

## 3 SWM Master Plan

### 3.1 Master Plan

#### 3.1.1 Goal

As mentioned in Chapter 2, the current SWM system in the municipality of Phnom Penh is so weak that it is placing an extreme burden on the urban environment and civil life. The situation is very serious.

The fundamental goal of the M/P for SWM in MPP is:

**“To establish a sustainable SWM system in MPP by the target year 2015”.**

The establishment of such a system will:

- Maintain the urban environment and public health of MPP, which is the center of economic and industrial activities of Cambodia and has 8.7% of national population (1998 census), and contribute to the sound development of urban life.
- Motivate foreign investment whereby the economic development of Cambodia will be promoted.

In the sustainable SWM system, the following situation should be established.

- Waste reduction is encouraged at the generation source such as households and offices.
- Waste generated after the attempt of waste reduction is reused or recycled as much as possible.
- Only after the effort of waste reduction, reuse or recycling, waste is properly collected, treated, and finally disposed of in a proper manner without negative environmental impacts.
- Such a SWM system will be established by requiring the governmental sector, private sector and general public to bear adequate responsibilities under a transparent and fair rule.

The specific approaches to achieving the goal are summarized as follows.

#### 3.1.2 Target year

The target year of the M/P is 2015. In order to achieve the goal of the M/P step by step, the planning period is divided into the following three phases:

**1<sup>st</sup> Phase :                      2005 to 2007 (urgent improvement)<sup>1</sup>**

To develop the new disposal site as SMCDS is improved. A waste collection system under public and private partnership is established.

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<sup>1</sup> Since the proposed 6.0 ha of expansion area was changed to 3.6ha the capacity of the SMCDS was reduced almost for one year operation. Therefore, the inaugural year of the urgent improvement is hastened from 2008 to 2007.

- 2<sup>nd</sup> Phase :**                      **2008 to 2012 (short term improvement)**  
The new disposal site and waste collection system established in Phase 1 are operated properly.
- 3<sup>rd</sup> Phase :**                      **2013 to 2015 (middle term improvement)**  
The target of the Master Plan is achieved and the preparation works for the next plan targeting a higher grade of management will be started.

## 3.2 Planning Framework for the Master Plan

### 3.2.1 Population Forecast

It was confirmed that the future population forecasted in the “Study on Transport Master Plan in Phnom Penh: Nov. 2001 JICA” was adopted for this study in the discussion for the Interim Report held on the 23<sup>rd</sup> of September, 2003. The population in 2015 is forecasted as 1.7 million, which is about 200 thousand less than the population projected by the National Institute of Statistics (NIS). Because this difference is so big, the Study team studied the impact on the disposal plan based on the population forecasted by the NIS.

Table 3-1: Population Forecast

Khan	2003	2007	2012	2015
1. Chamkar Mon	208,750	227,664	246,777	253,935
2. Daun Penh	137,186	141,744	146,320	148,028
3. Prampir Makakra	104,013	110,815	117,681	120,253
4. Toul Kork	178,373	199,115	220,109	227,941
<b>Urban area</b>	<b>628,322</b>	<b>679,338</b>	<b>730,887</b>	<b>750,157</b>
5. Dang Kor	114,333	126,904	161,871	208,136
6. Mean Chey	210,027	258,336	307,295	325,489
7. Russei Keo	246,732	307,403	381,379	418,384
<b>Rural area</b>	<b>571,092</b>	<b>692,643</b>	<b>850,545</b>	<b>952,009</b>
<b>Whole Phnom Penh</b>	<b>1,199,414</b>	<b>1,371,981</b>	<b>1,581,432</b>	<b>1,702,166</b>

### 3.2.2 Economic Framework

The study team used the economic growth and inflation rate given in the 5-Year Economic Development Plan for the economic framework until 2005 and estimated it for after 2006 based on “Enhancing Governance for Sustainable Development” 2000, by ADB.

There were two kinds of expectancy in the ADB report; one was predicted with a Non-Reform Scenario and the other was with a Reform Scenario. The study team adopted the predicted value with the reform scenario to take priority avoiding any harmful effects, such as a change for the worse of environmental sanitation due to a delay in development of the new disposal site and/or collection system, caused by a low estimate. The Cambodian government was promoting administrative reform basically in line with the Reform scenario..

Table 3-2: Economic Indicator in the Study Area

	2003	2004	2005	2005-2010	2010-2015
Economic Growth Rate (%/year)	6.0	6.5	7.0	8.4	6.8
Inflation Rate (%/year)	3.7	3.7	3.7	3.4	3.5

### 3.2.3 Forecast of Future Waste Amount and Composition

#### a. Waste discharge amount forecast

The Study team forecasted the waste generation rate based on the assumption that it will increase in proportion to the growth of GDP per capita. The Japanese statistics, which were recorded from 1963 to 1988 and are the only available data of its kind in the world as far as the Study team investigated, show the trend of the rate due to the development of the economy. In consideration of the efforts to be made on the 3Rs, the Study team adopted 50% of the growth rates from 1963 to 1970, which was a period of high economic growth without any measures for waste reduction, etc.

Based on the above figure, the team concluded the increase in waste discharge per capita per year is as follows:

2003-2005 :	1.7 - 2.0%/year
2006-2010 :	2.3%/year
2013-2015 :	1.9%/year

However, the increase in the waste discharge ratio per year as shown above will not apply to public cleansing services such as street sweeping and cleaning parks but their amount will be implicitly increased in accordance with the growth of population, expansion of the city, etc.

On the other hand, the number of generation sources are forecasted based on the assumption that it will increase in proportion to the growth rate of GDP.

Table 3-3: Forecasted Waste Generation Ratio

Generation source		Unit	2003	2007	2012	2015
Household		g/person/day	487	529	588	622
Commercial	Restaurant	g/table/day	1,664	1,807	2,020	2,127
	Other shop	g/shop/day	4,502	4,889	5,438	5,754
Market		g/stall/day	1,823	1,980	2,202	2,330
School		g/student/day	20	22	24	26
Street sweeping		g/km/day	53,373	53,373	53,373	53,373
Hotel		g/room/day	231	251	279	295
Office		g/office/day	3,560	3,866	4,300	4,550

Table 3-4: Forecasted Number of Waste Discharge Sources

Generation source		Unit	2003	2007	2012	2015
Household	Urban area	Person	623,322	679,338	730,887	750,157
	Rural area		571,092	692,643	850,545	952,009
	Whole area		1,199,414	1,371,981	1,581,432	1,702,166
Commercial	Restaurant	Table	27,808	32,285	39,070	43,186
	Other shop	Shop	33,524	38,921	47,101	52,063
Market		Stall	51,766	60,100	72,731	80,393
School		Student	385,013	447,000	540,943	597,925
Hotel		Room	13,385	15,540	18,806	20,787
Office		Office	368	427	517	572

Therefore, the waste generation amount is estimated by the product of generation ratios and number of discharge sources.

Table 3-5: Forecasted Waste Generation Amount

Area	Unit	2003	2007	2012	2015
Whole Phnom Penh	Ton/day	927.8	1,158.7	1,511.9	1,739.3
Urban area	Ton/day	556.1	659.4	808.4	894.2
Rural area	Ton/day	371.7	499.3	703.5	845.1

#### b. Waste Composition Forecast

The future waste composition was forecasted by comparing the results of the WACS with the waste data on other countries. The forecast was mainly based on the following assumptions:

- Significant changes in dietary habit and living environment is not anticipated. Therefore, the discharge amount of kitchen waste, garden waste (grass, ceramic, rubber and leather and stone and others) is assumed to remain the same.
- The discharge amount of wastes used for wrapping, e.g., paper, plastics, bottles and glass, is assumed to increase in accordance with economic growth.

Table 3-6: Forecasted Waste Composition

Classification			2003	2007	2012	2015
Combustible waste	Paper	(%)	6.4	8.5	9.9	10.9
	Rubber and Leather	(%)	0.1	0.1	0.1	0.1
	Kitchen waste	(%)	63.3	56.3	51.4	47.9
	Textile	(%)	2.5	3.3	3.8	4.2
	Plastic	(%)	15.5	20.2	23.7	25.9
	Grass & wood	(%)	6.8	6.1	5.5	5.2
	Sub-合計	(%)	94.6	94.5	94.4	94.2
Incombustible waste	Metal	(%)	0.6	0.9	1.0	1.1
	Bottle & Glass	(%)	1.2	1.5	1.8	2.0
	Ceramic & Stone	(%)	1.5	1.2	1.1	1.1
	Others	(%)	2.1	1.9	1.7	1.6
	Sub-total	(%)	5.4	5.5	5.6	5.8
Total			100.0	100.0	100.0	100.0

### 3.2.4 Medical and Industrial Waste Forecast

The generation amounts of medical waste and industrial waste in Phnom Penh were forecasted as shown in the below table, considering the results of the medical institution survey, factory survey and the economic growth rate.

Table 3-7: Forecasted Medical Waste Generation

Phase	Present (2003)	Phase 1 (2007)	Phase 2 (2012)	Phase 3 (2015)
Components				
Generation (ton/day)	General 9.7 Medical 0.96	General 12.3 Medical 1.22	General 16.5 Medical 1.63	General 19.3 Medical 1.91

Table 3-8: Forecasted Industrial Waste Generation

Phase	Present (2003)	Phase 1 (2007)	Phase 2 (2012)	Phase 3 (2015)
Components				
Generation (ton/day)	General 29.7 IW 28.5	General 37.5 IW 36.0	General 50.5 IW 48.5	General 59.0 IW 56.6

### 3.3 Selection of the Optimum Technical System

The Study team selected an optimum technical system shown in the following table for the SWM in Phnom Penh out of several technical systems.

Table 3-9: Selected Optimum Technical System

Work	Proposed System
Storage & Discharge	<ul style="list-style-type: none"> <li>Storage method: Plastic bags</li> <li>Introduction of discharge rule: Standardized discharge method, discharge time</li> <li>Discharge method: Popularize the use of containers such as bamboo basket to prevent waste scattering.</li> <li>Source separation (in the area where the recycle centre will be introduced): Separation of compostable and non-compostable waste</li> </ul>
Collection	<p><u>PPWM service area</u></p> <ul style="list-style-type: none"> <li>Collection frequency: More than three times a week (every day for commercial waste)</li> <li>Collection method: Mixed collection Separate collection (in the area where the recycling centre will be introduced)</li> <li>Collection system: Combined primary and secondary collection system Communal container collection system (point collection) Curb/bell collection system</li> <li>Collection time: Daytime</li> <li>Collection vehicle: Skip loader trucks Compactor trucks (15m<sup>3</sup>, 8m<sup>3</sup>, 4 m<sup>3</sup>)</li> <li>Haulage system: Direct haulage from collection points Transfer station should be considered in accordance with the disposal site location and work efficiency</li> </ul> <p><u>CINTRI service area</u> Collection system is provided by CINTRI</p>
Street Sweeping	<ul style="list-style-type: none"> <li>Manual sweeping in the PPWM service area</li> <li>Both manual sweeping and machinery street sweeping in the CINTRI service area</li> <li>Park waste is basically collected by communal container.</li> </ul>
Recycling	<ul style="list-style-type: none"> <li>Recycling activities are encourages through PPWM support and educational programmes.</li> </ul>
Intermediate Treatment	<p><u>Composting and sorting at recycling center</u></p> <ul style="list-style-type: none"> <li>Non-compostable waste: Manual sorting</li> <li>Compostable waste: Composting plant</li> <li>Residue from sorting plant and composting plant: Sanitary landfilling</li> </ul> <p><u>Composting at the disposal site</u></p> <ul style="list-style-type: none"> <li>Compostable waste: Composting plant</li> <li>Residue from the composting plant: Sanitary landfilling</li> </ul>
Final Disposal	<ul style="list-style-type: none"> <li>Promote as the first priority project the construction of a sanitary landfill site.</li> <li>Sanitary landfill with leachate treatment system is adopted.</li> </ul>
Equipment & Facility O/M	<ul style="list-style-type: none"> <li>Building of a small workshop for preventive maintenance.</li> <li>Major repairs will be entrusted over to private workshops.</li> </ul>
Medical SWM	<ul style="list-style-type: none"> <li>Disposal of infectious and hazardous medical SW shall be allowed at the municipal landfill and strictly controlled from generation to final disposal.</li> <li>All of the infectious and hazardous medical SW generated in the target area shall be treated at the generations or disposal of the HW landfill..</li> </ul>
Industrial WM	<ul style="list-style-type: none"> <li>Disposal of industrial hazardous waste shall be allowed at the municipal landfill and strictly controlled from generation to final disposal.</li> <li>All of the industrial hazardous waste generated in the target area shall be disposed at the HW site approved by the MOE.</li> </ul>

## 3.4 Institutional Issues

Institutional consideration such as correction of the monopolistic waste collection service, strategies to strengthen the PPWM as an executing agency and development of the legal system and standards for establishing an appropriate SWM are indispensable to formulate a master plan for SWM in the municipality of Phnom Penh.

### 3.4.1 Legal System

#### a. Development of Detailed Solid Waste Classification

The Sub-decree on SWM classifies solid waste (SW) into non-hazardous waste (non-HW) and hazardous waste (HW) and the classification is reasonable. However, more detailed classification is necessary for proper SWM. In order to establish a proper SWM system, the Study team has proposed a detailed classification of SW for the study as shown in the table below.

Table 3-10: Solid Waste Classification

Category in Sub-decree	Waste Category by Source	Sub-Waste Category	Detailed Waste Category or Description
Non Hazardous Waste (Non-HW))	Municipal Waste	Domestic Waste	1. Household waste 2. Institutional (school, government office, etc.) waste 3. Public area (road, drain, etc.) cleaning waste 4. Septage
		Commercial Waste	5. Commercial (shop, office, restaurant, hotel, etc.) waste 6. Market waste 7. Construction waste
	Industrial (Factory) Waste	Non-hazardous Industrial Waste (Non-HIW)	8. Non-HIW from non-production sources 9. Non-HIW from production process
	Medical Waste	General Medical Waste	10. Non-infectious and non-hazardous medical waste
	Agricultural Waste <sup>*1</sup>	Agricultural Waste	11. Non-hazardous agricultural waste
Hazardous Waste (HW)	Municipal Waste	Hazardous Municipal Waste	12. Domestic HW 13. Commercial HW
	Industrial (Factory) Waste	Hazardous Industrial Waste (HIW)	14. Hazardous factory waste
	Medical Waste	Medical Waste	15. Infectious waste 16. Hazardous medical waste
	Agricultural Waste <sup>*1</sup>	Hazardous Agricultural Waste	17. Hazardous agricultural waste

(Note) \*1: This study does not cover agricultural waste.

#### b. Preparation of Municipal Regulation on SWM

The Sub-decree on SWM stipulates that MOE shall establish guidelines on non-hazardous waste management (Non-HWM). The MOE in collaboration with the Ministry of Interior (MOI) made the “Inter-ministerial Declaration (*Prakas*) on SWM (non-HWM) in Provinces and Cities in the Kingdom of Cambodia” on February 25, 2003. In response to the *Prakas*, DOE of MPP prepared a “Draft Instruction for Conducting the Inter-ministerial Declaration, Interior-Environment, No. 80 dated February 25, 2003 on SWM in Phnom Penh” to establish a municipal regulation on SWM in Phnom Penh. In order to ensure the practicability and

establish proper SWM in Phnom Penh, meetings with the concerned people to discuss the draft of municipal regulation are urgently needed.

**c. Guidelines for SWM**

Although MOE is establishing several guidelines for proper SWM, the following guidelines need to be gradually prepared in collaboration with relevant organizations:

- Technical guidelines for landfill design and operation
- Detailed regulations and guidelines for the collection and treatment of medical waste
- Detailed regulations and guidelines for the management of hazardous waste other than medical waste
- Regulations and guidelines for environmental impact analyses and public hearings
- Guidelines for establishing appropriate waste collection systems in poor urban areas that cannot afford the regular waste collection services
- Guidelines for establishing, introducing and collecting service fees and tipping fees
- Procurement regulations and guidelines for contracting out the different types of SWM service, including model contracts

The Team recommends MOE and other responsible organizations to ask for foreign technical cooperation for the preparation of the above guidelines.

**3.4.2 Administration and Organization**

**a. Clarification and Integration of Roles/Responsibilities on SWM**

At present, the roles and responsibilities on SWM in Phnom Penh are dispersed and/or duplicated in the several departments and organizations under the MPP. The Team proposed the following roles/responsibilities on SWM of MPP and the proposal was approved in the meeting for the interim report held on September, 2003:

- PPWM is the SWM service provider under MPP
- DPWT supports and supervises the SWM service provided by PPWM
- DOE is the enforcer responsible for monitoring and control of SWM services to be provided by both PPWM and private contractor(s)

**b. PPWM Statute**

The PPWM Statute, which was approved by MPP on the 9<sup>th</sup> of September, 2003 but has not yet been authorized by the central government, does not give PPWM the necessary independence and powers in certain areas to carry out its mandate as described in it.

For instance, the Governor of MPP appoints and determines the remuneration of the management team (Governor and Deputy Governors of PPWM). The governor of PPWM should in-turn select his Deputies with the appointments approved by the Business Committee. This would make the Governor of PPWM more responsible and accountable for the management performance of the Authority.

The present low levels of salaries tend to corrupt the work force and reduce performance, effectiveness and efficiency. Under these circumstances PPWM may find it difficult to compete with the private contractors. The Business Committee should have the power to set appropriate salary levels based on a sustainable business plan.

The PPWM Statute stipulates that PPWM should monitor and control the cleansing activities provided by the private company(s), however, there is a contradiction between the executing agency and supervisor.

The Study team recommended that DOE be an agency to monitor and control the cleansing service provided by the public and private company(s). And MPP approved this recommendation in the second steering committee meeting.

Since the present PPWM Statute has some items to be amended, the Study team recommends that MPP revise these according to the master plan.

### 3.4.3 Public-Private Partnership

To establish a SWM system, the division of responsibilities and roles between public and private sectors needs to be clearly established.

#### a. Delineation of Responsibilities and Roles between MPP and Private Service Contractors

MPP should eliminate areas that do not receive the collection service as early as possible and establish an urban environment conservation system so that the people enjoy fair services.

The private sector (CINTRI), which has the right to provide the service to the whole city based on the concession agreement, cannot provide it to economically unfeasible areas. Therefore, the public sector should provide the service to those areas the private cannot cover. According to the present situation acknowledged through surveys, the team proposed that the private sector provide the service to the four urban Khans in which the collection coverage rate has already reached more than 90 % and that the collection coverage rate in this area should be raised to 100% by 2012. On the other hand, it was found through the surveys that the collection coverage rate in the three rural Khans was almost 50% and that there were many unserved areas. However, it may be difficult for the private sector to provide the service due to the fact that it is not economically feasible, as the settlements are scattered and the majority of residents living in most of the unserved areas are low income. Accordingly, the team proposed that the public and private sector eliminate the unserved areas in the three rural Khans in collaboration with each other. The study team amended the area-wise responsibilities and roles of PPWM and CINTRI as shown in Table 3-11. PPWM and CINTRI have to make efforts to achieve the targets given in Chapter 3.5 in the areas allocated to them respectively.

MPP/DOE should check whether the service provider achieves the targets or not. If one does not achieve the target verified by DOE, the other party should provide the service to eliminate the non-served area or insufficiently serviced area.

Table 3-11: Proposed Area Wise Responsibilities and Roles of PPWM and CINTRI

Area	Four Urban Khans	Three Rural Khans
Work Items		
Monitoring and Control	MPP	MPP
Collection and Transport	CINTRI	PPWM/CINTRI
Treatment and Recycling	CINTRI	PPWM/CINTRI
Final Disposal	PPWM	PPWM
Public Area Cleaning	CINTRI	PPWM/CINTRI
Service Fee Collection	CINTRI	PPWM/CINTRI



Based on the above responsibilities and roles, MPP and CINTRI organized the working group in the middle of January, 2005, and it has identified the unserved area, where CINTRI would not provide the service for the time being. However, both parties did not reach an agreement on the area demarcation as of the end of February, 2005.

## **b. Contract Management for Private Companies**

### **b.1 Basic Consideration**

The justifications for engaging the private sector to carry out SWM services, and the reasons for this are:

1. Open and transparent competitive bidding and pricing of the contracted services lead to lower costs for the users.
2. Service performance and costs of the private contractor's work is contested and monitored by the municipal cleansing department, encouraging the contractor to maintain high service standards and low costs.
3. The contractor will be accountable to the client and customers for the standards and manner in which his service is provided. The customers' satisfaction will influence the service charges that can be levied on the customers, and he will be fined for not meeting the contract performance specifications, which encourages the contractor to meet the performance specifications.
4. Finally, auditing of the contractor's account by an accredited independent auditing firm will ensure transparency and avoid corrupt practices.

However, most of the basic conditions for the justifications for engaging the private sector are not secured under the current SWM.

### **b.2 Contract Management for Private Companies**

As described in the above, the supply of SWM services will be contracted out to the private sector through a transparent, open and fair bidding procedure. Services should be carried out under conditions of competition and contestability. The roles and responsibilities of the private sector will be to supply the services in accordance with the contractual conditions, applicable laws, regulations and obligations. Therefore, the tender document specifies:

- Service regulations (Municipal Regulation on SWM, etc.) and rules
- Contents of the services such as service area, target wastes, population to be served, cleansing service length and/or area, frequency of the services, etc.
- Payments and penalties against breach of contract
- Others necessary

Once the contract is made, the public sector (MPP/DOE) shall establish a system to monitor and control the performance of the private companies in accordance with the conditions set in the contract.

### 3.4.4 Capacity Building

MPP's capabilities for proper SWM are so weak in all aspects. Therefore, the Study team will formulate a master plan for SWM considering that capacity building for MPP in the following fields is required.

- Capability for operating a SWM system
- Capability for establishing policy and regulations on SWM
- Capability for facilitating construction of SWM facilities, such as a landfill
- Capability for enforcement which includes supervision, monitoring and control of the SWM services

## 3.5 Numerical Targets and Strategies of the Master Plan

### 3.5.1 Numerical Target

To achieve the target of the Master Plan step by step, phased targets are setup as shown in the below table.

Table 3-12: Numerical Targets of the Master Plan for SWM in Phnom Penh

Technical Component	Present (2004)	Phase 1 (2007)	Phase 2 (2012)	Phase 3 (2015)
Service coverage of waste collection to population* <sup>1</sup> (Service coverage of waste collection to waste generation amount* <sup>2</sup> )				
4 Urban Khans	95.6% (90.7%)	97.8% (92.5%)	100% (94.1%)	100% (93.8%)
3 Rural Khans	53.4% (48.2%)	73.4% (68.1%)	88.8% (83.0%)	95.7% (89.7%)
Generation reduction				
• Growth rate of household waste *3 (proportion of household waste to the total waste generation)	1.00 (63.0%)	1.14 (62.6%)	1.32 (61.5%)	1.42 (60.9%)
• Growth rate of commercial waste *4 (proportion of commercial waste to the total waste generation)	1.00 (37.0%)	1.16 (37.4%)	1.41 (38.5%)	1.55 (39.1%)
Proportion of recycled waste to the total waste generation * <sup>5</sup>				
4 Urban Khans	11.1 %	14.6 %	15.5 %	16.0 %
3 Rural Khans	6.8 %	8.3 %	10.4 %	11.7 %
Proportion of composted waste (intermediately treated waste) to the total waste generation (amount treated, tons/day)	0.1% (1.3)	2.4% (26.3)	2.0% (29.3)	1.9% (32.3)
Proportion of improper waste disposal* <sup>6</sup>				
4Urban Khans	2.2 %	1.1 %	0.0 %	0.0 %
3 Rural Khans	13.8 %	7.2 %	1.8 %	0.0 %
Street Sweeping				
4 Urban Khans	46km	46km	46km	46km
3 Rural Khans	10km	14km	19km	24km
Final disposal method of municipal waste	Control tipping/ Open Dumping	SLF level 1 (Control tipping)	Sanitary landfill (SLF) Level 4	
Final disposal method of hazardous waste	A system for reduction of the waste generation, recycling, proper treatment and disposal will be established in phases.			

Note:

- \*1: The collection service coverage rate is, in general, expressed by the rate of served population to the total population. In this study, however, the rate is expressed by the rate of collected waste and recycled waste at the generation as shown in the waste flow to the total waste generated because it is not possible to obtain data of population who receive waste collection service and due to lack or insufficient waste collection service self-disposal and illegal dumping by the resident would be done.
- \*2: This rate is the collection service amount to the total generation amount, which excludes waste that is recycled at generation source.
- \*3: The number of generation sources is assumed to increase in proportion with population. Reflecting the promotion activities to be paid to 3Rs, the increase in unit generation is assumed to be half of that in Japan, and figures in the table are the growth rate of unit generation with letting that in 2003 be 1.
- \*4: The number of generation sources is assumed to increase in proportion with GNP. Reflecting the promotion activities to be paid to 3Rs, the increase in unit generation is assumed to be half of that in Japan, and figures in the table are the growth rate of unit generation with letting that in 2003 be 1.
- \*5: The recycling rate in Japan in 1999 was 13.1%.
- \*6: Although a part of self disposal may be inappropriate disposal, it is difficult to distinguish what extent it is improper. In this study therefore only the rate of illegal dumping is considered as improper disposal.

### 3.5.2 Strategies to Achieve the Target

The strategies for the three phases to be taken in order to achieve the goal of the M/P are shown below.

Although the M/P for waste collection may be modified according to the agreement between MPP and CINTRI, the strategies for waste collection are proposed based on the area wise responsibilities and roles between PPWM and CINTRI shown in the Table 3-11.

Table 3-13: Strategies to Achieve the Targets of the SWM M/P

Items	Four Khans in the Urban Area	Three Khans in the Rural Area
<b>Phase 1 (2005-2007)</b>		
<b>Technical aspects</b>		
1. Generation and waste management at source	<ul style="list-style-type: none"> <li>• DOE carries out public education campaign in cooperation with PPWM and CINTRI to encourage a reduction of illegal dumping and instill proper discharge rules.</li> <li>• The campaign also promotes waste reduction.</li> <li>• DOE gives guidance and popularizes a proper storage method according to the collection frequency.</li> </ul>	
2. Discharge, collection and transport	<ul style="list-style-type: none"> <li>• Operation of secondary collection in NIP area is transferred to CINTRI.</li> <li>• CINTRI fixes waste collection routes and time and keeps these services.</li> <li>• CINTRI introduces a primary collection system or establishes a point collection system based on public cooperation in areas where collection vehicles cannot access in order to eliminate unserved areas. (The collection system is decided by CINTRI)</li> <li>• CINTRI charges a fee based on a service agreement signed between the client and CINTRI.</li> <li>• Transfer stations may be introduced according to the CINTRI's decision.</li> </ul>	<p><b>PPWM</b></p> <ul style="list-style-type: none"> <li>• PPWM strengthens its capability to provide the waste collection service to the 3 rural Khans by the end of 2006 and starts providing service from the beginning of 2007.</li> <li>① PPWM decides which areas will be serviced by curbside/bell collection and by container collection, considering area conditions.</li> <li>② PPWM decides whether to adopt point collection or primary collection in each area where the container system applied.</li> <li>③ PPWM works in cooperation with NGOs and communities to organize primary/secondary collection schemes where appropriate to maximize collection efficiency and employment creation.</li> <li>④ Expenses for the primary collection</li> </ul>

Items	Four Khans in the Urban Area	Three Khans in the Rural Area
		<p>⑤ provided by collectors are borne by the community in principle, and the fee is decided based on the agreement among PPWM, Sangkat and community.</p> <ul style="list-style-type: none"> <li>• PPWM makes a service agreement with the clients in cooperation with Sangkat.</li> <li>• PPWM examines the introduction of transfer stations for the areas that are farther than 20 km from the final disposal site.</li> </ul> <p><u>CINTRI</u></p> <ul style="list-style-type: none"> <li>• Same as left column</li> </ul>
	<ul style="list-style-type: none"> <li>• MPP supports the communities that decide to introduce primary collection.</li> </ul>	
3. Street sweeping and park cleansing	<ul style="list-style-type: none"> <li>• The present cleansing system of public places, which is labor oriented, should be maintained from the viewpoint of job creation.</li> <li>• DOE carries out a public education campaign and regulates illegal practices such as illegal dumping in order to stop waste scattering in the city center.</li> <li>• MPP commits resources in 2006 so that PPWM can prepare the material and human resources required to take over cleansing services in the PPWM service area from the private provider by 2007.</li> </ul>	
4. Intermediate treatment and recycling	<ul style="list-style-type: none"> <li>• PPWM develops a compost plant to reduce and recycle organic waste collected from the markets at the new final disposal site in Dang Kor.</li> <li>• MPP through PPWM secures surplus government or other land and equips it with simple facilities for use by NGO, SHG or community groups to operate recycling and composting activities to increase waste recycling and employment creation.</li> <li>• MPP through PPWM develops rules and policies to promote private recycling and regulate inappropriate or dangerous practices.</li> <li>• MPP develops a scheme to support private long-established recycling systems to maintain and conserve the existing recycling system.</li> <li>• MPP in collaboration with MOI, etc. encourages local recycling activities for the valuable resources collected.</li> <li>• MOE in collaboration with ministries concerned encourages reusable and recyclable products and promotes the 3Rs infusing an extended producer responsibility (EPR).</li> </ul>	
5. Final disposal and O&M of machinery	<ul style="list-style-type: none"> <li>• PPWM improves the existing SMC disposal site based on the experience of the pilot project implemented during the study, and uses the site as long as possible.</li> <li>• PPWM organizes the waste pickers and makes them work according to rules. Furthermore, PPWM encourages waste pickers to become primary or secondary waste collectors after closure of the SMCDS in 2006.</li> <li>• PPWM constructs a new final disposal site at Dang Kor, and purchases the necessary vehicles and machinery with its own funds and external assistance by 2005, and starts the operation of the new site in 2007. It prohibits waste picking at the new site.</li> <li>• The plan of facilities should consider avoiding a leachate spillage, while measures for minimizing outflow of leachate which may be caused by an unexpected large scale flood should be prepared.</li> <li>• PPWM constructs a maintenance workshop with its own funds and external assistance where preventive maintenance is carried out for the vehicles and machinery of PPWM.</li> <li>• PPWM should utilize landfill gas.</li> <li>• A closure plan for SMC disposal site is formulated.</li> </ul>	

Items	Four Khans in the Urban Area	Three Khans in the Rural Area
6. Septage management	<ul style="list-style-type: none"><li>• PPWM studies and understands the current situation of septage disposal and the use of septic tanks in the city.</li><li>• PPWM formulates a septage management plan and an action plan, which is in line with public and private sector partnership and should include a plan for the development of a new septage treatment and disposal facility.</li><li>• MPP allocates a budget for the implementation of the action plan, and PPWM puts it into action involving the private sector.</li><li>• PPWM sets a guideline for the appropriate management of septic tanks.</li><li>• MOE examines a legal system to prevent illegal septage dumping.</li></ul>	
Institutional aspects		
7. Legal system	<ul style="list-style-type: none"><li>• MOE clarifies the uncertainty of the Sub-Decree on SWM, adds a supplemental explanation, and develops regulations, standards or guidelines that are suitable for priority issues.</li><li>• MOE encourages the municipalities to develop municipal regulations that complement the legal system at the national level.</li><li>• MOE diffuses the methodology of SWM plan development to other major cities in Cambodia in cooperation with MPP/PPWM based on the result of the study.</li><li>• MOE promotes the construction of proper waste treatment and disposal facilities and strictly regulates inappropriate waste treatment and disposal.</li><li>• MPP approves a draft municipal regulation on SWM prepared by DOE and establish an enforcing system of improper disposal.</li><li>• MPP develops municipal rules on SWM and guidelines for waste discharge and other activities in order to ask for people's cooperation.</li></ul>	
8. Administration and organization	<ul style="list-style-type: none"><li>• MPP clarifies the organization(s) responsible for SWM of MPP as follows.<ul style="list-style-type: none"><li>✓ MPP/Cabinet formulates a comprehensive SWM policy and enforces it.</li><li>✓ DPWT supervises the construction of the disposal site and waste collection service to be carried out by PPWM.</li><li>✓ DOE monitors and controls SWM operated by PPWM and takes charge of public education.</li><li>✓ PPWM operates and maintains the SWM under their jurisdiction.</li><li>✓ MPP/Cabinet constitutes the coordination committee consisting of the above four agencies to coordinate each function and manages smoothly through a regular meeting.</li></ul></li><li>• MPP strengthens PPWM in terms of property (machinery and facility), human resources (quality and quantity of personnel) and finance by utilizing international assistance programs as much as possible so that PPWM can operate and control the technical system proposed above.</li></ul>	
9. Public-private partnership	<ul style="list-style-type: none"><li>• MPP amends the contract with CINTRI, and transfers the waste collection and public cleansing work in the area where CINTRI will not provide waste collection service to PPWM by the end of 2006.</li><li>• MPP develops a system for systematic monitoring and data control. The system should make it possible to evaluate the unit cost for each component of SWM by which MPP can evaluate cost/benefit, cost/efficiency and cost/impact. In parallel to the above, MPP should also establish a database of all activities of SWM and make PPWM and the private company to continuously check the performance of their services and costs.</li></ul>	
10. Capacity building	<ul style="list-style-type: none"><li>• PPWM establishes a human resource development program to build the capacity of staff in each of the key activity areas (management, accounting and administration, SW collection, equipment maintenance and operation of sanitary landfill site.)</li><li>• DOE establishes a monitoring and control system to ensure that PPWM's performance is in accordance with the PPWM Statute.</li><li>• DOE establishes a monitoring and control system to ensure the private company(s)'s performance is in accordance with the contract.</li></ul>	

Items	Four Khans in the Urban Area	Three Khans in the Rural Area
11. Finance	<ul style="list-style-type: none"><li>CINTRI employs external financial auditors who audit the revenue and expenditure of waste collection and public cleansing services, discloses the result of audit, and shows the justification of the waste fee.</li></ul>	<div><u>PPWM</u><ul style="list-style-type: none"><li>MPP draws finances from bilateral and multilateral donors to strengthen the SWM service capability of PPWM.</li><li>PPWM establish a fee collection system involving Sangkat, based on the result of the pilot project implemented in the present study.</li><li>MPP allocates a budget for PPWM to start public area cleansing work in 2007.</li></ul></div> <div><u>CINTRI</u><p>Same as left column</p></div>
12. Public education and cooperation	<ul style="list-style-type: none"><li>DOE raises public awareness through basic education such as the necessity of public hygiene and environmental conservation.</li><li>DOE in collaboration with PPWM and CINTRI carries out a public education campaign to obtain public participation. It promotes cooperation with NGOs.</li><li>PPWM and CINTRI carry out public education and PR activities to ask for public cooperation in order to gain the understanding of the people. In doing so, they work closely with NGOs.</li></ul>	
13. Hazardous waste management	<ul style="list-style-type: none"><li>MOE studies the real situation of hazardous waste generation in cooperation with generation sources such as factories, and examines the appropriate treatment and disposal measures by taking account of the size of the economy and the total generation amount.</li><li>MOE promotes the construction of appropriate treatment and disposal facilities for hazardous waste and strengthens the control on improper hazardous waste management.</li><li>MOE develops a code of practice for medical waste management in cooperation with the Ministry of Health (MOH). MOE strengthens its relevant unit to establish a proper control/supervision system for medical waste management.</li><li>DOH (Department of Health) and PPWM introduce a separate collection system for infectious waste, and regulate its disposal at the municipal waste disposal site.</li><li>DOH examines the integration of existing incinerators or the introduction of new treatment facilities that receive waste from several medical institutions in consideration of the efficiency improvement of treatment and operation.</li><li>PPWM strictly controls the hazardous waste incoming to the disposal site.</li></ul>	
Phase 2 (2008-2012)		
Technical aspects		
1. Generation and waste management at source	<ul style="list-style-type: none"><li>PPWM, in cooperation with CINTRI, carries out a public education campaign and regulates illegal dumping and improper disposal at households. Finally, illegal dumping and improper self disposal is eliminated in 2012.</li><li>The campaign also promotes waste reduction.</li></ul>	<div><u>PPWM</u><ul style="list-style-type: none"><li>PPWM carries out a public education campaign and regulates illegal dumping and improper disposal at households to reduce the rate of these up to 1.8% in 2012.</li><li>The campaign also promotes waste reduction.</li></ul></div> <div><u>CINTRI</u><p>Same as left column</p></div>

Items	Four Khans in the Urban Area	Three Khans in the Rural Area
2. Discharge, collection and transport	<ul style="list-style-type: none"><li>• DOE supervises the collection works by CINTRI.</li><li>• CINTRI, in cooperation with NGOs, organizes waste pickers as primary waste collectors and achieves a collection rate of 100% in 2012.</li><li>• Separate collection is continued in the NIP area.</li></ul>	<u>PPWM</u> <ul style="list-style-type: none"><li>• PPWM, in cooperation with NGOs, organizes former waste pickers as primary or secondary waste collectors.</li><li>• PPWM improves its collection efficiency and increases the collection rate up to 88.8% in proportion to the population receiving services.</li><li>• PPWM introduces separate collection in part of the area.</li><li>• Following the result of examination in Phase 1, PPWM introduces the transfer stations if necessary.</li></ul> <u>CINTRI</u> <p>Same as left column</p>
3. Road and park cleansing	<ul style="list-style-type: none"><li>• The labor oriented cleansing system of public places should be maintained as long as it has an economical advantage over machinery cleansing.</li><li>• PPWM continues to carry out a public education campaign and to regulate illegal practices such as illegal dumping in order to stop waste scattering in the city center.</li></ul>	
4. Intermediate treatment and recycling	<ul style="list-style-type: none"><li>• PPWM operates a composting facility on the Dang Kor disposal site.</li><li>• PPWM promotes recycling by constructing small-scale recycling centers, where groups of former waste pickers, organized by NGOs, carry out waste sorting and composting under the simple structure with a roof, when it acquires land.</li><li>• PPWM promotes the improvement of recycling activities by individual recyclers and regulates improper recycling.</li></ul>	
5. Final disposal and O&M of machinery	<ul style="list-style-type: none"><li>• PPWM continues to operate the sanitary landfill at the Dang Kor disposal site.</li><li>• PPWM constructs the second stage disposal site by the end of 2012.</li><li>• PPWM carries out preventive maintenance of its vehicles and machinery regularly.</li><li>• Installation of gas removal pipes and soil covering works are executed at the SMCDS after closure at the beginning of 2007.</li></ul>	
6. Septage management	<ul style="list-style-type: none"><li>• PPWM and the private sector follow the septage management plan and the action plan formulated in Phase 1.</li><li>• PPWM appropriately manages the septage disposal facility.</li><li>• PPWM and the private sector carry out public campaigns to enforce the guideline issued in Phase 1.</li><li>• MOE develops legislation and enforcement measures to prevent the illegal dumping of septage.</li></ul>	
Institutional aspects		
7. Legal system	<ul style="list-style-type: none"><li>• MOE develops regulations, standards or guidelines following the Sub-Decree.</li><li>• MOE encourages the municipalities to develop municipal regulations.</li><li>• MOE encourages other major cities in Cambodia to develop a SWM plan.</li><li>• MOE and MOH more strictly regulate inappropriate waste treatment and disposal.</li><li>• MOE together with MPP diffuse the municipal regulations on SWM and guidelines for waste discharge and other activities in order to ask for people's cooperation to other major cities in the country.</li></ul>	
8. Administration and organization	<ul style="list-style-type: none"><li>• MPP further strengthens PPWM.</li><li>• MPP monitors the progress of the M/P.</li></ul>	

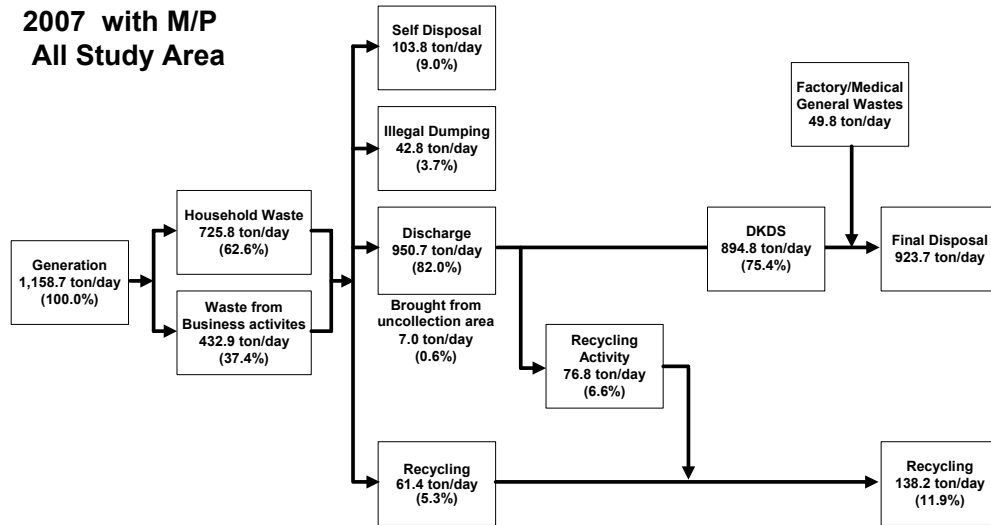
Items	Four Khans in the Urban Area	Three Khans in the Rural Area
9. Public-private partnership	<ul style="list-style-type: none"><li>• MPP reviews the contract with CINTRI and examines amendments necessary to introduce a market mechanism.</li><li>• MPP/DOE enforces the system for systematic monitoring and data control. Through the system, MPP/DOE regularly evaluates the performance of PPWM and the private contractor by checking the unit cost for each component of SWM and the key performance indicators. The result of the evaluation should be disclosed to the public.</li></ul>	
10. Capacity building	<ul style="list-style-type: none"><li>• PPWM carries out the training program suitable for the different jobs of all the personnel engaged in SWM.</li></ul>	
11. Finance	<ul style="list-style-type: none"><li>• CINTRI improves the transparency of financial information, and raises its fee collection rate.</li></ul>	<u>PPWM</u> <ul style="list-style-type: none"><li>• PPWM strengthens its fee collection system in its service area to totally cover the cost.</li><li>• MPP allocates a budget for PPWM to execute public area cleansing from 2007.</li></ul>
		<u>CINTRI</u> Same as left column
12. Public education and cooperation	<ul style="list-style-type: none"><li>• PPWM and CINTRI continue to carry out public education and PR activities to ask for public cooperation in order to gain the understanding of the people, working closely with NGOs.</li></ul>	
13. Hazardous waste management	<ul style="list-style-type: none"><li>• MOE promotes the construction of appropriate treatment and disposal facilities for hazardous waste and further strengthens the control on improper hazardous waste management.</li><li>• MOE studies the real situation of hazardous waste generation and instructs relevant organizations to take the most suitable treatment and disposal measures.</li><li>• Each medical institution follows the code of practice for medical waste management.</li><li>• DOH and DOE instruct medical institutions to separately discharge infectious/hazardous waste, and control them to pay the necessary cost for the management (including collection and final disposal) of medical waste.</li><li>• DOH promotes the integration of small incinerators for infectious waste and hazardous medical waste and minimizes the number of facilities.</li></ul>	
Phase 3 (2013-2015)		
Technical aspects		
1. Generation and waste management at source	<ul style="list-style-type: none"><li>• DOE, in cooperation with PPWM and CINTRI, carries out a public education campaign and regulates illegal dumping and improper disposal at households.</li><li>• The campaign also promotes waste reduction.</li></ul>	
2. Discharge, collection and transport	<ul style="list-style-type: none"><li>• DOE supervises the collection works by CINTRI.</li><li>• CINTRI continues to provide 100% of collection services.</li><li>• CINTRI examines the introduction of separate collection systems in the area other than the NIP area.</li></ul>	<u>PPWM</u> <ul style="list-style-type: none"><li>• PPWM improves its collection efficiency and increases the collection rate up to 95.7% in proportion to the population in 2015.</li><li>• PPWM expands the area of separate collection.</li><li>• Following the result of examination in Phase 1, PPWM introduces the transfer stations if necessary._</li></ul>
		<u>CINTRI</u> Same as left column
3. Road and park cleansing	<ul style="list-style-type: none"><li>• The labor oriented cleansing system of public places should be maintained as long as it has an economical advantage over cleansing by machine.</li><li>• DOE continues to carry out a public education campaign and to regulate illegal practices such as illegal dumping in order to stop waste scattering in the city center.</li></ul>	



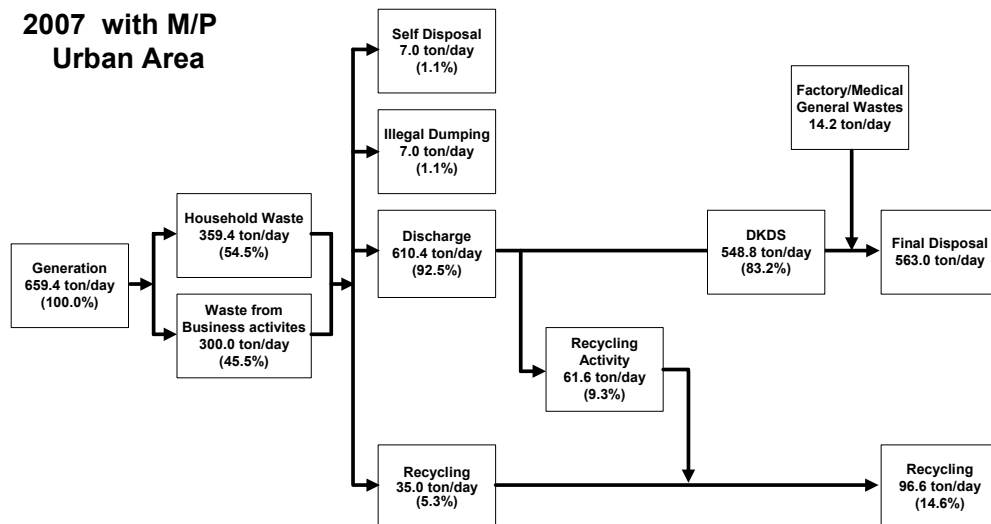
Items	Four Khans in the Urban Area	Three Khans in the Rural Area
4. Intermediate treatment and recycling	<ul style="list-style-type: none"><li>• PPWM operates a composting facility on the Dang Kor disposal site.</li><li>• PPWM continues to promote NGOs' recycling activities.</li><li>• PPWM promotes the improvement of recycling activities by individual recyclers and regulates improper recycling.</li><li>• PPWM attempts to coordinate the separate collection system and the private recyclers' activities.</li></ul>	
5. Final disposal and O&M of machinery	<ul style="list-style-type: none"><li>• PPWM continues sanitary landfill at the Dang Kor disposal site.</li><li>• PPWM properly maintains its vehicles and machinery.</li></ul>	
6. Septage management	<ul style="list-style-type: none"><li>• PPWM and the private sector follow the septage management plan and the action plan.</li></ul>	
Institutional aspects		
7. Legal system	<ul style="list-style-type: none"><li>• MOE encourages other major cities in Cambodia to develop a SWM plan.</li><li>• MOE and MOH more strictly regulate inappropriate waste treatment and disposal.</li><li>• MOE in cooperation with MPP diffuses the municipal regulations on SWM and guidelines for waste discharge and other activities in order to ask for people's cooperation to other cities in the country.</li></ul>	
8. Administration and organization	<ul style="list-style-type: none"><li>• MPP further strengthens PPWM.</li><li>• MPP evaluates the progress of the M/P and formulates a new M/P starting 2016.</li></ul>	
9. Public-private partnership	<ul style="list-style-type: none"><li>• MPP amends the contract with CINTRI and develops a private-public partnership based on the market mechanism.</li><li>• DOE maintains the system for systematic monitoring and data control. Performance evaluation work and its publication should be continued.</li></ul>	
10. Capacity building	<ul style="list-style-type: none"><li>• PPWM carries out the training program suitable for the different jobs of all the personnel engaged in SWM.</li></ul>	
11. Finance	<ul style="list-style-type: none"><li>• CINTRI improves the transparency of financial information, and raises its fee collection rate.</li></ul>	<div><u>PPWM</u><ul style="list-style-type: none"><li>• PPWM keeps the collection system financially sustained by collecting a fee from the residents.</li><li>• MPP continues to allocate a budget for PPWM to execute cleansing work._</li></ul></div> <div><u>CINTRI</u><p>Same as left column</p></div>
11. Human resources development	<ul style="list-style-type: none"><li>• PPWM carries out the training program suitable for the different jobs of all the personnel engaged in SWM.</li></ul>	
12. Public education and cooperation	<ul style="list-style-type: none"><li>• DOE, in cooperate with PPWM and CINTRI, continues to carry out public education and PR activities to ask for public cooperation in order to gain the understanding of the people, working closely with NGOs.</li></ul>	
13. Hazardous waste management	<ul style="list-style-type: none"><li>• MOE promotes the construction of appropriate treatment and disposal facilities for hazardous waste and further strengthens the control on improper hazardous waste management.</li><li>• The relevant organizations carry out their roles in hazardous waste management.</li><li>• MOE and DOE regulate and supervise the medical waste management system.</li><li>• MOE and DOE regulate small incinerators for infectious and hazardous medical waste.</li></ul>	

### 3.5.3 Future Waste Flow

#### 2007 with M/P All Study Area



#### 2007 with M/P Urban Area



#### 2007 with M/P Rural Area

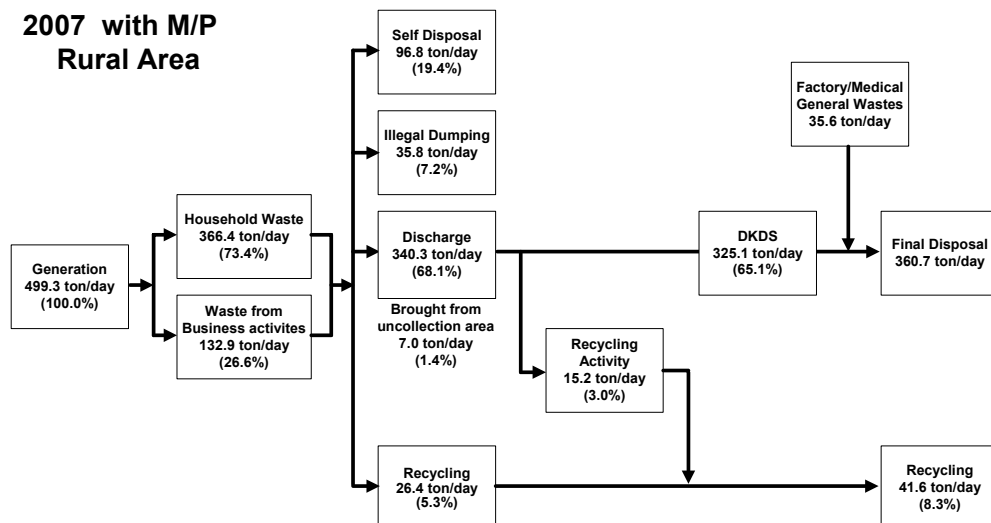
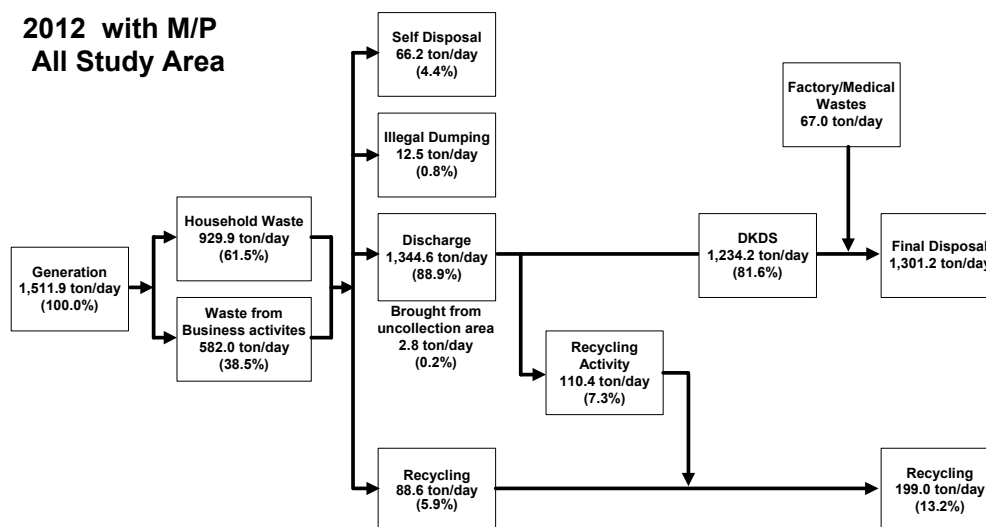
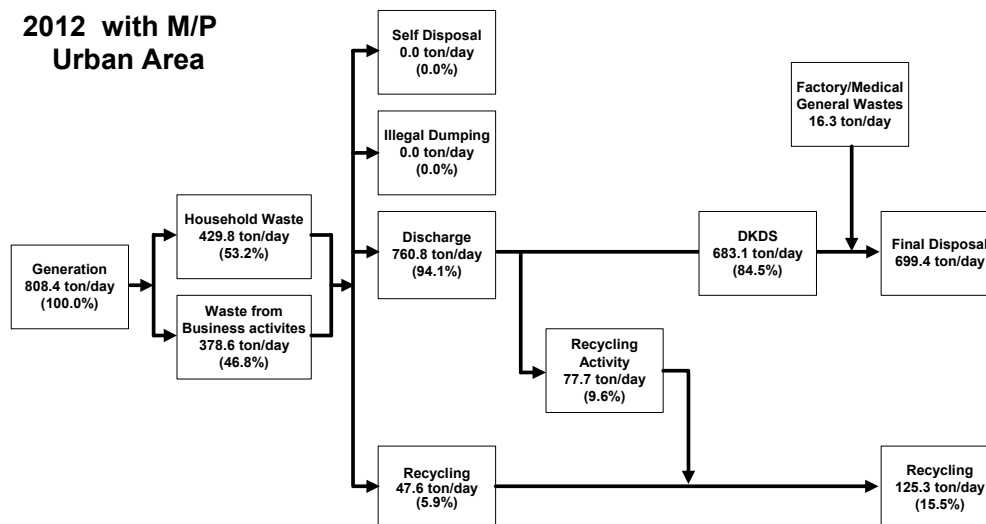


Figure 3-1: Waste Flow in 2007

### 2012 with M/P All Study Area



### 2012 with M/P Urban Area



### 2012 with M/P Rural Area

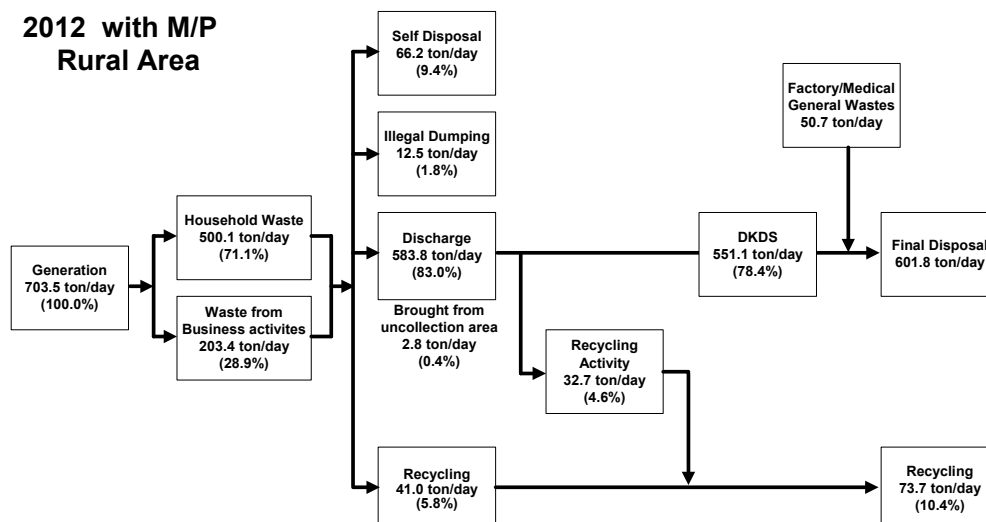


Figure 3-2: Waste Flow in 2012

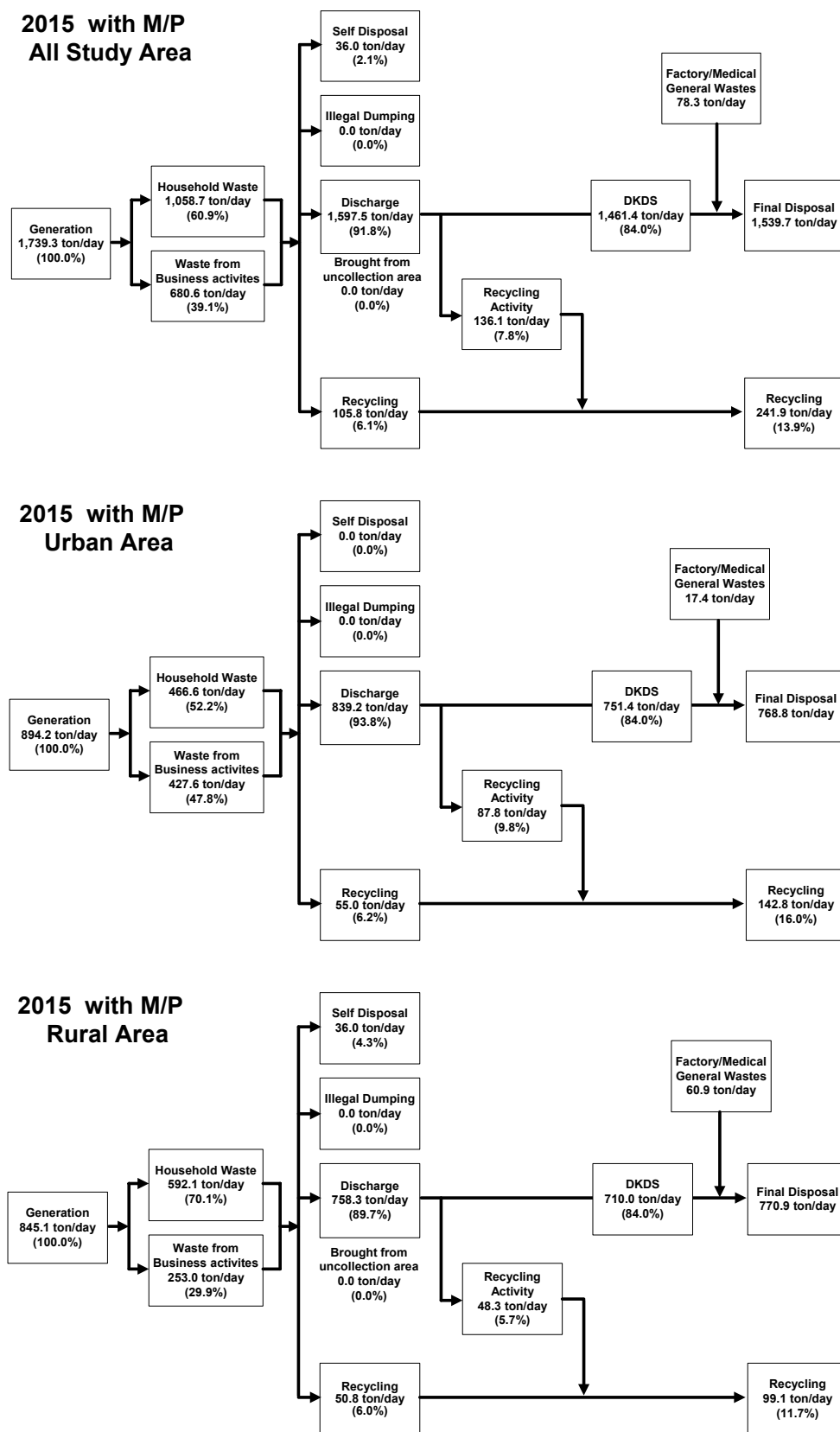


Figure 3-3: Waste Flow in 2015

### 3.5.4 SWM Master Plan

Components	Phase	Present (2004)	Phase 1 (2007)	Phase 2 (2012)	Phase 3 (2015)
<b>1. MSW Generation</b>					
Population in Phnom Phne	Rural:	601,449	Rural: 724,409	Rural: 850,545	Rural: 952,009
	Urban:	642,392	Urban: 692,036	Urban: 730,887	Urban: 750,157
	Total:	1,242,841	Total: 1,416,445	Total: 1,581,432	Total: 1,702,166
<b>MSW Amount (ton/day)</b>					
Generation		977.6	1,158.7	1,511.9	1,739.3
Discharge		716.6	950.7	1,344.6	1,597.5
Collection	Rural:	189.8	Rural: 325.1	Rural: 551.1	Rural: 710.0
	PPWM:	29.9	PPWM: 156.5	PPWM: 281.1	PPWM: 404.4
	Private:	159.9	Private: 168.6	Private: 270.0	Private: 305.6
	Urban:	502.8	Urban: 548.8	Urban: 683.1	Urban: 751.4
	Total:	692.6	Total: 873.9	Total: 1,234.2	Total: 1,461.4
<b>MSW Composition (%)</b>					
Non-compostable		29.9	38.4	43.1	46.9
Compostable		70.1	61.6	56.9	53.1
<b>2. Waste Collection &amp; Transportation</b>					
Collection rate (%)	Rural:	48.2	Rural: 68.1	Rural: 83.0	Rural: 89.7
	Urban:	90.7	Urban: 92.5	Urban: 94.1	Urban: 93.8
	Total:	73.3	Total: 82.0	Total: 88.9	Total: 91.8
Ratio of improper disposal to generation (%)	Rural:	13.8	Rural: 7.2	Rural: 1.8	Rural: 0.0
	Urban:	2.2	Urban: 1.1	Urban: 0.0	Urban: 0.0
	Total:	6.9	Total: 3.7	Total: 0.8	Total: 0.0
Separate collection rate to refuse collection (%)	Rural:	0	Rural: 1.8	Rural: 1.6	Rural: 1.7
	Urban:	0.7	Urban: 0.7	Urban: 0.7	Urban: 0.7
	Total:	4 ton/day	Total: 6 ton/day	Total: 9 ton/day	Total: 12 ton/day
Collection system	PPWM		PPWM	PPWM	PPWM
	Curb side/bell collection		Curb side/bell collection	Curb side/bell collection	Curb side/bell collection
	Stationary collection with container		Stationary collection with container	Stationary collection with container	Stationary collection with container
	Primary + container collection		Primary + container collection	Primary + container collection	Primary + container collection
	Private		CINTRI	CINTRI	CINTRI
	Curb side/bell collection Container collection		Depend on the plan of the private collector contracted out	Depend on the plan of the private collector contracted out	Depend on the plan of the private collector contracted out
Major type of vehicles (units)	CT (18m <sup>3</sup> ):	1	CT (15 m <sup>3</sup> ): 8	CT (15 m <sup>3</sup> ): 14	CT (15 m <sup>3</sup> ): 19
	CT: Compactor Truck	CT (4.5 m <sup>3</sup> ): 1	CT (8 m <sup>3</sup> ): 3	CT (8 m <sup>3</sup> ): 4	CT (8 m <sup>3</sup> ): 6
	SL: Skip Loader	CT (4 m <sup>3</sup> ): 2	CT (4 m <sup>3</sup> ): 3	CT (4 m <sup>3</sup> ): 5	CT (4 m <sup>3</sup> ): 8
	CO: Container	SL: 1	SL: 5	SL: 8	SL: 11
		CO (5 m <sup>3</sup> ): 10	CO (5 m <sup>3</sup> ): 37	CO (5 m <sup>3</sup> ): 61	CO (5 m <sup>3</sup> ): 86
			WL: 1	WL: 1	WL: 1
Number of staff (collection workers)	PPWM:	21(16)	PPWM: 75 (48)	PPWM: 108 (74)	PPWM: 142 (100)
Transportation system	Direct haulage		Direct haulage	Direct haulage	Direct haulage
Executing organisation	PPWM: 4 Sangkats		Rural: PPWM	Rural: PPWM	Rural: PPWM
	Private: Whole Phnom Penh other than PPWM area		CINTRI Urban: CINTRI	CINTRI Urban: CINTRI	CINTRI Urban: CINTRI
Unit cost (US\$/ton)		6.73 (in 2003)	8.14 (PPWM area)	6.98 (PPWM area)	7.07 (PPWM area)
<b>3. Public Area Cleansing</b>					
Method of sweeping	Manual sweeping by private		Rural: PPWM: Manual CINTRI: Private plan Urban: CINTRI	Rural: PPWM: Manual CINTRI: Private plan Urban: CINTRI	Rural: PPWM: Manual CINTRI: Private plan Urban: CINTRI

Phase Components	Present (2004)	Phase 1 (2007)	Phase 2 (2012)	Phase 3 (2015)
Type of collection vehicles in Rural area	-	Dump truck: 1	Dump truck: 1	Dump truck 1
Length of served road (km)	Rural: 10km Urban: 46 km	Rural: 10 km PPWM: 4 km CINTRI: 6 km Urban: 46 km	Rural: 13 km PPWM: 7 km CINTRI: 6 km Urban: 46 km	Rural: 16 km PPWM: 8 km CINTRI: 6 km Urban: 46 km
Operation by	Rural: PPWM CINTRI Urban: CINTRI	Rural: PPWM CINTRI Urban: CINTRI	Rural: PPWM CINTRI Urban: CINTRI	Rural: PPWM CINTRI Urban: CINTRI
No of Staff (Sweepers)	PPWM: 0	PPWM: 28 (25)	PPWM: 47 (44)	PPWM: 53 (50)
Unit cost (US\$/ton)	-	238.8 (PPWM area)	183.0 (PPWM area)	153.9 (PPWM area)
<b>4. Recycling Intermediate Treatment</b>				
Compost plant 1 Site	SMCDS	DKDS	DKDS	DKDS
Treated amount (ton/year)	365	7,300	7,300	7,300
Unit cost (US\$/material -ton)	N/A	10.3	10.3	10.3
(US\$/Product-ton)	N/A	51.4	51.4	51.4
Recycling at generation	Market waste etc.	Market waste etc.	Market waste etc.	Market waste etc.
Overall recycling rate	0.6	1.8	1.4	1.2
Recycling system	Windrow	Windrow	Windrow	Windrow
Compost plant 2	Rural: - Urban: Waste Recycle Development Centre in NIP (WRDC)	Rural: Waste Recycle Centre (WRC) Urban: WRDC	Rural: WRC Urban: ERDC	Rural: WRC Urban: ERDC
Treated amount (ton/year)	110	110+2,190= 2,300	110+3,285= 3,395	110+4,380= 4,490
Unit cost (US\$/ton)	N/A	N/A	N/A	N/A
Recycling at generation	MSW	MSW	MSW	MSW
Overall recycling rate (%)	0.1	0.6	0.7	0.8
Recycling system	Windrow	Windrow	Windrow	Windrow
<b>5. Final Disposal</b>				
Method of operation	Open-dumping	Sanitary landfill level 4	Sanitary landfill level 4	Sanitary landfill level 4
Final disposal site	SMCDS	DKDS	DKDS	DKDS
Distance from city (km)	5	10	10	10
Operation by	PPWM	PPWM	PPWM	PPWM
Disposal amount (ton/day)	715	924	1,301	1,540
Nos. of workers	9	51 (include Administration staffs)	54 (include Administration staffs)	61 (include Administration staffs)
Unit cost (US\$/ton)	0.43	5.92	5.92	5.92
With grant	-	4.40	4.40	4.40
Without grant	-			
Main equipment	Bulldozers (leased) 2	Bulldozer 4 Wheel loader 1 Water tank truck 1 Dump truck 2 Pickup truck 2 Excavator 2	Bulldozer 5 Wheel loader 1 Water tank truck 1 Dump truck 2 Pickup truck 2 Excavator 2	Bulldozer 6 Wheel loader 1 Water tank truck 1 Dump truck 3 Pickup truck 2 Excavator 3
<b>6. Maintenance &amp; Repair (for PPWM)</b>				
Preventive Maintenance	By private	By PPWM	By PPWM	By PPWM
Major repair	By private repair shop	By private work shop	By private work shop	By private work shop
Operation by	PPWM	PPWM	PPWM	PPWM

Components	Phase	Present (2004)	Phase 1 (2007)	Phase 2 (2012)	Phase 3 (2015)
Maintenance staffs			WS Manager: 1 Technician: 2 Mechanics: 6 Store keeper: 1 Office clerk: 2	WS Manager: 1 Technician: 2 Mechanics: 8 Store keeper: 1 Office clerk: 2	WS Manager: 1 Technician: 2 Mechanics: 9 Store keeper: 1 Office clerk: 2
<b>7. Financial Matters of PPWM (present data are in 2003)</b>					
Unit SWM Cost (US\$/ton)		7.16	12.54	11.38	11.47
Revenue Source		MPP Budget 0 SW collection 39 Tipping fee 104 Selling of soil 0	MPP Budget 35 SW collection 663 Tipping fee 1,483 Selling of soil 0	MPP Budget 47 SW collection 1,191 Tipping fee 2,090 Selling of soil 133	MPP Budget 51 SW collection 1,714 Tipping fee 2,473 Selling of soil 66
Total revenue (US\$ 1,000)		143	2,181	3,461	4,304
Collection rate of waste collection fee		Household 80% Business 0%	Household 80% Business 100%	Household 80% Business 100%	Household 80% Business 100%
Budget allocation from general finance to the total income from SWM		0%	2%	2%	2%
Coverage rate of waste collection fee to the total income from SWM		27%	30%	34%	40%
Tipping fee to the total income from SWM		73%	68%	60%	57%
Selling soil to the total income from SWM		0%	0%	4%	2%
Total revenue per capita (US\$/year)		0.12	1.54	2.19	2.53
Municipal Budget estimated (thousand US\$)		5,811	8,435	11,305	13,772
Share of SWM budget		0%	0.4%	0.4%	0.4%
<b>8. Medical SWM</b>					
Generation (ton/day)		General : 9.7 Medical: 1.0	General: 12.3 Medical: 1.2	General: 16.5 Medical: 1.6	General: 19.3 Medical: 1.9
Treatment at generation		General: Landfill Medical: Incineration	General: Landfill Medical: Incineration	General: Landfill Medical: Incineration	General: Landfill Medical: Incineration
Final disposal		General Waste : Open dumping	General Waste :Sanitary landfill at DKDS Medical waste without treatment is not allowed to dispose in the DKDS	General Waste :Sanitary landfill at DKDS Medical waste without treatment is not allowed to dispose in the DKDS	General Waste :Sanitary landfill at DKDS Medical waste without treatment is not allowed to dispose in the DKDS
Final disposal operation		PPWM	PPWM	PPWM	PPWM
<b>9. Industrial SWM</b>					
Generation (ton/day)		General: 29.7 IW: 28.5	General: 37.5 IW: 36.0	General: 50.5 IW: 48.5	General: 59.0 IW: 56.6
HW treatment		N/A	Landfill	Landfill	Landfill
Final disposal		Open dumping	Prohibit and control HW disposal at DKDS and oblige disposal at HW landfill site	Prohibit and control HW disposal at DKDS and oblige disposal at HW landfill site	Prohibit and control HW disposal at DKDS and oblige disposal at HW landfill site

### 3.5.5 Priority Projects

The following three projects were selected as priority projects to be targeted in the feasibility study and implemented urgently in the first phase of the Master Plan.

#### 1. Dang Kor Disposal Site Development Project

As the SMCDS will reach full capacity by end of 2006, the development of a new disposal site to continue landfill operation from the beginning of 2007 is an urgent and serious issue. To deal with this issue, the Study team will make a development plan for the new disposal site in Dang Kor, which has been verified as a suitable candidate site in this study.

#### 2. Waste Collection Service Expansion Project

This project is to strengthen the PPWM's capability of waste collection to eliminate unserved and insufficiently serviced areas from the city in collaboration with the private sector according to Table 3-11.

The service area of each will be decided through negotiations between MPP and CINTRI. However, because both parties did not reach an agreement on area demarcation as of the end of February 2005, the Study team estimated the waste amount to be collected by PPWM based on the site reconnaissance and the weighbridge data, and planned the waste collection system required to collect it according to the request of MPP.

#### 3. SMCDS Closure Project

SMC disposal site can be used until early 2007 due to the 3.6 ha area that was expanded through the study. By carrying out the aged waste to the neighbouring barrow pit requested by its owner, the remaining life of the SMC disposal site is prolonged. Therefore, PPWM can have additional time for managing waste disposal until the new disposal site is opened. Preparation of a plan to smoothly transfer the landfill operation from the existing site to the new site must be carried out simultaneously with the planning of the new disposal site development. It is also important to plan countermeasures to minimize possible environmental impacts of the landfilled waste on the surrounding area.

### 3.5.6 Site Plan for Future Facilities

The facilities proposed in the Master Plan targeting 2015 are a final disposal site, a depot and maintenance workshop for the waste collection vehicles and a recycling centre where the waste collected by the primary collection will be reloaded.

The sites for these facilities are planned as follows:

#### a. Final Disposal Site

##### a.1 25ha of Land (Original plan)

One hundred hectares of land in Dang Kor was recommended for the future disposal site in a study conducted by the MPP and a German consultant from 1995. MPP purchased an 11 ha lot in Dang Kor in 2001 based on this recommendation.

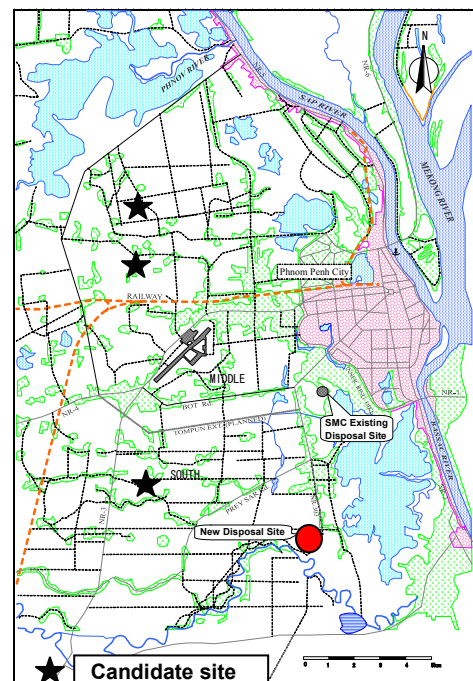


Figure 3-4: Candidate sites



The study team compared the four candidate sites that had been nominated in the previous study from the viewpoint of accessibility, soil condition by visual observation, development in the surroundings, and possibility of future expansion. However, the study team did not compare the development cost required for each candidate, because it must be different according to the operation period which was decided by the possible area.

According to the results of the comparison study, the study team concluded the site in Khan Dang Kor was most suitable and the land that had been acquired by MPP located in this site was appropriate.

The proposed site is located at the southern edge of the municipal area under jurisdiction of Phnom Penh, which is in the downstream area in the plain spread out across the diluvial upland. This area is used as a paddy field and there are no houses in the planned area. This area used to be flooded by the Prek Thnaot river, but it has not been since 2002 when the bank was constructed.

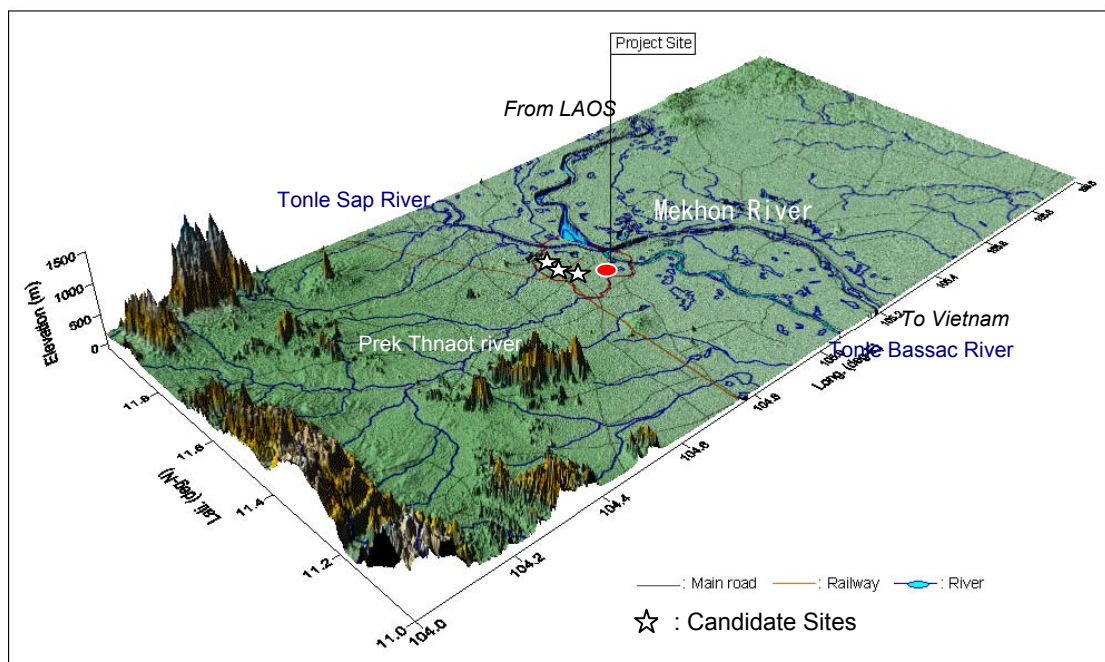


Figure 3-5: Candidate Sites in the Geographical Feature

At first, the study team proposed an area of about 100 ha, which was enough for more than 20 years of landfill operation, in the Dang Kor district by using aerial photos. Then, within the 100ha mentioned above, the study team proposed a 25ha area including the 11ha of land MPP had already acquired, which could be used for about 5 years.

MPP approved this proposal in the steering committee meeting held on the 3<sup>rd</sup> of July, 2003 and applied to the central government for this land acquisition. The ministry of council ministers approved the application submitted by MPP on the 29<sup>th</sup> of October, 2003 and notified the Governor of Phnom Penh and the Minister of Economy and Finance of this decision.

MPP organized the land evaluation committee in the municipality for the new disposal site development after this notification, and started to acquire the land.

**a.2 31.4ha of Land (Amended plan)**

Although the land evaluation committee tried to acquire the land according to the development plan prepared by the study team, the price of land along national route 303 rose suddenly. It became difficult to acquire the proposed area within the budget. Therefore, the land evaluation committee decided to change the area and acquired 20ha (31.4 ha in total) of land adjacent to the 11 ha, located almost 1km on the western side from national route 303.

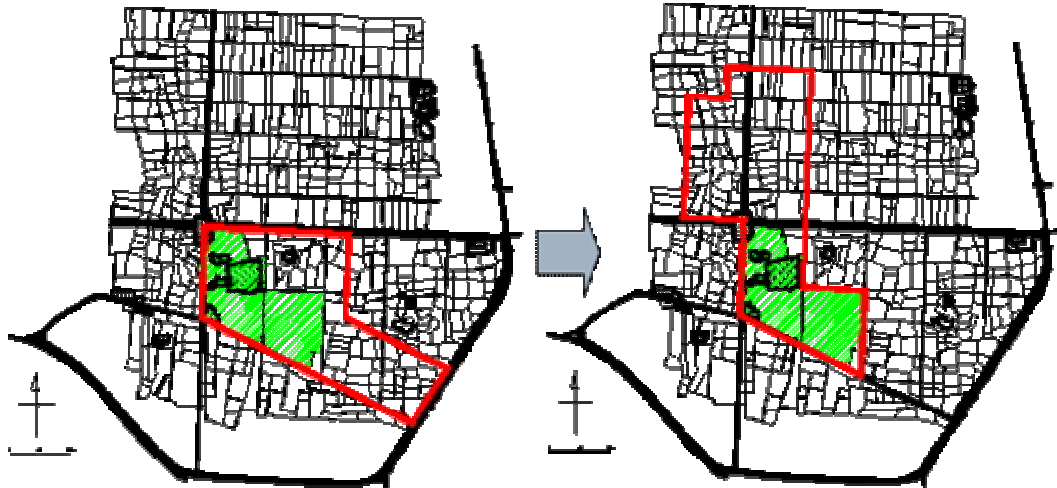


Figure 3-6: Change of the Land for the New Disposal Site

**b. Depot and Maintenance workshop for collection vehicles**

Thirty eight collection vehicles are planned to be introduced based on the waste collection service expansion project. A 1 ha area is necessary for parking and the maintenance workshop.

MPP requested to set up a depot and workshop as an annex to the new disposal site.

**c. Land for other facilities**

The Study team will make a plan for a compost plant targeting market waste. In discussions between MPP and the Study team, it is decided that the compost plant is to be set up within the new disposal site.

**d. Recycling centre**

In order to reduce unserved areas, M/P proposes the collection system where primary collection is done by groups such as Self Help Groups and the waste is transported to communal containers or a recycling centre for areas that are inaccessible by collection vehicles. The Study team proposes to continue recycling activities following that valuable resource separation and composting are being carried out at the waste recycle development centre in the NIP area based on the 3Rs policy targeted in the Master Plan.

The required lot for recycling centres will be rented or purchased based on information to be obtained through expansion of the waste collection service. Although the lots for recycle centres are not identified, the Study team assumes one centre needs a 1,000 m<sup>2</sup> lot in which the small scale facility can be installed and considers the cost necessary to construct the facilities.

### 3.5.7 Implementation Schedule

The implementation schedule for the priority projects is shown in the following table.

Table 3-14: Implementation Schedule

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Development Study													
Dabg Kor Disposal site Development Project	Plan/Design												
	Construction												
	Procurement												
	Operation												
Collection Service Expansion Project	Plan/Design												
	Procurement												
	Operation												
CB of Management/Operation													
CB of Monitoring/Control													

The preparatory works for expansion of the second phase development of the Dang Kor disposal site will start from 2011 and it will start operation from 2013.

### 3.5.8 Project Cost

The annual project cost for implementing the Master Plan is estimated as shown in the below table according to the implementation schedule.

Table 3-15: Project Cost for M/P

			2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Collection	Collection vehicles	Invest.	0	1,804	195	141	197	60	220	322	1,604	523	144	5,210
		O&M	0	0	316	359	386	417	428	475	527	569	634	4,111
Intermediate treatment	Compost plant	Invest.	59	1,135	0	0	0	0	0	0	110	0	0	1,304
		O&M	0	0	56	56	56	56	62	58	61	63	63	531
Final disposal	Admin. facility	Invest.	95	1,653	0	0	0	0	4	75	0	0	0	1,827
	Landfill facility	Invest.	316	5,485	0	0	0	0	193	3,349	0	0	0	9,343
	Landfill equipment	Invest.	0	1,341	0	0	0	175	0	0	1,724	0	0	3,240
	Workshop	Invest.	76	1,498	0	0	0	0	0	0	0	0	0	1,574
	Landfill operation	O&M	0	0	795	777	777	777	844	820	897	871	984	7,542
SMCDS closure project	Invest.	0	75	745	0	0	0	0	0	0	0	0	0	820
	O&M	0	0	24	14	14	24	14	14	14	24	14	14	156
Total			546	12,991	2,131	1,347	1,430	1,509	1,765	5,113	4,947	2,040	1,837	35,656

### 3.5.9 Financial Appraisal of the M/P

The Projects subject to financial appraisal here include:

- Waste Collection Expansion Project
- Dan Kor New Final Disposal Landfill Project

As to MSW collection and haulage in the remaining area of PPWM service area, the Study proposes that it will be carried out by CINTRI, which currently provides it in Phnom Penh. However, due to insufficient financial and cost data disclosed by CINTRI, the Study does not make financial appraisal of its operation.

#### a. Current cost of MSW

According to the data provided by PPWM, the cost of MSW collection/haulage in NIP zone per ton of waste collected and SMC disposal operation per ton of waste received are estimated as shown in the table below.

Table 3-16: The Cost of MSW Collection/Haulage and Operation of SMC Disposal Site by PPWM

Year	Unit	2002	2003
SWM			
Collection and haulage	US\$/ton	6.93	6.73
Final disposal	US\$/ton	0.57	0.43
Total	US\$/ton	7.50	7.16

Remark: The above cost does not include the depreciation cost of the buildings, vehicles and equipment. The cost of MSW collection and haulage by CINTRI is not included in the above estimation.

#### b. Financial appraisal of the M/P

The following preconditions are established for financial appraisal of the M/P.

Table 3-17: Preconditions of the Project

Implementation Body	PPWM
Project Period	12 years from 2005 to 2015
Project Income	<p>(Income from MSW collection and haulage by PPWM)</p> <ul style="list-style-type: none"> <li>• Income from user fee from the service area of PPWM from 2007 to 2015.</li> </ul> <p>(Income from Dang Kor final disposal landfill)</p> <ul style="list-style-type: none"> <li>• Income from tipping fee from CINTRI and PPWM.</li> <li>• Income from selling the excavated soil (The average annual income of 279,000 US dollars is assumed to be earned during its operation period from 2007 to 2015.).</li> <li>• Income from selling compost materials produced in the compost plant at the rate of 200 riel per kilogram (The average annual income of 61,250 US dollars is assumed during its operation period from 2007 to 2015).</li> </ul>
Investment Cost	<p><b>1. MSW collection and haulage</b></p> <p>Initial investment is made in 2006 for the following purposes.</p> <p>(Purchase of vehicles)</p> <ul style="list-style-type: none"> <li>• Compactor Truck (loading capacity of 4m<sup>3</sup>, 8m<sup>3</sup> and 15m<sup>3</sup>)</li> <li>• Skip Loader Truck</li> <li>• Skip Containers (5 m<sup>3</sup>)</li> <li>• Wheel Loader</li> <li>• Pushcarts</li> </ul>

	<ul style="list-style-type: none"> <li>Pick-up Trucks</li> <li>Dump truck</li> </ul> <p>(Construction)</p> <ul style="list-style-type: none"> <li>Container Stations</li> </ul> <p>Collection and haulage vehicles and equipment will be purchased in accordance with the increase in the number of service users and expansion of the service areas while the end-of-life vehicles and equipment will also be replaced.</p> <p><b>2. Dang Kor final disposal site</b></p> <p>The following investment and actions will be made from 2005 to 2012.</p> <ul style="list-style-type: none"> <li>2005 - 2006: Design, construction of landfill and compost plant and Maintenance workshop</li> <li>2006 - 2007: Closure of SMCDS</li> <li>1 Jan. 2007: Starting operation of the New disposal site</li> <li>Phase II development of landfill will start in 2012 for its operation from 2013.</li> </ul>
O/M Cost	O/M cost is estimated for each year from 2007 to 2015 based on the determined unit cost and amount.
Depreciation	<p><b>1. MSW collection and haulage</b></p> <p>20, 15 and 7 years of depreciation period are set for building and equipment and vehicles respectively. The scrap value is set at 10% for all vehicles and equipment while the buildings are assumed completely depreciated.</p> <p><b>2. Dang Kor final disposal landfill</b></p> <p>The site development and building for common use including road, administration building, leachate treatment facility, compost plant and so forth in the final disposal landfill are completely depreciated in 20 years while the landfill area itself is completely depreciated in the same years of possible landfill operation. Vehicles and equipment used in landfill are depreciated in 7 years with a scrap value of 10%.</p>
Price	All the cost is estimated based on the current price of 2003. No price escalation is included.
Discount rate	Discount rate is set up at 10%, taking into account inflation and market rate in Cambodia.

Based on the preconditions above, the Study analyzes the required fee rate MSW collection and final disposal to make the above projects financially feasible.

### b.1 Financial Analysis of MSW Collection by PPWM

Financial analysis of MSW collection by PPWM (hereunder described as PPWM-MSW Collection) is made in two cases. One is the case with normal public investment project with no grant assistance and the other is the case with grant assistance to initial development cost. The Study analyzes the required fee rate of MSW collection to make PPWM-MSW Collection financially feasible in these 2 cases. In the case of normal public investment project with no grant assistance, the Study established the financially feasible level of the project at 10 % of financial internal rate of return (FIRR), taking account the discount rate set above. In the case with grant assistance to initial investment, financial feasibility of the project is secured at the level of fee rate which assures enough income to cover the whole cost (depreciation, additional investment cost, and operational expenses) required during the project period.

#### b.1.1. Financial Analysis of Case 1 (Normal public investment with no grant assistance)

Based on the estimated amount of MSW generation from household and business establishment and the total cost of PPWM-MSW collection in the M/P, the Study here estimated the required level of SWM collection fee rate to meet FIRR of more than 10%. The fee rate is estimated in US dollar per ton of waste collected. As the baseline case, the

fee collection ratio for household and business establishment is set at 80%, which is equal to the fee collection ratio of PPWM at NIP Zone in 2003, and 100 % for business establishment while the same fee rate is applied to household and business establishment. The fees per ton of waste collected from the households and business establishment are assumed as equal in the case of baseline.

The result of estimation under the assumptions above showed that the required fee rate of MSW collection to reach FIRR of 10% was 13.94 US dollars per ton of waste collected. In the case of applying this fee rate, the average monthly fee of MSW collection for household will be as shown in the table below.

Table 3-18: Estimated Fee Rate of MSW Collection for Household

	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015
Amount of MSW collected	Kg/month/household	102	107	113	118	124	113	119	125	113
Fee rate	US\$/month/household	1.42	1.49	1.58	1.64	1.73	1.58	1.66	1.74	1.58

Remark: The decrease of MSW collection amount in 2012 and 2015 comes from the increase in reduction of MSW generation at source by recycling, etc., which is assumed in the M/P.

#### b.1.2. Financial Analysis of Case 2 (with grant assistance to initial investment)

The Study here analyzes the fee rate of MSW collection in the case of providing grant assistance to fully cover the initial investment cost arising in 2005 and 2006. Financial feasibility of PPWM-MSW collection in this case is secured if it earns enough income to cover the whole project cost including depreciation, additional equipment investment and operational expenses arising during the project period. The result of estimation showed that the required fee rate of MSW collection were able to be lowered to 11.61 US dollars per ton of waste collected in the case with grant assistance. The average monthly fee rate of MSW collection per household in this case is shown in the table below.

Table 3-19: Estimated Fee Rate of MSW Collection for Household

	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015
Amount of MSW collected	Kg/month/household	102	107	113	118	124	113	119	125	113
Fee rate	US\$/month/household	1.18	1.24	1.31	1.37	1.44	1.31	1.38	1.45	1.31

#### b.1.3. Financial Analysis of PPWM-MSW Collection

The results of financial analysis above indicated that the required fee rate of MSW collection was different as shown in the table below between the case with and without grant assistance.

Table 3-20: Comparison of MSW collection fee rate between the cases with and without grant assistance

	Fee Rate (US\$/ton)	Household Fee Rate (US\$/month/household)				
		2007	2009	2011	2013	2015
Without grant assistance	13.94	1.42	1.58	1.73	1.66	1.58
With grant assistance	11.61	1.18	1.31	1.44	1.38	1.31

The reduction rate of MSW collection rate in the case with grant assistance remains at comparatively low level of 17%. It is mainly due to the low ratio of initial investment cost to the total project cost. The project requires replacement of MSW collection vehicles within the project period as well as additional investment for purchasing new vehicle to meet the expansion of collection area and increase in number of household subject to MSW collection. Furthermore, ration of the operation and maintenance cost such as fuel cost etc. to the project cost is comparatively high as 44%. All of these factors lower the effect of grant assistance upon financial viability of the project.

Even in the case with grant assistance, the required fee rate of MSW collection is higher by approximately 80% than the current collection cost of 7US dollars per ton of waste collected by PPWM in NIP Zone while it is more than 1.5-fold in the case without grant assistance. Moreover, the above fee rate is estimated with the comparatively higher assumption of fee collection ratio for household (80%) as well as business establishment (100%). The fee collection ratio may be lowered if the fee rate increases as shown above. However, the result of business establishment survey done by the Study showed that the current fee rate for business establishment is established at more than the household's one. Further investigation and analysis will be required for establishment of fee rate and collection ratio for household and business establishment.

## **b.2 Financial Analysis of Dang Kor Final Disposal Landfill**

The Study here makes a financial analysis of Dang Kor new final disposal landfill, which is responsible for sanitary landfill disposal of MSW collected in Phnom Penh. Similar with the case of PPWM-MSW Collection above, the analysis is made for the cases with and without grant assistance.

In analyzing the tipping fee at Dang Kor final disposal site, the Study assumes that the same fee rate is applied to CINTRI as well as PPWM. The required tipping fee rate for financially feasible operation of Dang Kor final disposal landfill is estimated in per ton of waste disposal. The tipping fee is collected on weight basis while its collection rate is assumed 100% for PPWM as well as CINTRI.

### **b.2.1. Case with no grant assistance**

Similar with the case of PPWM-MSW Collection, the required financial feasibility level in the case of normal public investment with no grant assistance is set at 10% of FIRR. The income from tipping fee collection is estimated as a result of multiplying the estimated amount of MSW disposed by PPWM and CINTRI by the tipping fee rate per ton of waste disposal.

Table 3-21: Estimated Amount of MSW Disposal by PPWM and CINTRI

	Unit: thousand tons/year								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
CINTRI	280	296	315	334	353	372	384	399	414
PPWM	57	65	74	82	87	103	115	126	148
Total	337	361	389	416	440	475	499	525	562

Besides the tipping fee collection above, the income from selling excavated soil and compost materials produced in the compost plant is included as the revenue of the project. The total cost of the project is taken from the estimation in the M/P. The result of financial analysis based on these assumptions showed that the required fee tipping fee rate to reach 10% of FIRR in the case with no grant assistance was 5.92 US dollars per ton of waste disposal,

which was more or less nine-fold of the current final disposal cost at SMC disposal site in 2002.

### **b.2.2. Case with grant assistance**

The Study analyzes the required tipping fee rate in the case with grant assistance to fully cover initial investment cost arising in the year from 2004 to 2006. Similar with the case of PPWM-MSW Collection, financial feasibility in this case is secured if the total project cost including depreciation, additional investment, and operational expenses arising during the project period is fully covered by the income. The result of analysis showed that the required tipping fee rate in this case was lowered to 4.4 US dollars per ton of waste disposal. Although the tipping fee rate can be reduced by about 25% in comparison with the case with no grant assistance, the project still requires seven to eight-fold of current disposal cost at SMC disposal site.

However, such low cost of final disposal at SMC disposal site stands at sacrifice of human health and environment by unsanitary open dumping of waste. The above estimation indicated the minimum cost required for the operation of waste landfill with proper consideration of human health, sanitation and environment.

Therefore, the Study concluded that the tipping fee rate of 4.4 US dollars per ton of waste disposal was the minimum cost required for proper operation of waste landfill to be equally collected from PPWM as well as CINTRI.

### **b.3 Analysis of Fee Rate for MSW Collection and Disposal and Its Impact Upon Household**

Based on the estimated fee rate for MSW collection and disposal above, the total fee rate of MSW management for household is analyzed here.

#### **b.3.1. MSW Service Fee in the PPWM Collection Area**

The total MSW service fee in the PPWM service area is estimated as follows:

##### **i) MSW Collection Fee**

The fee rates of MSW collection for household are estimated as follows in the case with and without grant assistance.

Table 3-22: Household Fee Rate for MSW Collection by PPWM

Unit: US dollar/month/household

	2007	2015
Case with no grant assistance	1.42	1.58
Case with grant assistance	1.18	1.31

##### **ii) MSW Disposal Fee**

The tipping fee to be paid by household is estimated as the result of dividing the product of the tonnage of MSW disposal collected from household and tipping fee rate per ton of waste disposal by the number of household subject to MSW collection by PPWM. The result of estimation is shown in the table below.



Table 3-23: Tipping Fee Rate to be Covered by Household

	Unit	2007	2015
Amount of waste disposal collected from household	ton/year	74,460	176,259
Number of household subject to MSW collection by PPWM	Number of household	64,530	135,731
(1) Case with no grant assistance	US\$/ton	5.92	
	US\$/month/household	0.57	0.64
(2) Case with grant assistance	US\$/ton	4.40	
	US\$/month/household	0.42	0.48

iii) **The Total Cost of MSW Service for Household**

As the result of estimation made in i) and ii) above, the total cost of MSW service for household is estimated as follows:

Table 3-24: Total Cost of MSW Service for Household

		2007	2015
With no grant assistance	MSW collection	1.42	1.58
	Final disposal	0.57	0.64
	Total	1.99	2.22
With grant assistance	MSW collection	1.18	1.31
	Final disposal	0.42	0.48
	Total	1.60	1.79

On the other hand, the result of the Study shows the willingness and affordability to pay of the household as shown in the table below.

Table 3-25: Household's Willingness and Affordability to Pay in 2003

1. Current fee rate	0.8~1.0US\$/month
2. Willingness to pay per household (Result from the Public Opinion Survey)	0.47US\$/month
3. Affordability to pay per household (0.5% of the average per household monthly income of US\$ 216 in rural 3Khans.)	1.08US\$/month

Although the current fee rate for household ranges from 0.8 to 1.0 Us dollar per household per month, the Study predicted the future affordability to pay of household based on the affordability to pay of 1.08 US dollars per month estimated above, assuming that it will increase with the rate of economic growth, as shown in the table below.

Table 3-26: Prediction of the Affordability to Pay of Household

Year	2003	2007	2008	2009	2010	2011	2012	2013	2014	2015
GDP	3.8	5.1	5.5	6.0	6.5	6.9	7.4	7.9	8.4	9.0
Growth rate	6.0	8.4	8.4	8.4	8.4	6.8	6.8	6.8	6.8	6.8
Minimum fee rate	0.80	1.07	1.16	1.26	1.36	1.46	1.56	1.66	1.78	1.90
Maximum fee rate	1.00	1.34	1.45	1.57	1.71	1.82	1.95	2.08	2.22	2.37
Affordable rate	1.08	1.45	1.57	1.70	1.84	1.97	2.10	2.24	2.40	2.56

The result of analysis on willingness to pay and affordability to pay of household above indicates that the increase in fee rate of MSW services for household needs to be minimized so that every household can afford to pay. The required household fee rate for the MSW services proposed in the M/P is 1.99US dollars per month per household in the case with no grant assistance while it is 1.60 US dollars in the case with grant assistance, ranging from 1.1 to 1.4 fold of the estimated minimum fee rate in 2007 given in the table above.

#### **b.4 Financial Appraisal of PPWM's MSW Services and Sensitivity Analysis**

The result of financial analysis made above indicates that the PPWM's MSW Services proposed in the M/P is difficult to implement in a financially viable manner without application of considerably higher fee rate for household even in the case with grant assistance.

In addition, the cases established for financial analysis above made comparatively optimistic assumptions on fee collection of 80% for household and 100% for business establishment. If they are lowered, higher fee rate is required for financially feasible operation of PPWM's MSW Services.

On the other hand, the fee rate for business establishment, which was set up at the same rate as household's in the analysis above, can be increased, taking into account its current fee rate, relatively higher benefit to obtain, and actual fee payment identified by business establishment survey.

Considering these conditions, the Study here made a sensitivity analysis of MSW services fee rate for household with the variables of fee rate and fee collection ratio of business establishment so as to examine possibility of lowering the fee rate for household by increasing the fee rate for business establishment.

According to the results of the sensitivity analysis, when the fee rate of business establishments is two fold that of households, the household fee rate becomes lower than the affordable fee rate shown in Table 3-26, even if the fee collection ratio is 70% in 2007. With the same condition, the household fee rate becomes lower than the minimum fee rate in 2015.

From a financial point of view, raising the fee of business establishment keeps the household fee rate below affordability even if the fee collection ratio is considerably low and the project implemented by PPWM is feasible.

#### **b.5 Recommendations regarding the implementation of the M/P from financial viewpoint**

Based on the result of financial analysis above, the Study makes the following recommendations regarding the implementation of the M/P from financial viewpoint.

- **Use of grant type assistance to cover initial investment for implementation of the M/P**

The result of financial analysis clearly shows that the M/P will not be financially feasible as a normal public investment since it requires the increase of current fee rate for household that cannot afford to be paid. The tipping fee rate for CINTRI also needs to be increased by about nine-fold.

Taking these into account, the Study strongly recommends that MPP should make its best effort of obtaining grant type assistance to cover the initial investment cost required in the M/P so that the household fee rate and tipping fee rate for CINTRI can be minimized.

- **Reduction of household fee rate**

To make PPWM-MSW Services financially feasible, the household fee rate needs to be increased by 1.5 to 2 fold. Such increase in the fee rate is difficult to accept for the average household in Phnom Penh since its income is not expected to grow by such rates. The increase in fee rate has to be minimized so that the M/P can be well accepted by household as well as fee collection can be maintained at high ratio.

The Study examined the possibility of raising the fee rate for business establishment as an option of minimizing the increase in fee rate for household based on the following rationales:

- Business establishment will receive higher quality MSW services than household, e.g. high frequency of MSW collection, door-to-door collection, etc.)
- Street sweeping and public cleansing services provided by PPWM will provide not only the benefit business establishment in terms of health and sanitation as well as improvement of its business environment.
- The current fee rate is set up higher than the required fee rate in the M/P in most of the types of business establishment. In addition, the business establishment survey done by the Study showed that the average monthly payment of business establishment for MSW services is about 14.6 US dollars per establishment. Although we have to consider the difference in type and scale of business establishment, it can be estimated that business establishment has a considerably higher affordability to pay than household.

The result of sensitivity analysis above showed that the increase in the fee rate for business establishment could lower the household fee rate even though it decreases fee collection ratio from business establishment to a certain extent. The Study strongly recommends that MPP should review the current fee rate system for households and business establishments based on the analysis results considering the affordability of households shown in Table 3-26, so that every MSW service users can well accept them.

- **Revision of current tipping fee rate for CINTRI**

The currently applied tipping fee rate for CINTRI is below 1 US dollar per ton of waste received. The required tipping fee rate for financially feasible operation of Dang Kor Final Disposal Landfill is 4.40 US dollars per ton of waste disposal even in the case with grant assistance. This cost is the minimum requirement for proper operation of MSW disposal landfill with proper consideration of human health and environment, replacing the currently operating unsanitary open dumping in SMC disposal site. The Study recommends that the above cost should be equally covered by PPWM and CINTRI based on the amount of MSW disposal.

- **Establishment of the new fee rate system for MSW services**

To make the M/P financially feasible, the current fee rate system needs to be improved to best reflect the actual cost arising from providing new MSW services proposed in the M/P. In the financial appraisal above, the Study estimated the required fee rate to cover the total cost of MSW collection and disposal per ton of waste collection and disposal on the basis of prediction of MSW generation by household and business establishment. The current fee rate system should also be improved so that the cost of MSW collection and disposal can be

equally covered by service users based on the amount of MSW they generate. Establishment of the weight/volume-based fee rate system is the foundation of sound and equal share of the cost by service users. It should be studied in detail in the F/S.

- **Maximizing fee collection ratio through better understanding of MSW services by users and establishment of reasonable fee rate**

To make the M/P financially feasible, the fee collection ratio has to be maximized to stabilize the project income. The key of high fee collection ratio is the people's understanding of the improved MSW services and establishment of reasonable and transparent fee rate system based on the actual cost arising from provision of MSW services.

- **MPP Budget allocation for street sweeping and public cleansing**

Since the above cost estimation does not include street sweeping and public cleansing expenses, they need be covered by MPP budget allocation. According to our estimation, it will annually cost 35,400 – 51,200 US dollars for providing such services in the PPWM service area.