill site operators, recycling vendors, equipment and chemical manufacturers, R&D institutions, industry association etc.

2.2.2 Federal Government Agencies

(1) Ministry of Housing and Local Government (MHLG)

The MHLG is responsible for the development of national policies related to Local Government. It plays a coordinating role pertaining to the development, financing and operations of Local Authorities. All Local Authority applications for Federal Government financial and development assistance are channelled through the Ministry for consideration before it is forwarded to the central agencies for approval.

The Department of Local Government, within the MHLG, has been active in developing uniform standards, by-laws and guidelines for use by Local Authorities. The Ministry is also the Secretariat for the National Council for Local Government, which is the supreme body for the coordination of all policies and laws related to Local Authorities.

The Town and Country Planning Department, under the MHLG, is responsible for the implementation of the Town and Country Planning Act 1976 (TCPA) and it advises State Governments with regards to land use and physical planning. The Department is responsible for the preparation of detailed plans for urban development and the allocation of land for various purposes. Such detailed plans include the identification and allocation of sites for the treatment and disposal of solid wastes.

(2) Economic Planning Unit, Prime Minister's Department

The Economic Planning Unit (EPU) is charged with charting the economic development of the nation. National development plans are produced by the EPU every five years and this will include matters pertaining to SWM. Financial allocations for development projects are largely determined in accordance with the five year plans. The EPU is also responsible for privatisation programmes. Major capital investment in solid waste management facilities such as incinerators or sanitary landfills, particularly where it involves federal funding, would generally require the approval of the EPU.

(3) Ministry of Finance

The Ministry of Finance is the approving agency for all budgetary and financial allocations to government agencies. Annual allocations are approved by this Ministry. Allocations of grants or loans to Local Authorities would require the approval of this Ministry.

(4) Ministry of Natural Resources and Environment - Department of Environment

The Department of Environment (DOE) is charged with the responsibility for the prevention, control and regulation of environmental pollution. It is the main implementing agency for the EQA. In relation to wastes management, the DOE's emphasis is on the control and regulation of scheduled wastes, while control the management of non-scheduled solid wastes rests with the Local Authorities. The DOE has issued the Guidelines on the Code of Practice for the Disposal of Solid Waste on Land. This Code and the other existing regulations provide advice to the Local Authorities on the development, sitting and operation of landfills and incinerators.

(5) Ministry of Health – Engineering Services Division

The Ministry of Health (MOH) is responsible for public health in the country. Its role in SWM is confined to ensuring that solid wastes are disposed off in a hygienic way in areas where no Local Authority has jurisdiction. Such areas are largely rural areas.

2.2.3 State Government and Local Authorities

City Councils (Majlis Bandaraya) are established for those large urban areas which have been conferred city status (generally an area having a very large population). Municipal Councils (Majlis Perbandaran) are established for areas with more than

(100,000) population. District Councils (Majlis Daerah) are administered by District Officers who are also in charge of the overall administration of the district.

2.2.4 National Councils

The National Councils are national level sectorial councils which report directly to the Federal Ministerial Cabinet and advise the Federal and State Governments on sectorial policies and guidelines. Presently, the Councils that have relevance for solid waste management including National Land Council, National Council for Local Government; and Environmental Quality Council

2.2.5 Non-Government Stakeholders

There are several groups in the private sector that are stakeholders in solid waste management. They include the following:

(1) Solid Waste Concessionaires

These are the companies that were awarded the concession based on a regional basis, i.e.Alam Flora Sdn Bhd, Southern Waste Management Sdn Bhd and Environment Idaman Sdn Bhd

(2) Solid Waste Contractors

These are the companies that were given contracts for solid waste collection services in the concessions areas in the Local Authority areas where solid waste services have not been taken over.

(3) Solid Waste Recyclers

These are the companies that utilize recyclables in their manufacturing process. The main recyclables used are paper, plastic, glass and aluminium cans.

2.2.6 Research Institutions and Universities

The stakeholders from research institutions and universities provide an important link by carrying out studies related to solid waste and provide technical expertise to assist the government in assessing waste management technologies.

2.3 PRIORITY PLANS ON SWM AND PRIVATISATION

2.3.1 Priority Plans on SWM

Priority plans showing the government development policy related to the solid waste management in Malaysia are the "*Eighth Malaysian Plan (EMP), 2001-2005*" and the "*National Strategic Plan for Solid Waste Management (NSP), 2003*".

(1) Eighth Malaysian Plan 2001-2005 (EMP)

The Eight Malaysian Plan (EMP) is placed as the first phase in implementation of the Third Outline Perspective Plan for 2001-2010 (OPP3) which will chart the development of the nation in the first decade of the 21st century.

The EMP does not specifically mention about the SWM sector, however, it is described with relationship to the privatisation of the SWM.

(2) National Strategic Plan for Solid Waste Management (NSP)

National Strategic Plan for Solid Waste Management (NSP) has been prepared by the Local Government Department of the Ministry of Housing and Local Government in 2003. The status of the NSP is still confidential; therefore, details are not yet ready for release to the public. However, it should be noted that one of the main issues for the safe closure of landfill sites are "who will be responsible for this matter (institutional set up)" and "who will pay for the measures (fund resources)". From this point of view, adjustment with the NSP is considered to be substantial for the preparation of landfill safe closure guideline.

2.3.2 Privatisation of SWM

(1) Privatisation Practice on SWM

Privatisation of SWM sector in Malaysia is still in a transition period. In order to introduce the full privatisation in Malaysia, the NSP was prepared.

Under the privatisation, Malaysia has been divided into four regions as follows, and four consortia were selected for each region.

- Central region: Selengor, Pahang, Terengganu and Kelantan States, and FTKL
- Northern region: Kedah, Penang, Perak and Perlis States
- Southern region: Johor, Melaka and Negeri Sembilan States
- East Malaysia: Sabah and Sarawak state and FT Labuan

(2) Contracted-out Landfill Site Operation

In Malaysia, at present there is no privately owned landfill site and all the landfill sites are either owned by the State Government or by the Local Authorities. However, in recent years, several landfill sites in the Peninsular Malaysia have now being operated by the State or LA appointed private companies.

Under the interim agreements, Alam Flora Sdn Bhd took over the operations of 20 landfill sites (1 in Kuala Lumpur, 5 in Selangor and 14 in Pahang) from the Local Authorities. In Pahang, all the landfill sites are operated by Alam Flora.

The Southern Waste Management Sdn Bhd operates only two (2) landfill sites (Ulu Tiram and Krubong) of the 18 landfills recently operated in the State of Johor.

2.4 WASTE AMOUNT AND COMPOSITION

2.4.1 Waste Amount Generated

Table 2.4.1 shows the latest waste generation rate data as published by MHLG in 2002.

For example, in Kuala Lumpur, the unit generation rate of waste is about 1.87 kg/capita/day as compared with the national average of 0.88 kg/capita/day.

The amount of waste generated in Malaysia is estimated to be about 19,800 ton/day. The amount of waste disposed of at various landfill sites distributed across Malaysia is estimated to be about 13,500 ton/day.

Table 2.4.1 Estimated Solid Waste Generated in Malaysia

No	States	Estimated Population (2002)	Unit Generation Rate (kg/cap/day)	Waste generation amount (ton/day)	Waste generation amount (ton/year)
1	Johor	2,366,934	0.88	2,083	760,260
2	Melaka	636,007	0.88	560	204,290
3	N. Sembilan	935,683	0.88	823	300,540
4	Selangor	3,493,602	0 88	3,074	1,122,140
5	Pahang	1,183,004	0.88	1,041	379,980
6	Terengganu	1,091,007	0.88	960	350,430
7	Kelantan	1,278,368	0.88	1,125	410,610
8	Perak	1,887,527	0 88	1,661	606,270
9	Kedah	1,636,095	0.88	1,441	525,790
10	P Pinang	1,344,243	0.88	1,183	431,770
11	Perlis	241,644	0.88	213	77,620

12	Sarawak	2,007,528	0.70	1,405	512,920
13	Sabah	2,115,546	0.70	1,481	540,520
14	FTKL	1,470,875	1.87	2,751	1,003,950
Total		21,688,063	0.91	19,801	7,227,090

Note: Data for Peninsular Malaysia is taken from publications by Ministry of Housing and Local Government, Malaysia, 2002 Data for Sarawak and Sabah is taken from "NREB and DANCED, 2001"

2.4.2 Waste Composition and Characteristics

Statistics gathered by the Government indicated the average amount of organic wastes for high income areas like Petaling Jaya and Kuala Lumpur is around 48.32%. This is followed by paper (23.56%), plastic and rubber (9.37%), metal (5.93%), wood (4.82%), glass and ceramics (4.03%) and textile (3.97%) [1].The average bulk density of residential waste is about 287.5 kg/m^3 and the average moisture content is about 56.2%.

2.5 LANDFILL SITES IN MALAYSIA

2.5.1 Existing Landfill Sites in Malaysia

Approximately 170 landfill sites are in operations and about 60 landfill sites have been closed. The list of existing/operating landfill sites as prepared by MHLG is summarised in **Table 2.5.1**.

Table 2.5.1 Existing Landfill Sites in Malaysia

No	States	Number of landfill	Average area(ha)	Waste received (ton/day)	Landfill level				
					Level 0	Level 1	Level 2	Level 3	Level 4
1	Johor	18	5 6	1,082	10	6	2	1	0
2	Melaka	4	18.5	1,065	2	0	1	1	0
3	N Sembilan	11	10.9	727	7	3	1	0	0
4	Selangor	14	10.6	2,285	0	7	1	1	5
5	Pahang	14	8.7	895	5	3	2	3	1
6	Terengganu	8	5.6	707	2	4	1	0	1
7	Kelantan	12	5.6	424	10	1	1	0	0
8	Perak	19	10.3	1,450	9	6	3	1	0
9	Kedah	10	7.7	893	3	2	4	0	1
10	P. Pinang	2	22.3	1,400	0	0	1	1	0
11	Perlis	1	4.0	100	0	0	0	0	1
12	Sarawak	36	2.9	1,000	20	14	2	0	0
13	Sabah	20	21 7	851	15	4	1	0	0
14	KL	1	12.0	600	0	0	1	0	0
15	Labuan	1	12 1	12	0	1	0	0	0

[1] Project Formulation Study for Promotion of Solid Waste Recycling in Malaysia by JICA, 2002

	Total	171	91	13,491	83 48%	51 30%	21 12%	8 5%	9 5%

Notes: Level 0: Open dumping; Level 1: Controlled tipping; Level 2: Controlled landfill with bund and daily cover soil; Level 3 Sanitary landfill with leachate recirculation system; Level 4: Sanitary landfill with leachate treatment system

Source: MHLG, 2001

2.5.2 Closed Landfill Sites in Malaysia

The list of closed landfill sites as prepared by MHLG is summarised in **Table 2.5.2**.

Table 2.5.2 Closed Landfill Sites in Malaysia

No	States	Number of closed landfill site	Average operation period (years)	Operation start year			Landfill closed year		
				1970'	1980'	1990'	- 1994	1995-1999	2000 -
1	Johor	7	7	2	2	3	0	4	3
2	Melaka	4	20	2	2	0	1	0	3
3	N. Sembilan	1	n a.	0	1	0	n.a.	n.a.	n.a.
4	Selangor	9	8	0	4	5	1	7	1
5	Pahang	9	8	0	2	7	0	1	8
6	Terengganu	7	13	1	3	3	2	4	1
7	Kelantan	5	12	0	3	2	0	2	3
8	Perak	4	9	1	1	2	1	2	1
9	Kedah	5	8	3	1	1	3	0	2
10	P. Pinang	0	--	--	--	--	--	--	--
11	Perlis	0	--	--	--	--	--	--	--
12	Sarawak	5	12	1	4	0	1	2	2
13	Sabah	5	13	2	2	1	3	1	1
Total		59	9.3	12 20%	25 41%	24 39%	12 20%	23 39%	24 41%

Source: MHLG, 2001

2.5.3 Existing Landfill Sites in Peninsula Malaysia by NSP

The list of landfills prepared through the *National Strategic Plan for Solid Waste Management in Malaysia (NSP)* is shown in **Table 2.5.3**.

Table 2.5.3 Existing Landfill Sites in Peninsular Malaysia

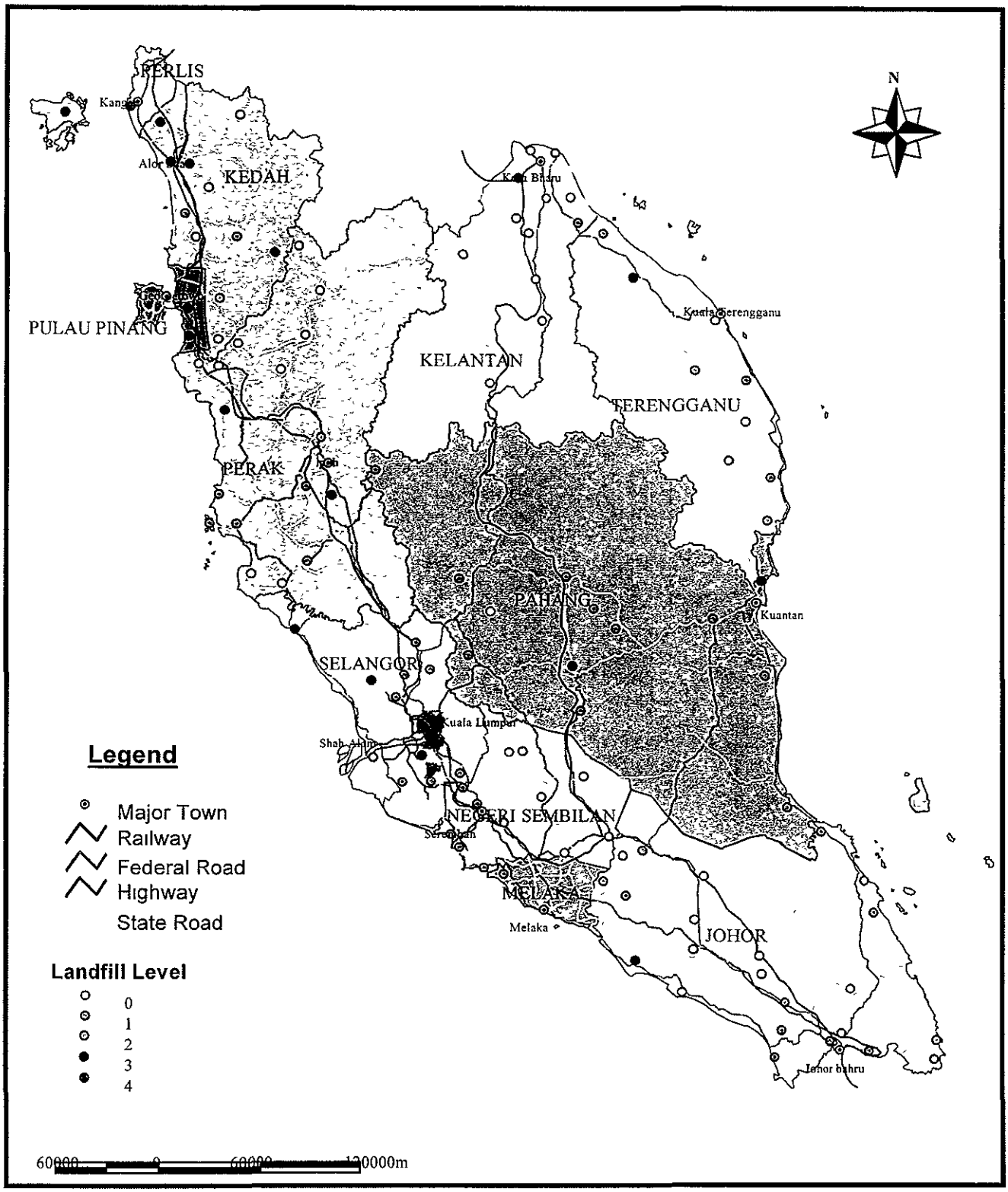
No	States	No of landfill	Landfill level					Lifespan of landfills (years)				
			Level 0	Level 1	Level 2	Level 3	Level 4	0-5	6-10	11-15	16-20	> 20
1	Johor	24	11	8	4	1	0	11	5	5	1	1
2	Melaka	3	2	0	1	0	0	2	1	0	0	0
3	N. Sembilan	10	6	3	1	0	0	2	3	0	2	3
4	Selangor	11	0	7	1	1	2	5	0	1	4	1

5	Pahang	14	5	3	2	3	1	8	2	1	0	1
6	Terengganu	8	2	4	1	0	1	2	3	1	0	2
7	Kelantan	12	10	1	1	0	0	5	4	1	0	1
8	Perak	18	9	5	2	1	1	12	2	0	1	1
9	Kedah	9	3	2	3	0	1	1	3	2	1	1
10	P Pinang	2	0	0	1	1	0	0	0	0	1	1
11	Perlis	1	0	0	0	0	1	0	0	1	0	0
Total		112 (105)	48 43%	33 30%	17 15%	7 6%	7 6%	48 46%	23 22%	12 11%	10 10%	12 11%

Note: These data were obtained through questionnaire survey. Only 90% Local Authorities have responded at the date of compilation

Source: MHLG, 2003

The location and the level of the landfill sites in the Peninsular Malaysia as prepared by the *National Strategic Plan for Solid Waste Management in Malaysia in 2003* is shown in **Figure 2.5.1**.



Source: MHLG, 2003

Figure 2.5.1 Location and Level of Landfill Sites in Peninsular Malaysia

CHAPTER 3 ISSUES OF SAFE CLOSURE OF LANDFILL SITES

As a result of baseline survey in the first stage of the Study, the following issues caused by the landfill sites were observed. They include institutional and financial aspects as well as environmental and technical aspects. It was confirmed that guideline which provides regulations and action plans should be formulated, and landfill safe closure should be implemented in line with them in order to overcome the issues and implement appropriate measures for landfill safe closure. The guideline for safe closure and action plan are shown in **Chapter 4** and **Chapter 5** respectively. Outline of the pilot projects, which are implemented in order to verify the technical requirments to be regulated in the guideline for safe closure, is shown in **Chapter 6**.

3.1 FINDINGS AND ISSUES OF LANDFILL SITES IN MALAYSIA

Approximately 170 landfill sites are in operations and about 60 landfill sites have been closed.

The followings are a summary of the findings and issues of the landfill sites in Malaysia.

- Of the 171 landfill sites, 48% of them (83 sites) are operated as so called "open dumping" grounds.
- Measures for the collection and treatment of leachate have not been addressed for 90% (155 sites) of the existing landfill sites.
- During the last 10 years, about 50 landfill sites (or about 80% of the total number of closed sites) were closed without consideration for safe closure or any environmental countermeasures.
- It is reported that about 43% of the existing landfill sites will exceed their capacity soon and shall be closed within the next 5 years.
- Based on the *National Strategic Plan for Solid Waste Management*, landfill sites in Peninsular Malaysia shall be rationalised. Therefore, most of existing landfill sites shall be replaced or closed in the near future.
- There is no guideline published by MHLG officially on the planning, design and operation, and safe closure of landfill sites. Most Local Authorities applied their own procedures and techniques and thus resulted in poorly operated and managed landfill sites.

- The financial capability of Local Authorities for landfill construction and operation is very limited; therefore, majority of the landfill sites operated by the Local Authority are in rather poor conditions. Similarly, landfill closures were not carried out properly.

3.2 POST CLOSURE LAND-USE PRACTICES AND ISSUES

During the survey, it was noted that several closed landfill sites and areas adjacent to operating landfill sites have been redeveloped as residential areas. With such developments around the sites, it seemed that consideration on the risk of hazard and environmental pollution caused by the closed landfill sites are not appreciated; i.e. the hazards caused by gas explosion/migration, landslide, landfill fire, health problem etc.

It is imperative that these issues should be highlighted to the Local Authorities and to the developers on the risks of redevelopment of the closed landfill sites.

3.3 ISSUES ON THE NUMBER OF LANDFILL SITES IN MALAYSIA

Based on the landfill inventory survey carried out by the JICA Study in March 2003, it was discovered that amongst the 64 landfill sites visited by the JICA team, 29 sites (about 45%, 9 operating and 20 closed sites) were not registered in the official MHLG list of landfill sites. The sites that were not recorded in the MHLG list are tabulated in **Table 3.3.1**.

It is recommended that MHLG should continue the inventory survey to cover the other sites in Malaysia presently not covered by the Study.

Table 3.3.1 Landfill Site List Not Recorded in MHLG List (as of 2003)

No	State	Local Authority	Name of Landfill	Status	JICA Inventory No.
1	N.Sembilan	MP Nilai	Kuala Sawah	closed	NS-02
2	N.Sembilan	MP Port Dickson	Quarters MPPD	closed	NS-04
3	N.Sembilan	MP Port Dickson	Pengkalan Kempas	closed	NS-06
4	N.Sembilan	MP Port Dickson	Sua Betong	operation	NS-07
5	Melaka	MB Melaka	Krubong A	closed	ML-04
6	Melaka	MB Melaka	Kota Laksamana	closed	ML-05
7	Johor	MP JB Tengah	Kempas	closed	JH-05
8	Johor	MD Kota Tinggi	Batu Empat	operation	JH-07
9	Johor	MD Kota Tinggi	Sungai Rengit	operation	JH-08
10	Johor	MD Kota Tinggi	Bandar Kota Tinggi	closed	JH-09

11	Pahang	MP Kuantan	Taman Bandar	closed	PH-03
12	Pahang	MP Kuantan	Gambang	closed	PH-04
13	Pahang	MP Kuantan	Indera Mahkota	closed	PH-05
14	Terengganu	MP Kemaman	Fikri	closed	TR-01
15	Terengganu	MP Kemaman	Gelugor	closed	TR-02
16	Terengganu	MP Kemaman	Gelugor	operation	TR-03
17	Terengganu	MP K.Terengganu	Wakaf Tok Keh	closed	TR-06
18	Kelantan	MP Kota Baru	Panji	closed	KL-01
19	Kelantan	MP Kota Baru	Tebing Tinggi	operation	KL-02
20	Kelantan	MD K.Krai Selatan	Sungai Sam	closed	KL-03
21	Kelantan	MD K.Krai Selatan	Bukit Tembeling	operation	KL-04
22	Perak	MD Kinta Selatan	Kg. Batu Putih (Kg. Tersusun)	closed	PR-02
23	Perak	MD Kinta Selatan	Taman Sri Kampar	closed	PR-03
24	Perak	MB Ipoh	Buntong	closed	PR-05
25	Perak	MB Taiping	Jebong	operation	PR-06
26	Perak	MB Taiping	Tekkah Jaya	closed	PR-07
27	Perak	MD Tapah	Pekan Getah	operation	PR-08
28	Kedah	MD Baling	Pulai	operation	KD-02
29	Kedah	MD Baling	Kuala Pegang	closed	KD-03

3.4 ENVIRONMENTAL ISSUES OF LANDFILL SITES

3.4.1 Surface Water

During the site visits in March, 2003, conducted by members of the JICA Study team, it was learned that approximately 16 sites, or 10%, of the landfill sites surveyed are located upstream of the water intake points to the drinking water treatment facilities. These posses a potential risk to the drinking water system and contamination of the water supply.

3.4.2 Groundwater

Majority of the landfill sites do not have any countermeasures for groundwater protection such as bottom liners and installation of monitoring wells. Proper integration of groundwater protection measure for the landfill site construction, operation, and closure should be looked into urgently and is highly recommended.

3.4.3 Sanitary Condition (Vector and Odour)

The Local Authorities have received large numbers of complaints from the residents and surrounding communities around the landfill sites regarding the unpleasant odour, fly infestation and large packs of stray dogs around the site.

3.4.4 Land Subsidence and Landfill Gas

There are large numbers of closed landfill sites that have been used for housing development. If the landfill closure has not been carried out properly there is the possibility of uneven land settlement and subsidence. The land subsidence may result in damages to the buildings and structures. The built up of landfill gas could also pose a hazard and may cause explosions.

3.4.5 Landslide/Collapse and Fire

It was observed that a number of landfill site have waste piled very high and with very steep slopes. With the heavy rainfalls and the absence of embankment in most sites, landslides and slope collapses are very likely to occur. Any fire at the sites will produce thick hazardous smoke and releases dioxin and toxic gases into the atmosphere.

3.4.6 Effects to Natural Drainage System

When a landfill is located on a swampy area, it may affect the natural flow of the drainage and surface water flow. This may lead to the destruction of existing plant life and vegetation, and also affects the natural eco-system of the area.

3.4.7 Necessity for Monitoring

To evaluate and manage the environmental effects and impacts caused by the landfill site, systematic monitoring of the leachate, surface water, groundwater, landfill gas and other ambient environment should be carried out. At present, majority of the landfill sites do not have any monitoring plan and it is highly recommended that such plan should be implemented in the near future.

3.4.8 Environmental Liabilities - Necessity for Good Record Keeping

From the site visits, it was noted that a number of closed landfill sites have been transferred to private ownership. There were no records outlining the exact boundary and the characteristic of the sites.

Precise record of the landfill history and condition should be readily available and information shared.

3.5 RISKS OF REDEVELOPMENT OF THE CLOSED LANDFILL SITES

For the post-closure re-utilisation of the closed landfill site, safety and environmental issues should be considered and counter-measures should be formulated, such issues of concerned are as follows:

- Risk of landslide or collapse of filled layer due to new ground loading imposed by the development plan.
- Damage to the infrastructure or sanitation lifelines caused by the subsidence.
- Discharge of leachate into the surrounding ground caused by the development.
- Risk of explosion or fire from landfill gas.
- Significant damage to plant life on the site and surroundings, by the landfill gas or soil contamination
- Risk of unintentional chemical reaction of substances that may be introduces into the site as a result of the development works or the preventive measures works.
- Diversion and prevention of gas migration and rainwater seepage that may be caused by the new land cover put in by the development.

The post closure land use should comply with regulations related to both the solid waste management regulations and the housing & building regulations.

3.6 LEGISLATION, INSTITUTIONAL AND FINANCIAL ISSUES

3.6.1 *Legislation Issues*

Almost all the landfill sites in Peninsular Malaysia are operated below the Level 2 standard. Of these, about 48% are just open dumping sites. One of the main factors that contributed to such poor landfill conditions is the lack of official legislation and control on the "landfills".

3.6.2 Institutional and Financial Issues

The safe closure and rehabilitation of landfill sites have not been implemented properly in Malaysia. One of the main issues for the lack of interest in implementing the safe closure and rehabilitation of landfill sites is solely due to insufficient funds. Without sufficient funds, the Local Authorities are unable to set aside the necessary resources to carry out the operations and maintenance or close the landfills properly.

CHAPTER 4 GUIDELINE FOR SAFE CLOSURE AND REHABILITATION OF MSW LANDFILL SITES

4.1 INTRODUCTION

The Guideline is divided into two sections, viz. Section I and Section II. Section I addresses the issues with regards to the general procedures for safe closure, and the legislation, institutional and financial aspects. Section II explains the technical requirements in more details.

The Guideline recommends that for all landfills that accept municipal solid waste, including abandoned sites, where waste-filling work has been completed should be closed properly for the safe storage of the wastes and to prevent pollution to the surrounding environment. The "Safe closure plan" should be formulated to include the physical closure (PC) and the post-closure management (PCM) activities. The safe closure plan should be prepared based on the priority and the closure level of the landfill site.

The closure-levels are classified into 4 categories as follows. The schematic diagrams representing each of the landfill closure levels are shown in **Figure 4.1.1**.

Level C1: Minimal closure level

Level C2: Low closure level

Level C3: Middle closure level

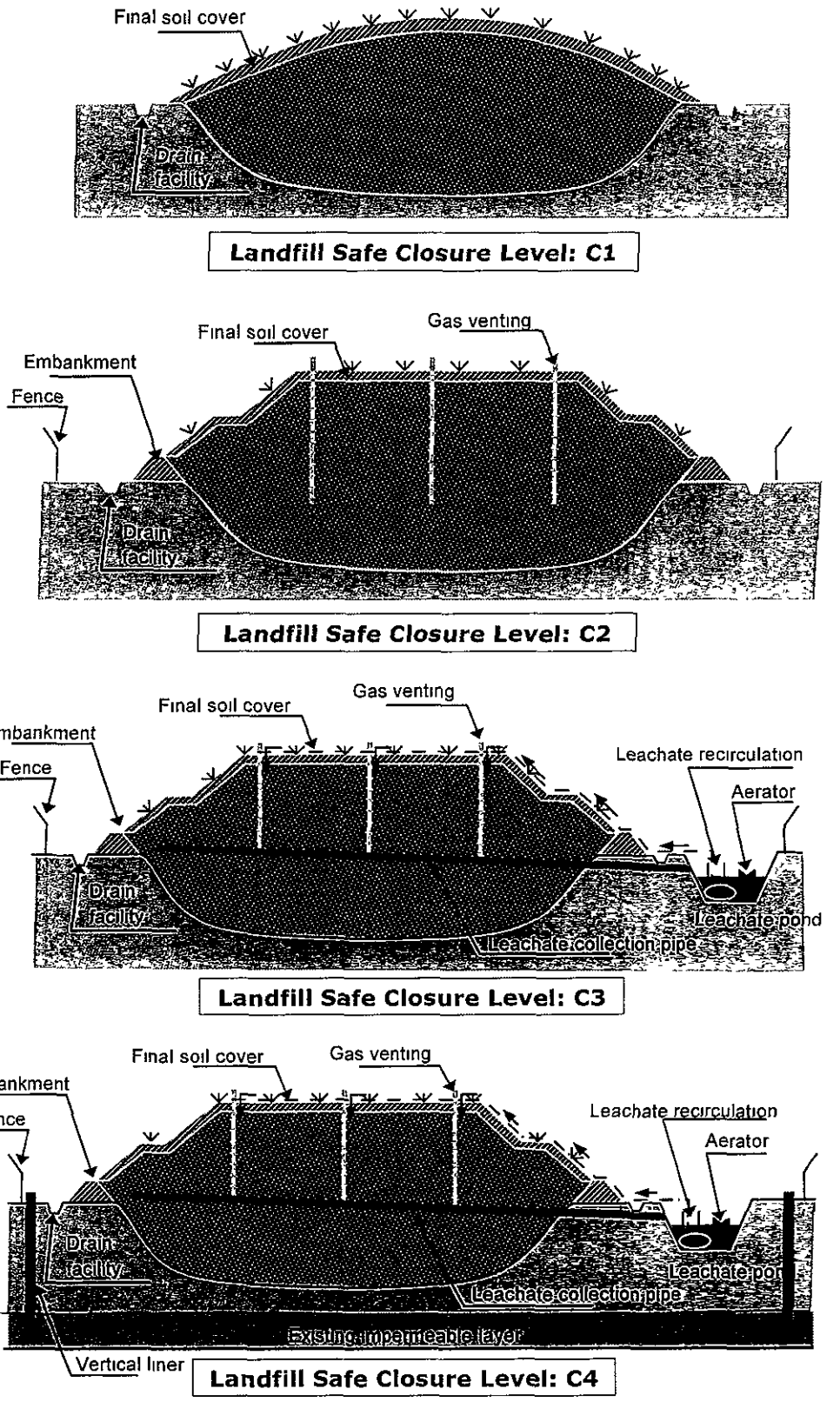
Level C4: High closure level

The technical requirements included such activities as the installation of the necessary facilities, i.e. the leachate treatment facility; the provision of adequate protection, i.e. top covering; and the environmental monitoring activities and schedule. The PCM (operation and maintenance of the landfill facilities and monitoring) will have to be continued even after the new land use has been implemented for the closed landfill site.

The "Post-closure Land Use" is also addressed and it recommends that all future post-closure land use of closed landfill sites should be carefully considered based on the clear understanding of the landfill during its term of operation and closure as well as the impacts it has had on the surroundings. The proposed land use should not endanger the lives of the public and the users.

The Guideline also addressed the necessity of setting up the relevant advisory and regulatory bodies at both the Federal Government and the State Government. All these are to ensure the necessary legislations are in place, and to streamline the inter-departmental or cross-ministerial bureaucracy by the dissemination and mutual understanding of the procedures as set out in the guideline. Another key issue that is addressed in the Guideline relates to the financial resources and funding structure. The Guideline recommends that a strategic funding system be set up at the Federal Governmental level to cater for the implementation of the sustainable landfill safe closure. The Federal Government will then manage the Fund and apportion the funds accordingly upon the requests from the State Governments and by taking into account of the landfill closure priorities.

This chapter described the main part of the Guideline (Part I and Part II), and the complete Guideline including Appendices is described in further details in Volume 3 of the Final Report.



Note For C3 & C4, aerobic area of existing landfill site will be expanded by safe closure measures.

Figure 4.1.1 Schematic Diagram of Landfill Safe Closure Level