



No.

REPUBLIC OF CUBA
MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT IN HAVANA CITY
PROVINCIAL DIRECTION OF COMMUNAL SERVICES

**THE STUDY
ON
INTEGRATED MANAGEMENT PLAN
OF
MUNICIPAL SOLID WASTE
IN HAVANA CITY
- REPUBLIC OF CUBA -**

**Final Report
《 Volume I : Executive Summary 》**



MARCH, 2007

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

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LIST OF VOLUMES

Volume I : Executive Summary

Volume II : Main Report

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PREFACE

In response to a request from the Government of the Republic of Cuba, the Government of Japan decided to conduct “The Study on Integrated Management Plan of Municipal Solid Waste in Havana City” and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected a study team comprised of experts from NIPPON KOEI CO., LTD. and PACIFIC CONSULTANTS INTERNATIONAL and dispatched the team between January 2004 and January 2006. In addition, JICA set up an advisory committee headed by Dr. Mitsuo Yoshida, Senior Advisor, Institute for International Cooperation, JICA, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of the Republic of Cuba and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and enhancement of the friendly relationship between our two countries.

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

March 2007

Ariyuki Matsumoto
Vice President
Japan International Cooperation Agency

March 2007

Mr. Ariyuki Matsumoto
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We are pleased to submit the final report of “The Study on Integrated Management Plan of Municipal Solid Waste in Havana City”.

Efforts for the appropriate collection, transportation, and disposal of solid waste generated by the general populace of Havana have been taken to secure public health. However, important aspects of solid waste management, such as the maintenance and replacement of existing waste collection/transportation equipment and operation of landfills, have become more difficult due to the serious economic conditions experienced since the collapse of the Soviet Union. The capability of the authorities concerned has not kept up with the increasing difficulty in preventing environmental pollution from inappropriate solid waste management. As a result, the living environment in the Havana region has been steadily deteriorating.

In order to tackle these problems, the aim of the Study was set to formulate a master plan for Havana City with an outlook to the year 2015 and to conduct a feasibility study for the prioritized project. The implementation and verification of pilot projects was also an integral component of the study process. The Study also undertook capacity development of the Cuban counterparts by jointly conducting many of the tasks of the Study to improve the capability of the responsible agencies for solid waste management.

We wish to express our sincere appreciation to the officials of JICA, the JICA Advisory Committee, the Ministry of Foreign Affairs, the Ministry of Environment, the Embassy of Japan for Cuba, and JICA Expert for Coordination in Cuba for their continuous support throughout the Study. Also, we would like to express our great appreciation to the Government of the Republic of Cuba, especially the counterparts for their active participation in the Study.

Finally, we hope that the outputs of the Study will contribute greatly to improve solid waste management in Havana City and to foster a long lasting partnership and friendship between the two nations of Cuba and Japan.

Yours faithfully,

JICA Study Team

Main Points of the Study

The Study consisted of: (1) the formulation of the Master Plan (M/P) for Municipal Solid Waste Management (MSWM) in Havana City with an outlook to the year 2015; (2) a pilot project (PLP) to test the practicability of projects suggested in the M/P; (3) a feasibility study (F/S) of the highest priority project included in the M/P; and (4) capacity development for Cuban counterpart staff with responsibility for solid waste management.

The Master Plan:

1. The M/P promulgates the following projects to upgrade the operational efficiency and environmental performance of solid waste management in Havana:
 - (1) Recycling: Recyclables to be recovered from the segregated waste at two new recycling centers (New Guanabacoa and Calle 100)
 - (2) Community composting: To be achieved with two new composting plants (New Guanabacoa and Calle 100) using segregated kitchen waste
 - (3) Home composting: To be introduced to households in eight sub-urban municipalities and gradually to expand the number of participating households at least until the year 2015
 - (4) Segregated collection: Initially to be introduced to two urban municipalities and later to seven urban municipalities, including procurement of collection vehicles and waste bins
 - (5) New landfills: Three new environment-friendly landfills to be constructed (New Guanabacoa for the eastern part of the City, and Calle 100 Extension and New Site 1 for the western part) and heavy equipment to be procured for their operation
 - (6) Closure of landfills: 11 existing landfills to be closed using environmentally appropriate measures. These are: the nine special period landfills, the existing Guanabacoa landfill, and the existing Calle 100 landfill and its extension
 - (7) Maintenance workshops: Equipment and tools to be procured to reinforce the functional capacity of the existing repair and maintenance workshops
2. When the above-mentioned projects are implemented, environmental mitigation measures and environmental monitoring plans specified in the IEE conducted during

the Study will be adopted. Similarly, social issues will be considered and awareness-raising will be carried out as an integral part of the implementation of each project proposed in the M/P.

3. The proposed projects will be implemented during the M/P period of 2007 to 2015. The attached figure shows the components and expected schedule of the proposed projects and the relevant supporting activities.
4. The estimated cost of the projects is US\$96.7 million in foreign currency (FC) and CUP138.4 million in local currency (LC) at 2005 prices. The cost is comprised of the following breakdown:

	<u>FC (US\$ million)</u>	<u>LC (CUP million)</u>
Capital cost	81.9	40.0
O/M cost for 9 years	14.8	98.4
Total	96.7	138.4

5. Within the economic analysis, four items were considered to derive economic benefit, and economic costs and benefits were calculated for foreign and local currency portions separately. The results indicate that the projects are not economically viable with respect to the foreign currency portion. However, due to the difficulty in placing a monetary value on the most important benefits, i.e., improving the hygiene and living environment of the city, the net benefit for input to a full economic evaluation was not assessed. In this kind of public service project, economic viability should not be regarded as a critical factor since the City is obliged to provide the services to a sufficient standard to safeguard public health and provide a hygienic living environment.
6. In reference to financial aspects of solid waste management, the M/P would not result in the operating agency becoming financially self-reliant in regard to operation and maintenance (O/M) work. For O/M to be sustainable, the government would be required to absorb the depreciation cost of facilities and equipment under the state account (no charge to the operating agency's account) and subsidize the MSWM by meeting the shortfall in revenue until such time as the DPSC is authorized to collect full fees from the designated recipients.
7. The M/P includes a proposal to restructure the responsibilities of the existing organizations, DPSC/UPPH and DMSCs, to act exclusively as regulators/supervisors and new Auroras to act as service providers. Six new Auroras are proposed, three for waste collection (one each covering the east, central and western parts of the City), one for landfill operation, one for managing and leasing equipment to the other Auroras, and one to serve as a holding company to manage the other five subordinate companies.

Pilot Project:

8. PLP was implemented as part of the M/P Study consisting of pilot operations for: (i) segregated waste discharge and collection, (ii) community composting, (iii) home composting, and (iv) weighing collected waste. In addition, landfill operations involving daily soil covering were conducted as a program for capacity development of counterpart personnel (C/P) and the present operating agencies (UPPH and DMSC).
 9. The major lessons learnt from the PLP were as follows:
 - (1) Segregated waste discharge and collection: Segregated discharge by residents was not always satisfactory in the initial period, but subsequent intensification of awareness-raising activities improved the residents' performance to an acceptable level. After the period of intense awareness-raising, the level of segregation soon declined again. This fact indicates the necessity of continuous awareness-raising for sustainable segregated discharge collection. In addition, the PLP highlighted how important it is for decision makers to understand the importance of awareness-raising and the provision of a reliable waste collection system with suitable equipment.
 - (2) Community composting: The trial operation in the PLP was of limited success due to the improper segregation of kitchen waste and a lack of experienced technical support. The quality of compost production could not be fully assured, and hence the requirements for successful community composting need to be further examined and confirmed through a new pilot project at some time in the future.
 - (3) Home composting: Most of the residents participating in the PLP were willing to conduct home composting, but some (11 out of 40) were not very active. The compost was thought to be of a quality acceptable for use in household gardening and farming during the pilot project period with monitoring and follow-up by the C/Ps and Study Team. After this period, however, some households did not continue home composting. Therefore, a more functional community-based approach should be taken so that home composting can take root.
 - (4) Waste weighing by truck scale: Staff dispatched from UPPH and DMSCs were able to conduct the work properly. The work is within
-

- the capability of present staff, provided that adequate training is given.
- (5) Landfill operation: Waste disposal by the cell method involving soil covering increased the operation of equipment and associated fuel consumption. Adequate planning of equipment operation, e.g., use of the right type and number of equipment, planning of orderly operation sequence, etc., is essential to minimize the increment of costs.

Feasibility Study:

10. F/S was conducted for the highest priority project, the procurement of equipment urgently required for the current operation of MSWM. The equipment listed for procurement are 12 collection vehicles (18 m³ compactor trucks), 27 units of heavy equipment (9 bulldozers, 6 dump trucks, 3 tank lorries, 4 power shovels, 2 shovel loaders, 2 wheel loaders, and 1 tow truck), 62 items of equipment and tools for the vehicle maintenance workshops, and 28 items of equipment and tools and two mobile workshops for the heavy-equipment maintenance workshops. The total procurement cost is estimated at US\$13.68 million in foreign currency and CUP15.31 million in local currency at 2005 prices.
11. In regard to financial considerations, the operating agency will be financially sustainable for the O/M of equipment on the condition that the government provides the support described in Para. 6 above.

Capacity Development:

12. One of the objectives of the Study was to undertake capacity development of C/Ps assigned to the Study. The capacity development was conducted by means of (i) lectures, (ii) on-the-job training, (iii) participation in workshops and meetings with the communities, and (iv) training in Japan.
13. The attainment of capacity development was evaluated in the middle and at the end of the Study. The evaluation showed that the C/Ps achieved a fair degree of attainment (excellent to fair varying by C/P) of knowledge on and ability for MSWM and incentives for continuing to contribute to this work in the future.

The Master Plan - Proposed Implementation Schedule

Description	Year											Remarks	
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015		
Proposed Project:													
1 Collection and Transportation													
1.1 Revision of Collection System in Existing Horse-Driven Cart													
(1) Planning of revised collection system													
(2) Procurement of equipment and materials													
1.2 Review and Continuous Updating of Collection System													
(1) Continuous review and updating of collection frequency and bin installation													
(2) Procurement of steel bins for replacing plastic bins													
1.3 Introduction of Segregated Collection													
(1) Awareness-raising program													
(2) Introduction in 2 municipalities													
(3) Introduction in 5 municipalities													
(4) Vehicle procurement to meet the segregated collection													
1.4 Monitoring and Improvement of Activities													
2 Landfill													
2.1 Construction of New Landfills													
(1) New Guanabacoa Landfill													
(i) EIA study and approval													
(ii) Design and contract procurement													
(iii) Construction													
(2) New Landfill 1													
(i) EIA study and approval													
(ii) Land acquisition and resettlement													
(iii) Design and contract procurement													
(iv) Construction													
(3) Expansion of Calle 100													
(i) EIA study and approval													
(ii) Design and contract procurement													
(iii) Construction													
2.2 Closure of Existing Landfills													
(1) Special Period Landfill													
(i) EIA and monitoring plan													
(ii) Design and contract procurement													
(iii) Construction													
(2) Existing Guanabacoa Landfill													
(i) EIA and monitoring plan													
(ii) Design and contract procurement													
(iii) Construction													
(3) Existing Calle 100 Landfill													
(i) EIA and monitoring plan													
(ii) Design and contract procurement													
(iii) Construction													
3 Reinforcement of Maintenance Workshops													
3.1 Procurement of Equipment and Tools													
3.2 Training of Staff and Workers													
4 Recycling and Composting													
4.1 Recycling Centers													
(1) Planning, design and contract procurement													
(2) Construction													
4.2 Community Composting													
(1) Continuation of trial operation for confirmation of quality													
(2) EIA study and approval													
(3) Design and contract procurement													
(4) Construction													
4.3 Home Composting													
(1) Awareness-raising program													
(2) Procurement of compost bins for delivery to households													
(3) Introduction in 8 municipalities													
(4) Monitoring and improvement of activities													
Supporting Activities:													
5 Regulations and Standards													
5.1 Legislation													
(1) Preparation of overall regulations for MSWM													
(2) Revision of EIA regulations to include social aspects													
(3) Legislation to authorize DPSC to sell recyclables to free markets													
5.2 Standards and Guidelines													
(1) Guidelines for landfill construction and operation													
(2) Standards for leachate													
(3) Standards for composting products													
6 Organizational and Institutional Aspects													
6.1 Establishment of a Task Force for Supporting Awareness-Raising													
6.2 Reformation of MSWM Organizations													
6.3 Mobilization of New Aurora Enterprise													
6.4 Collection of Fees from Recipients													

Legend: Continuous Activity Intermittent activity Commencement of Operation

EXECUTIVE SUMMARY

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Abbreviations

<Organizations>

CDR	Committee for Defense of Revolution
CITMA	Ministry of Science, Technology and Environment
CPC	Communist Party of Cuba
DMSC	Municipal Direction of Communal Services
DPSC	Provincial Direction of Communal Services
ERMP	Enterprise for the Recovery of Raw Materials
FMC	Federation of Cuban Women
GRC	Government of the Republic of Cuba
GOJ	Government of Japan
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
MEP	Ministry of Economy and Planning
MINAGRI	Ministry of Agriculture
MINSAP	Ministry of Public Health
MRF	Future Recovery Movement
UERMP	Association of Enterprises for the Recovery of Raw Materials
UPPH	Provincial Unit of Hygiene
WAL	Waste Analysis Laboratory

<Others>

3R	Reduce, Reuse, and Recycle
BOD	Biochemical Oxygen Demand
C/T	Compactor Truck
C/P	The Cuban Counterpart
CDP	Capacity Development Program
D/T	Dump Truck
DF/R	Draft Final Report
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EPEA	Provincial Strategy for Environmental Education
FC	Foreign Currency
FIRR	Financial Internal Rate of Return
F/R	Final Report
F/S	Feasibility Study
GDP	Gross Domestic Product
GNP	Gross National Product
GRP	Gross Regional Product
H/C	Horse-driven Cart
HDPE	High-density Polyethylene
IEE	Initial Environmental Examination
LC	Local Currency
M/P	Master Plan

MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NGO	Non-Governmental Organization
O/M	Operation and Maintenance
PDM	Project Design Matrix
PLP	Pilot Project
PVC	Polyvinyl Chloride
SC	Steering Committee
SPL	Special Period Landfill
SS	Suspended Solids
SWM	Solid Waste Management
T/C	Tractor-driven Cart
WS	Workshop
WTP	Willingness to Pay

Measurement Units

Area

cm² = square-centimeters
m² = square-meters
km² = square-kilometers
ha = hectares (10,000 m²)

Length

mm = millimeters
cm = centimeters
m = meters
km = kilometers

Currency

US\$ = United States dollars
US\$1.00 = J¥110
(September 2004)
J¥ = Japanese yen
CUC = Cuban convertible peso
CUP = Cuban local peso

Volume

cm³ = cubic-centimeters
m³ = cubic-meters
lit = liters

Weight

gr = grams
kg = kilograms
tons = metric tonnes

Time

sec = seconds
min = minutes
hr = hours

PART 1 INTRODUCTION OF THE STUDY

1.1 Background of the Study

The government of the Republic of Cuba (GRC) requested the government of Japan (GOJ) to conduct a study for the purpose of formulating an integrated management plan for municipal solid waste in Havana City. In response to the request of the GRC, the GOJ decided to conduct the ‘Study on Integrated Management Plan of Municipal Solid Waste in Havana City’ (hereinafter referred to as “the Study”).

The Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the government of Japan, dispatched a Preparatory Study Team to Cuba during the period from July 29 to August 8, 2003 to discuss the scope of works and other study requirements. The ‘Scope of Work’ agreed between Havana City and the JICA Preparatory Study Team on August 7, 2003 is contained in Appendix I, and the relevant Minutes of Meeting in Appendix II, both attached to the Main Report.

In accordance with the agreed Scope of Work, JICA dispatched the Study Team to Cuba at the beginning of February 2004 to commence study activities. Since then, the Study Team has conducted investigations and undertaken studies in Cuba and at the home office in Japan up to September 2005. After explanation and discussion of the draft final report, the Study Team reviewed and compiled all the outputs from the Study for finalization in March 2007.

1.2 Objectives of the Study

The objectives of the Study were as follows:

- a) To formulate the master plan (M/P) for integrated management of municipal solid waste in Havana City.
- b) To conduct the feasibility study (F/S) on priority project(s) to be selected from the M/P and implement pilot projects.
- c) To pursue technology transfer to the counterpart personnel during the course of the Study.

1.3 Scope of the Study

The scope of the Study was set as follows:

- a) The target year adopted for the M/P was set as 2015. A long term vision for solid waste management to the year 2025 was also to be prepared.
- b) The type of solid waste to be studied was municipal solid waste (MSW) generated in Havana City. With respect to medical waste and industrial solid waste, the Study was to be limited to examining current conditions and problems with collection, disposal, and the operation and maintenance capacity of relevant organizations; recommendations relating to these aspects were to be made as required.
- c) The Study was to cover all aspects of MSWM, including collection, transportation, and disposal of all types of municipal solid waste, recycling, institutional and organizational frameworks, awareness-raising, social and environmental considerations, and project evaluation.
- d) The Study was to include pilot projects, workshops and an awareness study.

1.4 Study Area

The study area agreed in the Scope of Works covers all 15 municipalities of Havana City, comprising 105 districts (communal zones). The Study Area has a total area of 727 km² and population of approximately 2.2 million. A map of the Study Area is shown in Figure 1.1.1

1.5 Study Period

The Study was commenced in January 2004 and was completed in March 2007. The major outputs during the Study period were:

Month/Year	Reports/Workshops
February 2004	- Inception Report
March 2004	- First Capacity Development Workshop - First Dissemination Workshop
July 2004	- Progress Report (1)
October 2004	- Second Dissemination Workshop (Pre Implementation Workshop for the PLP)
November 2004	- Second Capacity Development Workshop - Interim Report
March 2005	- Mid-term Workshop for the PLP - Progress Report (2)
June 2005	- Post Implementation Workshop for the PLP
July 2005	- Third Capacity Development Workshop
September 2005	- Draft Final Report - Seminar to present the results of the Study
January 2006	-explanation meeting in Cuba
March 2007	- Final Report

1.6 Cuban Counterparts

The counterparts to the Study Team were to be, in principle, personnel from the Ministry of Science, Technology and Environment in Havana City (CITMA – Havana) and the Provincial Direction of Communal Services (DPSC).

1.7 Final Report

This Final Report is hereby submitted as the final product of the Study.

The Report presents (i) the M/P for municipal solid waste management in Havana City toward 2015, (ii) results and findings from pilot projects (PLPs), (iii) feasibility study (F/S) on the priority projects, and (iv) the results of capacity development conducted during the course of the Study.

The Final Report consists of the following 4 volumes:

Volume I	Executive Summary (this volume)
Volume II	Main Report
Volume III	Supporting Report
Volume IV	Data Book

In the Main Report, the M/P is described in Chapter 5 of Part 2, PLPs are in Part 3, the F/S is in Part 4, and the capacity development is in Part 5.

All reports were written in English. Japanese and Spanish versions of the Executive Summary were prepared and a Spanish version of the Main Report was prepared.

Before preparation of this Final Report, the draft final report was explained and discussed at the Steering Committee meetings held in September 2005. An additional explanation of the revised draft final report was also conducted in January 2006. The Final Report was prepared incorporating the comments from the Committee and other relevant agencies.

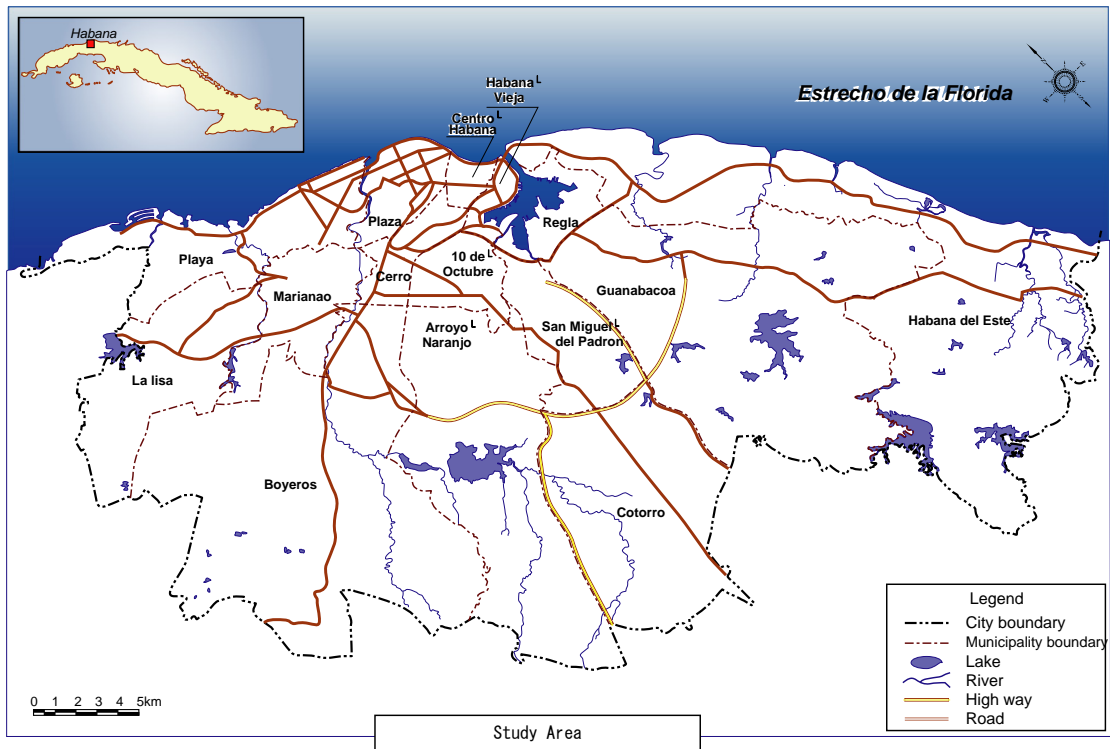


Figure 1.1.1 Map of the Study Area

PART 2 THE MASTER PLAN

CHAPTER 1 FORMULATION OF THE MASTER PLAN

1.1 Joint Responsibilities for Formulation of the Master Plan

One of the objectives of the Study was to formulate the M/P for MSW in Havana City, while simultaneously conducting capacity development of the C/Ps.

An expected outcome of the capacity development was that the C/Ps would develop the M/P through active participation and using their own initiative to provide a sense of ownership of the Study (see “Part 5 Capacity Development”). The C/Ps were also expected to acquire the ability to revise the M/P in the future with passive assistance from foreign advisers/experts.

To achieve these objectives, the M/P was formulated with the following joint responsibilities, considering the present capacity of the C/Ps and their busy work circumstances.

- In principle, the C/Ps formulated the M/P with technical assistances from the Study Team as necessary.
- Technology transfer for the formulation of the M/P was conducted by joint work including on the job training (OJT). Each C/P was paired with one expert from the Study Team with expertise in a particular field.
- Field surveys and the PLP, which were conducted to understand the current MSWM conditions were jointly planned, implemented, and verified through the frequent consultations between the C/Ps and the Study Team.
- Ideas for the draft M/P were first discussed by the experts from both sides and then prepared by the Study Team in documents.
- The draft M/P was then brushed up through a series of discussions among the C/Ps, the Study Team, and the organizations concerned such as CITMA, DMSC, ERMP, MINAGRI, Auroras, Havana Municipality, etc.
- The main points of the projects proposed in the draft M/P were also discussed and confirmed at the Steering Committee (SC), then the comments made by Cuban side were fed back to revise the draft M/P. Memoranda of discussions at the SC are attached to the Main Report as APPENDIX 3.
- The final draft of the M/P (Draft Final Report (DF/R)) was produced by the Study Team in September 2005. After receiving comments from the Cuban side on the DF/R, the main points of the M/P were again discussed and

confirmed by both sides in January 2006 and the M/P was finalized in this Final Report (F/R).

Therefore, although the reporting work has been the responsibility of the Study Team, the M/P presented in Chapter 3 was formulated fully based on the intentions of the Cuban side with their active participation to the greatest possible extent.

1.2 Steps in the Formulation of the Master Plan and Points Considered

The M/P was formulated through the following steps.

- 1st Step: Review of current situation of SWM and problem analysis
- 2nd Step: Setting of future framework and projection of waste quantity and quality in the future
- 3rd Step: Setting of the social economic conditions and long-term vision of SWM towards 2025
- 4th Step: Consideration of SWM strategies towards 2015
- 5th Step: Preparation of the draft MP
- 6th Step: Preparation of the implementation plan for the PLP and outlining of the draft M/P to residents as background to the PLP
- 7th Step: Implementation of the PLP and review of the draft MP based on evaluation of the results and lessons learned from the PLP
- 8th Step: Preparation of the DF/R with the final draft M/P and confirmation of its contents
- 9th Step: Formulation of the M/P (finalization)

In conducting the above steps, the most crucial point to be considered was the feasibility of the M/P. Therefore, the results of the PLPs were to be used to verify the proposed measures of the M/P and fed back into the formulation of the M/P. As shown in detail in Part 3, however, the results of the PLP could not fully verify the feasibility of all projects proposed in the M/P.

Considering that the PLPs were conducted within the limitations of the Study timeframe and resources, it cannot be concluded that the proposed projects should be rejected based only on the results of the PLP.

Therefore, the C/P and the Study Team identified the issues that need to be resolved when the projects in the M/P are implemented. Those issues are summarized in Chapter 4.

CHAPTER 2 CURRENT CONDITIONS AND PROBLEMS OF SOLID WASTE MANAGEMENT IN HAVANA CITY

2.1 General Condition of Present Municipal Solid Waste Management

Havana City, with an area of 727 km² and population of 2.2 million, is the capital of the Republic of Cuba and is the center of economic activity in the country. The City is known as an international tourist destination and the area known as the “old city” is designated as a world heritage area. Administratively, Havana City consists of 15 municipalities comprised of 105 districts.

At present, several organizations are involved in municipal solid waste management (MSWM) in the City at various operational levels. UPPH (Provincial Unit of Hygiene) under the DPSC (Provincial Direction of Communal Services) is in charge of MSWM at the City level and DMSC (Municipal Direction of Communal Services) at the municipality level. In addition, 4 public corporations¹, called ‘Aurora’, are also involved in solid waste collection. (Ref. Subsection 2.8.1 for more detail of the organizations.)

The quantity of solid waste generation and disposal at present is summarized in Table 2.2.1 below.

Table 2.2.1 Quantity of Solid Waste Generation and Disposal at Present

No.	Description	Unit: tons/day Quantity
a	Generation of Municipal Solid Waste	2,216
	- Domestic waste	1,517
	- Commercial waste	179
	- Bulky waste and other wastes	520
b	Reuse and Recycling	43
	- Material recovery by the DPSC/UPPH	10
	- Production of compost by the DPSC/UPPH	3
	- Material recovery by ERMP	30
c	Estimated Quantity of Illegal Dumping and Self-treatment	16
d	Final Disposal of Municipal Solid Waste=(a-b-c)	2,157
e	Generation of Industrial and Medical Wastes	372
	- Industrial waste	350
	- Medical waste	22
f	Total Generation of Solid Waste =(a+e)	2,588

Source: Estimated by waste quantity and quality survey conducted under the Study in 2004

Note: ERMP: Enterprise for Recovery of Raw Material

Domestic waste: Household waste

Commercial waste: Waste generated from business and economic activities

Bulky and other wastes: Construction waste, yard waste, trees, branches, etc.

Medical waste is solid waste generated in hospitals, which contains both hazardous and non hazardous waste.

¹ Of the 4 Auroras, 2 are actively in operation in 2 municipalities; one each in Plaza Municipality and Habana Vieja Municipality, while the activities of other 2 Auroras are only operating at a small scale.

Of the above quantity of municipal solid waste (MSW), UPPH, DMSC and Auroras are collecting 1,507 tons/day (see Table 2.2.2 hereinafter), and the remainder is collected and disposed of by the individual institutions that generated the waste. As stated in Table 2.2.1, the majority of waste is disposed of at final disposal landfills and the quantity of reuse and recycling remains small.

Collection of MSW in the City is carried out by compactor truck (C/T), dump truck (D/T), tractor-driven cart (T/C) and horse-driven cart (H/C), depending on the area. At the landfills, waste is disposed of by open-dumping without soil covering.

Presently, waste is discharged as mixed waste. Under the condition of mixed waste discharge, UPPH and DMSC will face a difficulty in quality control for recovering recyclable materials and producing compost. The mixed waste also often contains hazardous wastes of industrial and medical waste origins.

Economic difficulties, experienced especially since the collapse of the Soviet Union, have had an adverse impact on solid waste management in Havana City, resulting in significant deterioration in the performance of waste collection owing mainly to deterioration in the condition of collection vehicles and heavy equipment used for solid waste management.

Fourteen final disposal sites for solid waste operate in Havana City at various scales. None employ pollution control measures such as leachate treatment or soil covering operations. Most sites are causing adverse impacts on the surrounding environment.

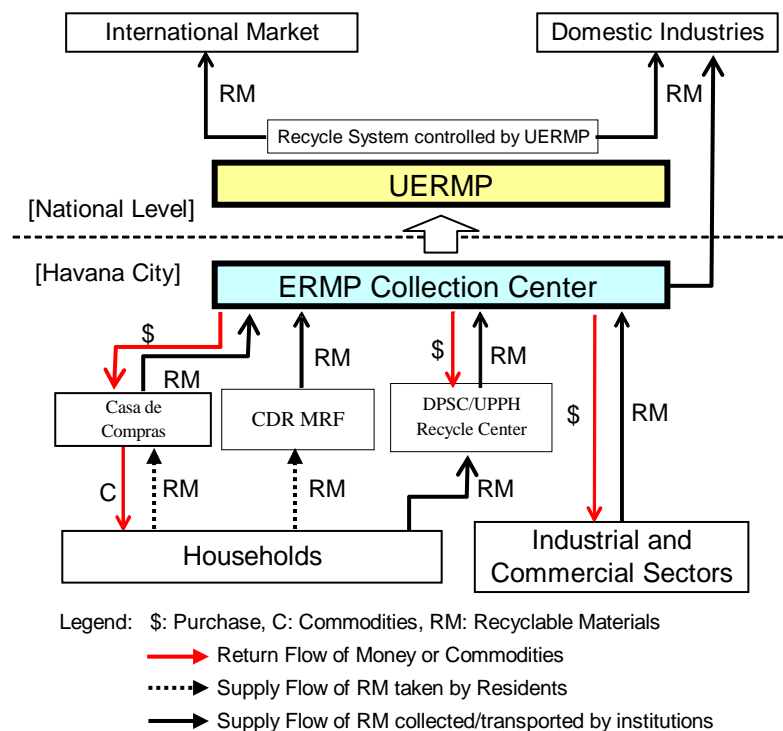
Of the 14 sites, 4 are relatively large-scale sites collecting waste from wide areas of the City. Of the 4 large sites, 2 are almost filled with waste and require closure within a few years. The other 10 small-scale sites, called 'special period landfill (SPL)', were constructed after the economic crisis with the intent of being used as temporary facilities until large-scale landfills could be constructed. The SPLs were located closer to the collection areas to reduce transportation costs during the economic crisis. However, 3 of the 10 sites were already closed and another 6 are also scheduled to which a few years due to environmental problems these are causing for adjacent areas.

Another issue is the lack of long-term planning. Although the City and organizations concerned are making efforts to improve MSWM, a long-term management plan has not yet been formulated.

2.2 Recycling

UERMP (Association of Enterprises for the Recovery of Raw Materials) is a national organization and controls all material recovery activities in Cuba. As an agency of UERMP, ERMP (Enterprise for the Recovery of Raw Materials) of Havana City collects 95-234 tons/day of recyclable materials directly from the industrial and commercial sectors and, in addition, 18-30 tons/day from the municipalities of the City through the community based organizations such as Casa de Compras, CDR (Committee for Defense of Revolution), MRF (Future Recovery Movement²), and the DPSC/UPPH.

The flow of recovered recyclable materials in Havana City and Cuba at present is shown in Figure 2.2.1. Presently, the majority of recovered recyclable materials (including those recovered by the DPSC/UPPH) are processed by ERMP, which pays the community based organizations in return for the material recovered, but at less than the market price. In regard to CDR and MRF, however, no payment is made because of the policy of voluntary activity. On the one hand, the waste quantity and quality survey conducted during the Study revealed that un-recovered materials remain in the MSW stream, indicating there is further potential for recovering recyclable materials from MSW.



Note : Data of recycling quantity for each organization is not available.

Figure 2.2.1 Flow of Recovered Recyclable Materials in Havana City and Cuba

² MRF: Future Recovery Movement, student activity for material recovery.

As indicated in the above Figure, the DPSC/UPPH is involved in recovering recyclable materials generated from household waste. The DPSC has a recycling plant located close to Calle 100 provincial landfill. However, the plant is not fully operating due to frequent malfunctions in plant facilities (e.g. pressing machine for cardboard, belt conveyor). Another reason for low production is the difficulty in recovering recyclable materials from mixed wastes collected from the City.

The materials recovered by the DPSC (through UPPH) over the past several years have been sold to industries under the control of UERMP. The quantity of materials recovered by the DPSC has fluctuated between 1 and 10 tons/day varying by day. The quantity is expected to increase by improving the performance of the recycling plant and also introducing segregated waste collection.

Under the present regulation, all collected recyclable materials have to be sold to market through channels established by UERMP. The DPSC and other MSW collecting agencies (e.g. Aurora) have no authorization to directly access the market. If the MSW collecting agencies were allowed to directly access the market and seek the opportunity of selling at their favored price, it would certainly provide an incentive to increase the recovery of recyclable materials. This is particularly effective where the operating agency is an Aurora, which should seek financially self-reliant operation by maximizing revenue. However, this concept requires amending the existing regulations and hence is subject to the approval of the government.

2.3 Composting

The waste quantity and quality survey conducted in the Study explained that organic material from kitchen waste and yard waste accounts for 50-60% of household and commercial waste. The reduction of organic waste in the waste stream by utilizing it for other purposes could help extend the service life of the landfills and decrease the work load of MSWM. A possible measure is the use of organic waste for composting. With this objective, the DPSC has so far undertaken the production of composting using MSW by providing composting yards at 3 provincial landfill sites: Calle 100, Guanabacoa, and Ocho Vias landfills.

Of the 3 composting yards operated by the DPSC, however, none have adequate facilities or equipment at the sites other than heavy machinery that is usually used for the operation of landfills; therefore, the organic waste has been piled in the open and exposed to direct sunlight and rainfall, which is not conducive to the

composting process. Most compost produced at the existing landfills is used as a cover soil or as soil for planting vegetation at the landfill sites. Only some of the product is sold to market as humus (earthworm compost). If better quality compost is secured, it could be used for more sophisticated purposes (e.g., as humus, soil conditioners, and fertilizers) and marketed.

The Ministry of Agriculture (MINAGRI) is intensively promoting organic agriculture in the country, partly because of the difficulty of importing chemical fertilizers and also because of a worsening problem of soil degradation. In accordance with this policy, agricultural residues and animal manure are used for producing compost and humus by agricultural enterprises. The agricultural enterprises produce and sell compost and humus in their shops (at a price of CUP2.50/kg).

According to MINAGRI, there are 10,560 ha of farmland in Havana City contributing to the potential demand for organic materials for use as soil conditioner. The quantity of compost that could be consumed by this quantity of farmland is estimated as 529,000 tons/year, greatly exceeding the amount that could be produced from the present quantity of organic waste.

2.4 Collection and Transportation

2.4.1 Waste Collection and Transportation

UPPH mainly collects MSW from urban areas in the 7 municipalities. These municipalities require more efficient collection because they have a high population density and generate large volumes of waste. DMSC covers the areas not serviced by UPPH, mainly in suburban and rural areas.

UPPH collects daily household waste from 13,000 waste bins installed along the curbsides of roads. DMSCs collect household waste daily by collecting bags or buckets discharged by residents along the curbsides.

For urban areas, UPPH is carrying out so-called “specialized collection” with compactor trucks (C/T) on 51 collection routes. DMSCs collect waste by tractor-driven cart (T/C), dump truck (D/T) and horse-driven cart (H/C). H/C is operated by workers employed by DMSC on a contract basis.

The quantity of waste collected by UPPH and DMSCs is summarized in Table 2.2.2. Presently, UPPH collects 703 tons/day and the DMSCs collect 237 tons/day of domestic and commercial waste. The DMSCs also have responsibility for collecting the bulky waste and others.

Table 2.2.2 Summary of Quantity Survey of Waste Collected by UPPH and DMSC

Unit: tons/day

Type of Waste	UPPH	DMSC			Total
		H/C	D/T	T/C	
Domestic and commercial waste* (%)	703 (75%)	75 (8%)	81 (9%)	81 (9%)	940 (100%)
Bulky waste and others	0	0	567**		567
Total	703	75	729		1,507

Source: Eight days field survey by the Study Team and UPPH in March 2004.

Note: * These values for domestic and commercial waste were based on the actual measurement at the surveyed landfill sites as mixed and the estimation for SPLs.

** The bulky waste and others consist of construction waste, yard waste, trees, and branches. This amount fluctuates by season, and 567 tons are assumed to be rather high because branches are more commonly cut before the hurricane season comes in summer.

UPPH had a total of 65 C/T (but only 40 are in service) in 2004. According to the result of the waste quantity survey conducted in March 2004, the operation distance of C/T was around 100 to 150 km/day³ with 2 trips per day in 8-9 working hours. The size of work crews is 3 to 5 persons per C/T, including the driver.

From the SWM expenditure data of Havana City in 2003, CUP⁴91 million and CUC0.9 million were spent on collection activities, excluding administration costs, which accounted for 58% (CUP) and 45% (CUC) of the total expenditure.

2.4.2 Vehicle Maintenance Workshops

The major problem in waste collection and transportation is the deteriorated work performance of collection vehicles. The vehicles are old and often out of service due to mechanical breakdown. Repair and maintenance of equipment is difficult due to a shortage of spare parts and tools arising from budgetary constraints.

One main UPPH workshop provides the maintenance service for all C/Ts owned by UPPH; it is also supporting the 14 DMSC maintenance workshops. A total of 40 employees comprised of engineers, technicians and workers are assigned at the main workshop. They check all vehicles every day before the vehicles leave the workshop to commence collection operations. They also undertake daily repair and maintenance work depending on the availability of required spare parts.

A total of 151 workers are working at the 14 DMSC workshops. The repair and inspection procedures are the same as at the UPPH workshop.

A major problem is that all the workshops do not have enough equipment, tools and spare parts. More than several vehicles are usually awaiting repair at any time.

³ Result of an 8 day field survey by the Study Team and UPPH in March 2004. Relatively long operation distance is due to remote location of landfills from the collection area.

⁴ CUP: Cuban Local Peso, CUC: Cuban Convertible Peso

2.5 Final Disposal

When the Study was commenced in the field, there were 14 landfill sites in Havana City. 3 of them: Calle 100, Guanabacoa, and Ocho Vias, are provincial landfill sites operated by the DPSC. One site, Barrenas, is a municipal landfill site. The other 10 are so-called ‘special period landfill’ (SPL) sites built as temporary facilities for use during the economic crisis until new large-scale landfills could be constructed and serviced by suitable transportation vehicles. The location of the landfills and approximate collection area of each is shown in Figure 2.2.2 below.

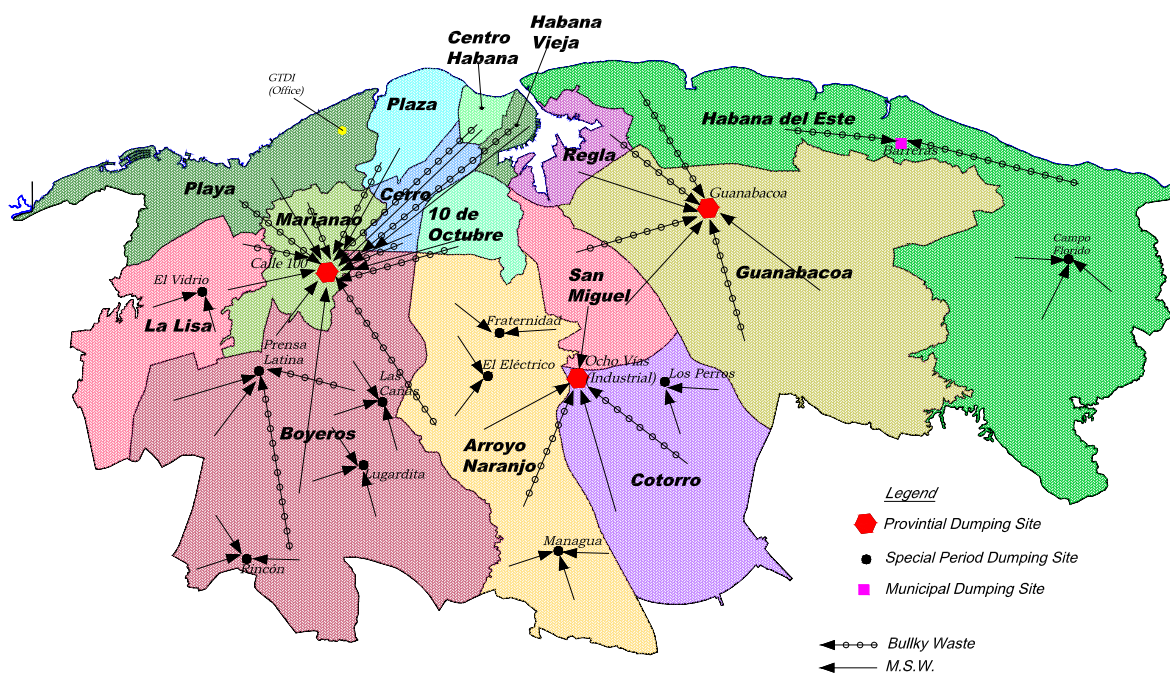


Figure 2.2.2 Location and Collection Area of Each Landfill (2004)

Of the above landfills, Guanabacoa and the 3 SPLs were closed in March 2005 because they were causing environmental problems in the surrounding areas. The waste from areas that was previously transported to Guanabacoa is now being disposed of in the Ocho Vias and Campo Florido landfills. The waste previously hauled to the 3 SPLs is now being directed to the Calle 100 landfill.

The most impending problem is the limited remaining capacity of existing landfills compared with waste volume being currently generated. The existing Calle 100 landfill is foreseen to be at full capacity by 2006 and, similarly, the existing Campo Florido landfill within 2005. To take over the function of these existing landfills, securing of new landfill area is under planning at 3 sites; New Guanabacoa, Calle 100 Extension, and Campo Florido Extension sites. Since the

service life of Calle 100 Extension is presumed to be only up to 2010, construction of a new landfill will be required by that period.

Many types of waste are dumped together at the landfill sites. Segregation of industrial waste, construction waste, medical waste, etc. is not performed properly at present. None of the landfill sites are operated in the manner of meeting the requirements of a sanitary landfill; i.e., there are no liner facilities in the foundation, no leachate collection and treatment, and no daily soil covering operation. Some construction waste is used as cover soil but the quantity is far from sufficient.

There is no truck weighing facility, although this is essential equipment for the monitoring and control of waste quantities disposed of at a landfill site. Waste volumes hauled to the landfills are estimated only by counting the number of trips of vehicles.

Regarding the budget allocation for direct landfill operation cost, only CUP7.6 million and CUC72,000 are allocated in 2003. This is 5% in CUP and 3.6% CUC of total SWM expenditure in Havana City. Such a small budget causes inappropriate landfill operation.

2.6 Environmental and Social Considerations

2.6.1 Environmental Considerations

The Cuban Environment Law was established in 1997. The Ministry of Science, Technology and Environment (CITMA) is the central governmental institution responsible for environmental aspects in Havana City. Although periodic monitoring of climate and air quality has been implemented following the national standards for environmental monitoring, the parameters monitored, locations and frequency of monitoring conducted over the last 5 years were insufficient mainly because of a lack of monitoring equipment and even consumables. In particular, the monitoring of landfill sites has been insufficient, and there are no data to grasp the environmental conditions in and around the landfill sites.

Development, expansion and modification of projects in Cuba require acquisition of an environmental license, which should be obtained through environmental considerations at the time of land use planning, location approval, environmental impact assessment (EIA) and preparation of an environmental monitoring plan.

Construction and operation of facilities related to MSWM require an EIA process. However, enforcement of this important mechanism in the MSWM sector has not been conducted properly, mainly due to budget constraints.

Present major environmental problems related to MSWM are summarized as below. All of them are regarded as hazard to people's health and livelihood.

- 1) Littering of waste around waste bins or trash boxes in the City due to insufficient alignment of those and illegal dumping of waste
- 2) Overflow of waste from waste bins due to irregular collection of waste
- 3) Environmental aggravation around landfill sites due to scattering of waste, odor, breeding of insects, spontaneous combustion, and degradation of water quality in surface and underground water bodies
- 4) Air pollution due to exhaust gases from aged equipment used for waste collection
- 5) Potential hazard to public and especially workers engaged in MSW collection and disposal due to mixed discharge of industrial and medical hazardous waste in MSW

2.6.2 Social Considerations

The social consideration framework in Havana City comprises 2 major tools: the Environmental Impact Study (EIS) required under the Cuban EIA procedure and the Provincial Strategy for Environmental Education (EPEA). The EIS is used to examine social aspects involved in projects and identify the potential issues through public hearings. The EPEA is a strategy that contemplates environmental education in general, with some aspects dealing with solid waste. The strategy is disseminated to people at all occasions of awareness-raising and education activities held for the projects. At present, however, these tools are not effectively utilized.

A compulsory requirement in EIS (or EIA) is to organize a public hearing during its preparation, the results of which have to be considered and the problems addressed in the final EIA report. At present, however, this requirement is not well implemented. Officials from CITMA have indicated that they will start to improve the enforcement of the public hearing requirements of EIA.

Some deficiencies can still be identified in the process of EIA; for example, technical teams responsible for the elaboration of the EIA are usually made up exclusively of professionals from technical fields, with social experts rarely included. This is an indication of the extent to which social impacts have been neglected.

The above suggests the need for further elaboration of EIA procedures for improving social considerations in the MSWM sector. The improved EIA

procedure would focus on problem identification and systematic documentation of social aspects involved in each project.

One of the most crucial problems is the negative impact of the existing landfills on the surrounding people. Smoke and odor often make local people complain to Havana City, and people are also exposed to health risks caused by leachate contamination of ground and surface waters. This causes more serious opposition to new landfill construction.

2.7 Awareness-Raising

Most environmental education and awareness-raising activities are done through government organizations, where CITMA takes the most important role. The government of Cuba gives a very high priority to education, so a comprehensive government structure is in place for all types of awareness-raising and environmental education activities. In addition, social organizations at the community level, such as the delegates of the “*circunscripciones*” (neighborhood) and the Committee for Defense of the Revolution (CDR), greatly facilitate efforts in accessing the population and obtaining their participation. MSW issue has been one of the subjects raised occasionally in the discussions at communities through these channels.

Notwithstanding the existing efforts, there are still some instances of waste littering around the waste bins of the City. This inadequate behavior owes to a lack of social discipline insufficient enforcement of laws on the part of the administration, and inappropriate waste collection service. The former is probably because people are simply not conscious of the need for proper MSWM, which must be rectified by intensifying public awareness-raising and education.

Although the DPSC formally nominates staff members to be responsible for contact with the public for awareness-raising and environmental education, these staff members do not seem to be assigned properly at present.

There is no centralized function to file complaints regarding MSWM at present. This makes it difficult for residents to request actions to be taken or to report problems to be solved. The provision of such a contact point, with standardized procedures, would be highly desirable.

Another important issue is the provision of an adequate waste discharge system and proper waste collection. Even if people are willing to contribute to maintaining a clean city free from litter, they may lose their willingness if there are too few waste bins and containers in good condition and if the collection of

waste is not frequent enough. Both hard and soft measures therefore need to be implemented together.

2.8 Organization and Institution

2.8.1 Present Organizational Framework

Solid waste management (SWM) in Havana City is a government responsibility, which is shared at the central government level by the Ministry of Economy and Planning (MEP), the Ministry of Public Health (MINSAP), and the Ministry of Science, Technology and Environment (CITMA).

Under the administration of the central governments, solid waste collection/disposal and street sweeping services are undertaken by the provincial government and 15 municipal governments. At the operation level, the Provincial Direction of Communal Services (DPSC) of Havana City⁵ is the agency fully responsible for administration, management and operation of MSWM of Havana City. The agencies directly responsible for operations are the Provincial Unit of Hygiene (UPPH), a subordinate unit of the DPSC, and the Municipal Direction of Communal Services (DMSC) of each municipality under Havana City. Responsibility for street sweeping is further decentralized into 105 districts (communal zones) under the 15 municipalities. Further details of the responsibilities of respective organizations are described in Volume II - Main Report.

In 2 municipalities (Plaza and Havana Vieja), semi-autonomous institutions called Aurora have been established to conduct SWM. The Government regards the 2 Auroras as semi-governmental enterprises and administers them accordingly. The 2 Auroras are responsible for solid waste collection, street sweeping, and also maintenance of parks and gardens in their assigned areas. As stated in Section 3.10 hereinafter, the 2 Auroras show efficient work performance compared with the other organizations. Introduction of the Aurora type organizational set-up may be one of the options for improving the overall performance of MSWM in the City.

It is noted that solid waste collection and disposal is being conducted by different institutions at different governmental levels, and that decisions on the control of MSWM involve several levels of management from different institutions. With a view to improving the present inefficiencies, restructuring of functions and responsibilities of the existing organizations will be one of the subjects to be looked into in the M/P.

⁵ Havana City is administratively regarded as one of the country's provinces.

2.8.2 Legal Framework

Although there is no national law or regulations concerned only with SWM, the National Constitution of 1976 (modified later in 1992) has several articles dealing with environmental care and control, especially Article No. 27, which says that the Cuban State is responsible for the environment and the natural resources of the country.

Some National Laws deal with solid waste related matters, such as, Law 1288 of 1974 dealing with recyclable materials collection, and Law 33 of 1981 dealing with environment protection and rational use of natural resources, which says that collection, transportation, final disposal and economic recovery of wastes shall not impair the environment.

There are also several technical norms regarding SWM. The most important existing norms are (i) NC 133 of 2002 regarding storage, collection and transport, (ii) NC 134 of 2002 regarding urban solid waste treatment, and (iii) NC 135 regarding final disposal. All these NCs describe environmental and hygienic-sanitary requirements related to MSWM.

Concerning recycling of solid wastes, the national recycling law (Law 1288) makes the collection of recyclable scraps, goods and raw materials mandatory for the government. Law 1288 allocates full responsibility for managing and operating all recycling operations in the country to UERMP, from collection and processing of recyclable to the delivery of secondary raw materials to industries.

At the provincial level in Havana City, the laws concerned with MSWM are Decree No. 272 of 20/Feb/2001 and the Law Decree No.99 of 25/Dec/1987: "Offenses for City Cleanliness", and Resolution No. 16/94: "Regulation of Hygiene and Beautification for Havana City". These codes are used for curbing mismanagement of solid wastes and imposing fines for those that violate the law.

The main MSWM activities done by the DPSC and DMSC are ruled by a guideline issued by the DPSC named "Guidelines Documents of the Fundamental Activities of the Communal Zones", 2001. This document specifies the duties and responsibilities of the communal zone chief, the administration manager and the hygiene manager. These duties and responsibilities are well described, as well as the methodologies that shall be used for street sweeping, specialized collection, environmental sanitation, etc.

There is, however, a need to revise and/or establish several technical guidelines and standards. The main items that need attention are the locating of landfill sites,

the structural requirements of environment-friendly landfill facilities (including leachate treatment facilities), and compost quality.

2.9 Financing for MSWM

The state expenditure for housing and community services, including expenditure on SWM, was 961 million pesos⁶ in 2003, which accounted for about 5% of the state's total expenditure. Havana City's expenditure on housing and community services was 230 million pesos in 2003, accounting for 17% of the City's total expenditure.

The MSWM operations of the service providers in Havana City (UPPH, Aurora Havana Vieja, Aurora Plaza, and DMSCs) are interrelated. UPPH is a part of the Government system and the cost of UPPH services are mostly met from the Government budget. The 2 Auroras are permitted to collect fees for waste collection and actually do so from most of the service users in their territories, which results in a certain amount of operational profit, though marginal. The DMSCs are departments of the municipal governments. They can set tariffs and collect fees for MSWM from non-domestic service users.

Overall, however, the operation of SWM in Havana City is unprofitable. The recurrent expenditure in 2003, mainly comprising O/M cost, was CUP156.9 million, and the deficit was CUP139.2 million, which was financed by the State Government. The details are given in Table 2.2.3. Other than the recurrent costs, capital investment for SWM in Havana City was 60 million pesos in 2003.

Table 2.2.3 Financial Balance of MSWM in Havana City (2003)

	CUP portion** (million pesos)	CUC portion** (million pesos)
Expenditure	156.9	2.0
Revenue from user charges	17.7*	1.8
Financing from the City government fund	139.2	0.2
Dependence on city government financing	89%	12%

Source: DPSC and estimation by the Study Team

Note: * Nominal total fee revenue was 28.3 million pesos, but a part of it, 10.6 million pesos, was paid by the City government as a subsidy to cover the amount that should have been paid by the citizens. Thus, the amount of actual fee revenue income was interpreted as 17.7 million pesos in this table. The 10.6 million pesos was included in the financing from the City government. The revenue is presently an income to the City government and therefore constitutes a part of the City government budget.

** CUP: Cuban local peso, CUC: Cuban convertible peso

The state financial position is already stretched, and there would appear to be constraints to further financing increases in expenditure from state funds. Another

⁶ The term 'peso' used herein is the combined amount of CUC and CUP at official exchange rate determined by the Government of Cuba.

financial source for the MSW operating agencies may be revenue from tariffs on MSWM services. Present tariffs for waste collection service set forth in regulations are shown in Table 2.2.4. However, residents are not actually charged any tariffs under the present governmental policy. Instead, the City government funds are transferred to the Auroras in place of payment from the residents.

Table 2.2.4 Present Rates of Tariff in 2005 for Solid Waste Collection in Havana City

Collection type \ Customer Type	Curbside Collection	Collection by Exclusive Bin
Household	CUP0.4/person/month *	Not applicable
Cuban institutions without CUC earning	CUP2.1/account/day	CUP3.8/bin/day
Cuban institutions with CUC earning	(CUP1.1 + CUC1) /account/day	(CUP2.3 + CUC1.5)/bin/day
Foreigners and tourists	CUC1/account/day	CUC4/bin/day

Note: * Although the tariffs are set, households are not charged and actual payment is made by the City government.

Another issue is that, as MSWM tariffs have not been reviewed since 2001, the current tariffs do not appropriately reflect the actual costs.

Besides the collection tariff stated above, a nominal fee is set for tipping of waste at landfills for final disposal at a rate of CUP0.5/tons. However, the fee is not actually collected and the operational costs of MSWM are covered by government subsidy.

At present, both CITMA and the DPSC are of the opinion that there would be no tariff charged to residents for the foreseeable future, in line with the government policy. This tariff issue will be studied further in the implementation of the M/P.

2.10 Industrial and Medical Waste Management

2.10.1 Industrial Waste

In Havana City, the collection and disposal of industrial solid waste generated by factories is the responsibility of each factory according to the relevant government regulations. The generated industrial waste, excluding hazardous waste, is mainly disposed of at Ocho Vias landfill. The landfill site has an area of 30 ha, and the remaining service life is assumed to be usable until 2015. Wastes designated as hazardous by CITMA are treated and disposed of by the waste generators.

UPPH and Auroras are only in charge of transporting industrial waste on a contract basis. It is estimated that they collected about 350 tons/day of industrial waste on average in 2004.

Basically, as previously mentioned, 350 tons/day of industrial waste generated in Havana City are being transported to Ocho Vias landfill by Auroras and individual

generators of the waste. However, since the closing of Guanabacoa landfill at the middle of March 2005, some of the MSW generated in Guanabacoa Municipality is also being transported to this area. Similar to other provincial landfills operated by the DPSC, soil covering is not conducted at Ocho Vias landfill, leading to various environmental problems such as odor, fire, or leachate contamination of the surrounding environment.

2.10.2 Medical Waste

In Havana City, the MINSAP is in charge of enforcement of the management of medical waste as well as health-care administration at the central level while the provincial public health authorities are responsible at the City level for all aspects of health-care, including hospital management. Health-care facilities are under the control of delegate of the MINSAP in Havana City.

According to CITMA, the amount of waste generated in the hospitals was 22 tons/day in Havana City. This figure included both hazardous and non-hazardous medical waste. On the other hand, based on the data issued by DPSC/UPPH, the daily weight of medical waste collected and hauled to landfill by Aurora or UPPH counted for 15 tons/day. This figure of waste amount included both hazardous and non-hazardous medical waste as well. It could be regarded that the difference between 22 tons/day-generated waste and 15 tons/day-hauled waste was the portion of self disposal including the amount incinerated.

Although MINSAP regulated hazardous waste as being treated separately from non-hazardous waste generated in hospitals, actually, it was observed that some unsafe wastes such as injector were disposed of at landfills. It could be said that appropriate separation of hazardous medical waste has not been developed in Havana City. Solid waste generated in hospitals including non-hazardous waste and a part of hazardous waste are treated as medical waste in the City.

CHAPTER 3 THE MASTER PLAN

3.1 Objective and Scope of the Master Plan

3.1.1 Objective

The objective of the M/P study is to provide a clean and sanitary living environment and adequate MSWM service for the citizens and institutions of Havana City. A clean city will also encourage further enhancement of the tourism industry, which is currently the biggest foreign currency-earning industry in both the country and the City.

3.1.2 Planning Horizon

Considering the need for coordination with relevant plans/programs and a practical time range for future projection, the planning horizon of the M/P for municipal solid waste management (MSWM) in Havana City was set at the year 2015.

3.1.3 Scope of the Master Plan

The M/P covers all aspects of MSWM: collection, transportation, disposal, and recycling of solid wastes; institutional and organizational frameworks; awareness-raising; and social and environmental considerations. Medical and industrial solid wastes are not included in the scope of the M/P.

3.2 Strategies for Municipal Solid Waste Management for Havana City toward 2015

3.2.1 Basic Strategy

The basic strategy is to achieve environment-friendly MSWM in the City in a feasible way.

3.2.2 Components of the Strategy

In line with the basic strategy, the following individual strategies were adopted as the components of the M/P:

(1) Priority of Strategies

- Considering the fundamental solid waste management policy, the waste generated from households and other sources should be removed from those generation sources promptly and neatly from the viewpoint of public hygiene.
- Therefore, establishment of an appropriate waste collection and transportation

system by improvement of the current system should be considered as having the highest priority.

- The introduction of properly operated sanitary landfills should be considered because landfills are intensive facilities with various kinds of environmental risks that need to be carefully controlled.
- Waste reduction activities such as recycling, composting or home-composting shall be introduced only after the appropriate waste flow from generation source to landfill is secured.

(2) Reduction of MSW quantity

- Recycling and reuse of recyclable materials and composting of kitchen waste will be promoted.
- In the semi-urban areas where households have enough space, home composting will be promoted.
- In urban areas, segregated collection will be introduced, dividing waste into 3 categories, i.e., recyclable materials, kitchen waste, and other wastes. The recyclable materials could be processed to recycling and the kitchen waste composted. This will concomitantly require constructing recycling plants and community composting yards.

(3) Adoption of environment-friendly landfill systems

- Among the options for waste disposal systems, incineration systems will not be adopted in view of the relatively low calorific value of the municipal solid waste and the requirement for high investment and operation costs.
- Existing landfills currently causing environmental problems will be closed with the provision of adequate soil covering and other environment protection measures as early as possible. Appropriate post-closure land use will be planned.
- Any new landfills will be of an environment-friendly type where the structure and operating method to be adopted will be decided considering the level of risk of environmental pollution at the sites, operation and maintenance (O/M) costs, and the service life of the landfills.

(4) Reinforcement of the maintenance workshops

- The capacity of maintenance workshops will be reinforced to improve maintenance of both collection vehicles and landfill equipment with the aim of reducing equipment failure and associated delays to waste collection and interruptions to landfill operations.

(5) Strengthening of awareness-raising and social consideration

- For the successful introduction of environment-friendly MSWM, cooperation

and support from citizens is essential; to achieve this aim, adequate information will be provided to citizens. The opinions of citizens are to be obtained through meetings and workshops. Further, adequate channels will be established to convey those opinions to the policy makers.

- For effective awareness-raising, well-developed community based organizations such as the Retired Members' Committees of the Communist Party of Cuba (CPC), the Committee for Defense of the Revolution (CDR), the Federation of Cuban Women (FMC) and Delegates of Electoral Districts will be called upon to play an active role.
- Sufficient time will be allocated to the awareness-raising of citizens. Continuous and repeated awareness-raising will be required to firstly create the understanding of the citizens and secondly to obtain their cooperation for environment-friendly MSWM.

(6) Utilization of domestic products

- Domestically available products will be utilized as much as possible with a view to reducing the requirement for foreign currency for the initial investment and also operation and maintenance. The use of local products will also reduce the time for repair, since spare parts will not need to be imported from abroad.

(7) Staged development

The undertaking of environment-friendly MSWM will be implemented in stages in consideration of the following:

- Review the lessons learned from the initial projects and improve them in the subsequent projects,
- Avoid the concentration of financial outlay into a short period of time to reduce the financial burden on the government.

(8) Reinforcement of organizational structure

To undertake the environment-friendly MSWM in an effective way, the following measures are proposed:

- Separation of the functions of control and operation of the MSWM; i.e., the DPSC acts as a supervisory body and the Auroras as service providers,
- Education and training of staff to gain the knowledge required for conducting environment-friendly MSWM,
- Achievement of good cost performance through enhancing the motivation of staff and workers.

- (9) Reinforcement of financial capacity of the operating agency
- The financial management capacity of the operating agency will be reinforced. A system of cost recovery through collection of fees from the service recipients would be one possible solution, subject to the approval of the government. The setting of tariffs will take into account the capacity-to-pay of the recipients.
- (10) Reinforcement of legal system
- Technical standards and guidelines will be prepared to define the technical requirements relevant to the conduct of environment-friendly MSWM. They will cover various aspects of MSWM such as leachate quality, compost quality, landfill specifications, segregated discharge and collection, environmental monitoring at landfills, and so on.
 - To encourage the recycling of materials from MSW, the DPSC/Auroras will be given authority to sell the recyclable materials directly to the open market, which will, however, be subject to the approval of the government.

3.3 Estimation of the Quantity and Quality of MSW in the Future

3.3.1 Conditions and Assumptions in Estimation

(1) Socio-economic projection

The population of Havana City is projected to decrease slightly during the period as shown in Table 2.3.1.

Table 2.3.1 Forecast of Population in Havana City

Year	2005	2010	2015	2020
Population	2,168,404	2,151,562	2,135,747	2,110,256

Source: Proyeccion de la Poblacion Nivel Nacional y Provincial Period 2000-2025, Office of National Statistic Center of Population and Development Study, 1999

During the period from 1995 to 2002, the GDP of Cuba increased by 30% at constant 1995 prices, with an average annual increase of about 4%. The rate of growth in GDP is tending to decrease, as indicated by the increase of only 1.2% recorded in 2002.

Cuba's economic weakness in the areas of basic foodstuffs and manufacturing has caused imports to expand at a rate much greater than the rate of GDP growth, resulting in deterioration in the balance of trade. Furthermore since Cuba is not a member of either the World Bank or the IMF, and most of its external debts are still in a state of moratorium, the possibility of borrowing new long-term capital is limited. Therefore, the shortage of hard currency remains unresolved. Overall, it is

expected that annual growth rate of GDP until 2015 will stay below those of the late 1990s, at between 0 and 1% annually.

In the sector of MSWM, it is assumed that, because of the stability in population size, the overall conditions will not change significantly from the present during the planning horizon up to the year 2015.

An exception is the tourism sector, which is predicted to grow continuously. The number of tourists is projected to increase from 978,000 in 2003 to 1.5 million in 2015.⁷ Similarly, the number of hotel rooms for international tourists in Havana City is predicted to increase from 8,977 in 2003 to 16,689 in 2015.⁸ It is assumed that restaurants and other tourism facilities will also increase in proportion to this growth. This factor will be taken into account in the planning of MSWM.

(2) Waste generation rate and composition ratio

In view of the absence of significant changes in the economic conditions relevant to MSWM, it is assumed that the unit waste generation rates of domestic waste will remain at the present level. The quantity of bulky and street sweeping waste, construction waste, industrial and medical waste will also not change from the present level. On the other hand, the total quantity of commercial waste generated in hotels and restaurants will change according to changing parameters such as the number of tourists and development of the tourism industry, though the unit generation rate of that waste would also remain unchanged.

Similarly, the physical composition of solid waste by type will remain similar to the current composition because the livelihood conditions of the City will not change significantly for a foreseeable period. The current waste composition was investigated through a field survey conducted as part of the Study.

3.3.2 Projection of Municipal Solid Waste Quantity

Table 2.3.2 shows the estimated quantities of waste generation and disposal in 2005, 2010 and 2015.

The quantity of MSW generation is estimated to decline slightly from 2,216 tons/day in 2005 to 2,202 tons/day in 2015. On the other hand, the quantity of waste sent for final disposal will be reduced from 2,157 tons/day in 2005 to 1,828 tons/day in 2015, owing chiefly to the removal of recyclable and composting materials.

Figure 2.3.1 shows the flow of MSW in 2015.

⁷ Source: Estimate by the Study Team based on projection by Havana City Territorial Office of Statistics, Ministry of Tourism

⁸ Source: Direction of Physical Planning of Havana City, 2003

Table 2.3.2 Forecast of Generation and Disposal Quantity of MSW

Unit: tons/day

Categories		2005	2010	2015
a	Generation of MSW	2,216	2,210	2,202
	Domestic Waste ^{*1}	1,517	1,505	1,494
	Commercial Waste ^{*2}	179	185	188
	Bulky Waste and Others ^{*3}	520	520	520
b	Reduction of MSW	43	166	374
	Material Utilization by DPSC/UPPH	-	-	-
	Material Recovery by DPSC/UPPH	10	13	59
	Production of Compost by DPSC/UPPH	3	45	108
	Loss in Composting Process ^{*4}	-	53	126
	Material Recovery by ERMP Havana City	30	30	30
	Home Composting	-	-	-
	Production of Compost	-	11	22
	Loss in Composting Process ^{*4}	-	14	29
c	Illegal Dumping and Self Treatment	16	15	0
d	Final Disposal of MSW: Waste disposed to Landfills = (a-b-c)	2,157	2,029	1,828
e	Generation of Industrial and Medical Wastes	372	372	372
	Industrial Waste	350	350	350
	Medical Waste ^{*5}	22	22	22
f	Total Waste Generation in the City = (a + e)	2,588	2,582	2,574

Note: *1 Household waste

*2 Waste generated from non-industrial business activities

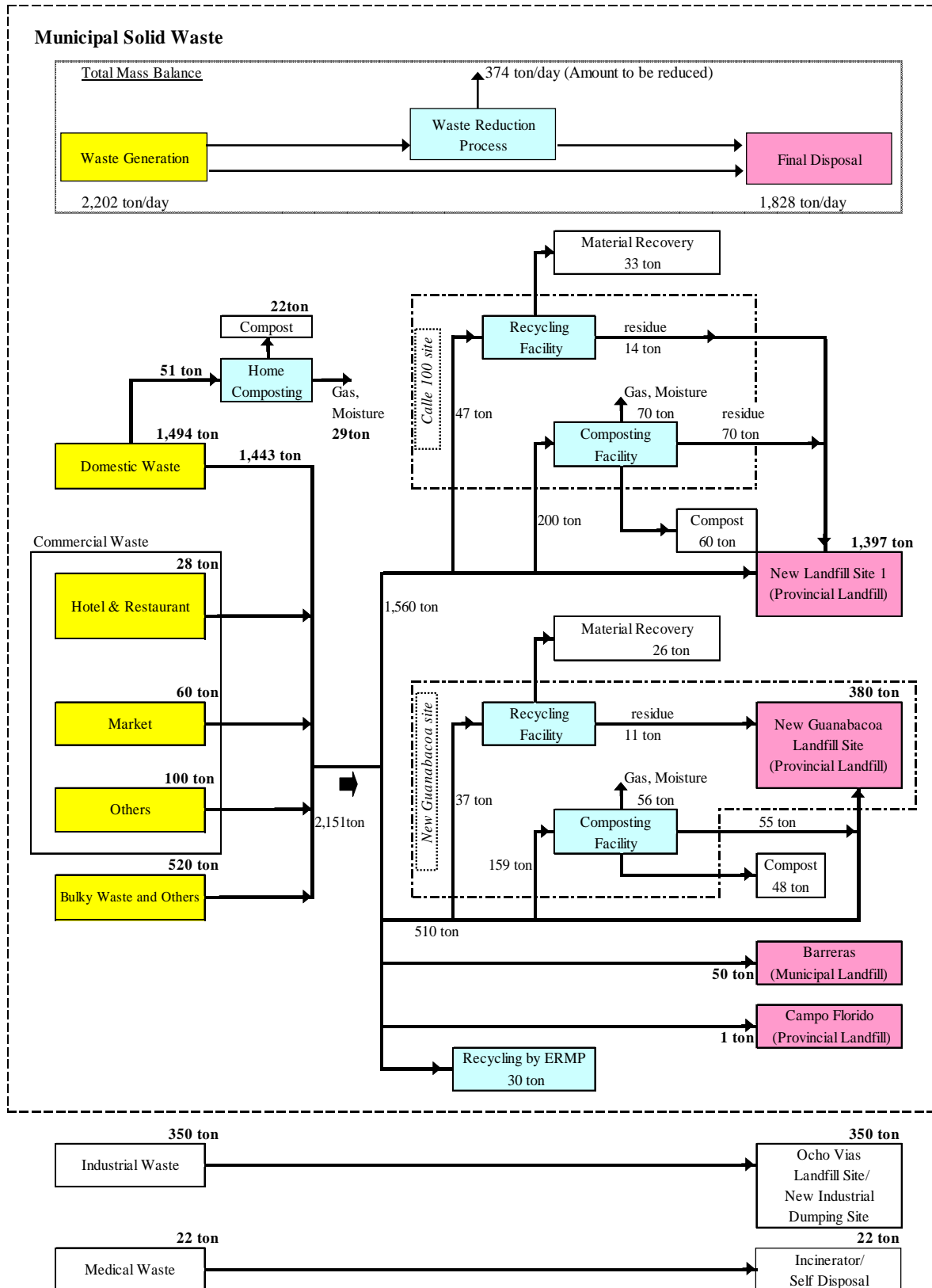
*3 Construction waste, yard waste, trees, branches, etc.

This value was estimated by the assumption that the actual amount measured by the 8 day survey during the Study which was 567 tons/day (ref. Table 2.2.2) and was about 10% more than the average because of pre-hurricane season.

Thus, 567 tons/day divided by 110% makes about 520 tons/day.

*4 Losses as evaporation and residues

*5 Solid waste generated in hospitals, which contains both hazardous and non-hazardous solid waste



Note: Medical waste is solid waste generated in hospital, which contains both hazardous and non-hazardous ones

Figure 2.3.1 Solid Waste Flow in 2015

Of the generated waste shown above, UPPH (including Auroras in 2 municipalities) collects 703 tons/day, and the DMSCs collect 237 tons/day of domestic and commercial waste as shown in Table 2.2.2. The DMSCs also collect 520 tons/day of bulky and other waste on average. Other waste is collected and transported to disposal sites by the institutions that generated the waste. As stated in Section 2.10, UPPH and Auroras also transport 350 tons/day of industrial waste and 15 tons/day of medical waste on a contract basis.

3.4 Municipal Solid Waste Reduction Plan (Recycling and Composting)

3.4.1 Necessity of Reduction of MSW

”Reduce, reuse, and recycle”, termed the 3Rs, is a well known strategy for the improvement of MSWM. The 3Rs concept will be introduced as part of the MSWM of Havana City with the dual objectives of recovering recyclable materials and reducing the quantity of MSW sent for disposal. The reduction of MSW is deemed to be an essential measure in view of the problems presently being faced, such as the burden of handling waste due to a shortage of equipment, the limited capacity of existing landfills, and the difficulty of developing new landfills.

The recycling and composting plans proposed in the M/P will contribute to this reduction of MSW quantities. Details of these plans are presented in later sections.

3.4.2 Recycling Plan

(1) Demand and supply of recycled materials

The current system of recycling in Cuba is fully controlled by UERMP. The basic policy is to utilize the recyclable resources within the country, and only surplus recovered materials are sold to the international market.

According to the statistics of ERMP of Havana City, all recovered materials have been utilized in local industries so far. This situation reveals that the demand for recycled materials in the domestic industrial sector is larger than the present supply capacity. Cuba is not rich in natural resources, so it is worthwhile attempting to recover recyclable materials to the maximum extent possible.

(2) Quantity of recyclable materials

The quantity of recyclable materials was estimated from the proportion of recyclable resources contained in the MSW as determined from the waste quantity and composition survey conducted under the JICA Study in 2004.

With the introduction of segregated waste collection, the recovery of recyclable materials from MSW will be possible from 2010 onwards. In addition, another

source of recyclables is the existing local recycling system that has been operated by ERMP for a long time.

As shown in Table 2.3.3, the quantity of recyclable materials that will be recovered from MSW through segregated waste collection in 2015 is estimated to be 59 tons/day. In addition, 30 tons/day of recyclable materials will be collected by ERMP. In total, the quantity of recyclable materials will be 89 tons/day in 2015.

Table 2.3.3 Estimate of Recyclable Materials for Reuse and Recycling

Unit: tons/day

Source of Waste	2005		2010		2015	
	Collected Waste	Recyclables Recovered	Collected Waste	Recyclables Recovered	Collected Waste	Recyclables Recovered
Households	1,517	NA	1,505	10	1,494	49
Commerce	Hotels & Restaurants	10	25	3	28	10
	Markets		60		60	
	Others		100		100	
Bulky Waste and Others	520	0	520	0	520	0
Material Recovery by DPSC		10		13		59
Material Recovery by ERMP		30		30		30
Total Collected Quantity	2,216		2,210		2,202	
Total Recovered Quantity		40		43		89
Recycling Rate in MSW		1.8 %		1.9 %		4.0 %

Note: "NA" means 'data not available'

*1 Collected waste is the total quantity collected through mixed and segregated waste collection.

*2 Recyclables recovered is the quantity recycled through the segregated waste collection and ordinary ERMP recycling system.

The quantities of recyclable materials recovered by the DPSC stated above are regarded as additional reduction of waste for disposal attributed to the recycling activity.

(3) Location of new recycling plant

The construction of 2 new recycling plants is proposed: one each at the Calle 100 and New Guanabacoa landfill sites. The plan takes into account the following:

- The establishment of new plants will be in accordance with the schedule of introducing segregated collection because the recovery and packing of recyclable resources for sale will only be possible if wastes are properly segregated at generation source. The segregated collection will be introduced in 2 phases: 2 municipalities in 2010 and another 5 municipalities in 2013, eventually covering 7 municipalities.
- The recycling plants will be located close to landfill sites because residue from the processing must be disposed of in the landfill. In this regard, no specific difficulty is noted for the New Guanabacoa landfill located at the eastern part of the City. This landfill site is not so far from the waste collection area.

- Another large-scale landfill is proposed in the western part of the City (called herein 'New Site 1'). But the proposed location of New Site 1 is too far from the waste collection area where the recyclables are also collected. Instead of New Site 1, the Calle 100 site, located in the western side of the City, is proposed as the site for a recycling plant. The Calle 100 site has an area sufficient for building a recycling plant as well as for its operation even after closing the existing landfill. The residue from the recycling plant will be transported to the New Site 1. Such transportation load of the residue will be less than the segregated waste load which should be transported directly to the New Site 1 if the recycling plant is not built at Calle 100.

3.4.3 Composting Plan

(1) Demand and supply of compost

Ministry of Agriculture (MINAGRI) is promoting organic farming in the country, encouraging the use of organic fertilizer, instead of chemical fertilizer. Actually, farmers are producing the compost from agricultural wastes by themselves and using them for farming. According to MINAGRI's estimate, the potential demand for organic fertilizer/soil conditioner for the 10,560 ha of farmland in Havana City is in the order of 529,000 tons/year, while the present production capacity is 58,000 tons/year.

The potential market for compost products is large enough to absorb the products from MSW, provided that the quality of the compost meets the requirements.

(2) Community composting plan

Community composting meant herein is composting at a centralized yard using kitchen waste collected from households in urban areas, hotels, restaurants, and markets. The kitchen waste from these sources will be collected through segregated collection. The establishment of 2 composting yards, one each at Calle 100 and New Guanabacoa landfill sites, is proposed for the same reason as for the recycling plants. The plan takes into account the following:

- The implementation schedule for composting will conform with the schedule for segregated collection:
 - 1) Composting at New Guanabacoa site to start in 2010
 - 2) Composting at Calle 100 site to start in 2013
- The production schedule will take into account the following considerations:
 - 1) The quantities of kitchen waste collectable from MSW for community composting in 2015 are as projected in Table 2.3.4.

- 2) Of the waste collected, 30% can be processed into final products, assuming 35% are lost due to drying or bio-decomposition and another 35% disposed as residue.
- 3) There will be a gradual increase in the quantity saleable to markets because the improvement in performance of segregated discharge of kitchen waste and improvement in the quality of compost will both be gradual.

The planned schedule for community composting is summarized in Table 2.3.4.

Table 2.3.4 Plan of Community Composting

Description	Unit: tons/day		
	2010	2013	2015
Kitchen waste quantity collected	150	359	359
Loss during composting process (e.g. evaporation)	53	126	126
Compost produced at plant	45	108	108
Quantity sold to markets (% to produced quantity)	14 (30%)	54 (50%)	65 (60%)
Quantity not saleable but consumed by UPPH	31	54	43
Reduction of disposal quantity by composting*	98	234	234

Note: * Loss during process + Compost produced

(3) Home composting

Home composting at householdes is to be applied in the semi-urban municipalities, which are defined as the municipality whose agricultural area occupies more than 25 % of the total area. The households in semi-urban areas seem to have sufficient space for home composting and farming to consume the produced compost. Eight municipalities are targeted for community composting: Havana del Este, Guanabacoa, San Miguel del Padron, Marianao, La Lisa, Boyeros, Arroyo Naranjo, and Cotorro.

Considering the fact that people in Havana City have not yet practiced home composting, the measure should be introduced gradually. The M/P plans to introduce home composting to 43,000 households in total, 15% of all households in semi-urban areas, by the year 2015. In principle, one home compost bin will be provided to each household and about 4,000–5,000 bins will be delivered every year from 2007. Home compost bin should be a simple structure that can be domestically manufactured.

The quantity of waste used for home composting is estimated at 294 g/day-capita, based on the unit generation rate (0.7 kg/day-capita), proportion of kitchen waste (60%) as derived from the waste quality survey in the JICA Study, and the proportion of kitchen waste segregated into compost bins (70%) as derived from the PLP. This amount can be regarded as the expected volume of waste to be removed from the waste stream by home composting.

The quantities involved in the home composting plan are scheduled as shown in Table 2.3.5. This shows that about 51 tons/day, or 18,615 tons/year, of kitchen waste in 2015 will be reduced by home composting from the waste quantity that is discharged to the waste collection system.

Table 2.3.5 Plan of Home Composting

Description	2005 (present)	2010	2015
Target ratio of introduction of home composting to population (%)	0	7.5	15
No. of households to which home composting is introduced (no.)	0	21,500	43,000
Reduction of kitchen waste from households (kg/household-day) *	1.176	1.176	1.176
Total quantity of kitchen waste reduction (tons/day)	0	25	51

Note: * Quantity is calculated based on unit kitchen waste yield of 0.294 kg/day-capita multiplied by 4 persons/household

3.4.4 Reduction of MSW Quantities by Recycling and Composting

Summarizing the findings of Subsection 3.4.2 and 3.4.3, the quantities shown in Table 2.3.6 would be reducible from the collection/transportation and final disposal quantities of MSW.

Table 2.3.6 Reduction of Collection/Transportation and Disposal Quantities by Recycling and Composting

Unit: tons/day

Description	2007	2010	2013	2015
(1) Reduction of Collection and Transportation Q'ty				
- Reduction by home composting	10	25	40	51
(2) Reduction of Final Disposal Quantity				
- Reduction by recovery of recyclable materials	10	13	47	59
- Reduction by community composting	3	97	234	234
- Reduction by home composting	10	25	40	51
Total of (2)	23	135	321	344

3.5 Collection and Transportation Plan

3.5.1 Collection and Transportation Plan for the Urban Area under UPPH Service

(1) Basic system for collection and transportation work

1) Selection of collection vehicle

Various types of collection vehicle were compared for use in Havana City from the viewpoint of collection efficiency and cost performance of the vehicles in March 2005.

Figure 2.3.2 shows a comparison of collection efficiency of 6 different types of collection vehicles according to the result of time and motion survey by the JICA Study.

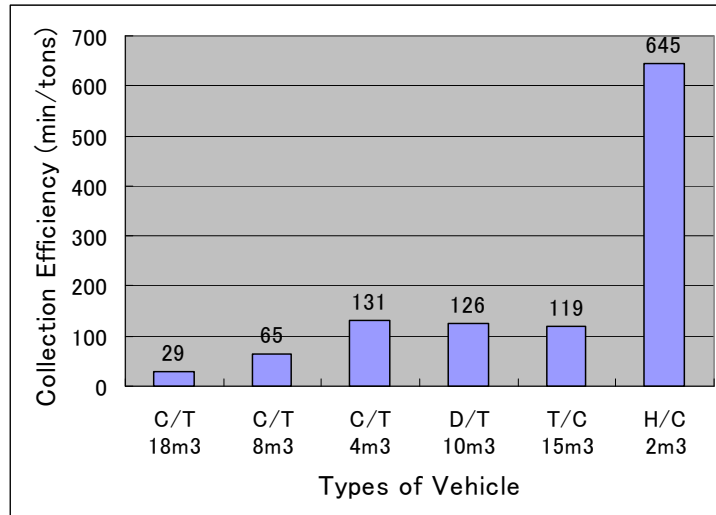


Figure 2.3.2 Collection Efficiency Based on Time and Motion Survey

Compactor trucks (C/T) of 18 m³ capacity showed the highest performance and it took only 29 minutes for collecting and transporting 1 ton of waste during the survey. Horse driven cart (H/C) took 645 minutes because of their smaller carrying capacity and lower speed than other types of mechanical transportation equipment.

On the other hand, the unit vehicle operation cost, as Figure 2.3.3 shows, is only US\$333 per year for H/C with capital cost and US\$224 without capital cost (O/M cost only) under current operational conditions. The operation of 18m³ C/T will cost more than US\$2,000 per year without considering the capital cost. If the capital cost is considered, the annual cost is about US\$35,000.

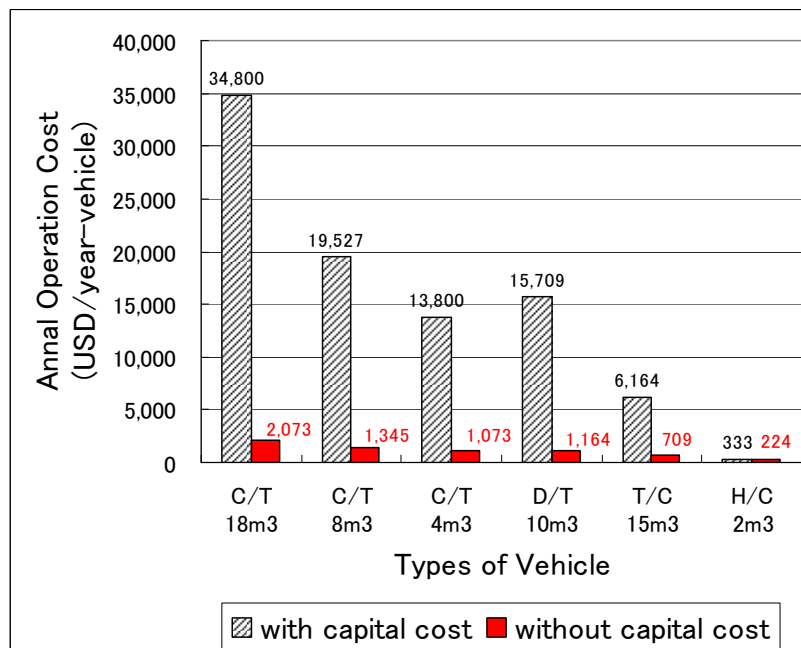


Figure 2.3.3 Estimated Unit Operation Cost per Vehicle

Another comparison was made, as shown in Table 2.3.7, to grasp the required number of other types of vehicles if they are to provide the same daily performance as 18 m³ C/T. According to the time and motion survey, 18 m³ C/T can, on average, carry 9.12 tons per trip, make 1.9 trips per day, and cover 125 km per day. This means the collection performance per day is 1,140 tons-km, while H/C can only collect 2 tons-km per day. It seems 570 units of H/C will be needed to carry the same load that one unit of 18 m³ C/T can carry.

Table 2.3.7 Comparison of Cost Performance for Vehicle and Collection Systems

Type of Vehicle	Collection System	Collection performance (ton-km/day)	Number of Vehicles Required
(1) 18 m ³ C/T	Station collection	1,140	1.0
(2) 8 m ³ C/T	Station collection	500	2.3
(3) 4 m ³ C/T	Door to door	250	4.6
(4) 10 m ³ D/T	Door to door	236	4.8
(5) 15 m ³ T/C	Door to door	209	5.5
(6) 2 m ³ H/C	Door to door	2	570

- Note:
- (i) C/T: compactor truck; D/T: dump truck; T/C: tractor cart; H/C: horse cart
 - (ii) Collection performance: the value is shown with the unit of ton-km based on the result of time and motion survey during the Study.
 - (iii) Number of vehicles required: Number of units of each type vehicle required to have the same performance with one unit of 18 m³ C/T

Unit operating costs per transportation of 1ton-1km were also estimated as shown in Figure 2.3.4. The unit cost of H/C is much higher than that of other mechanical collection vehicles in both with and without considering the initial capital cost.

Considering these estimates, it was finally concluded that 18 m³ C/Ts would be the appropriate type of collection vehicle for collection and transportation in urban areas.

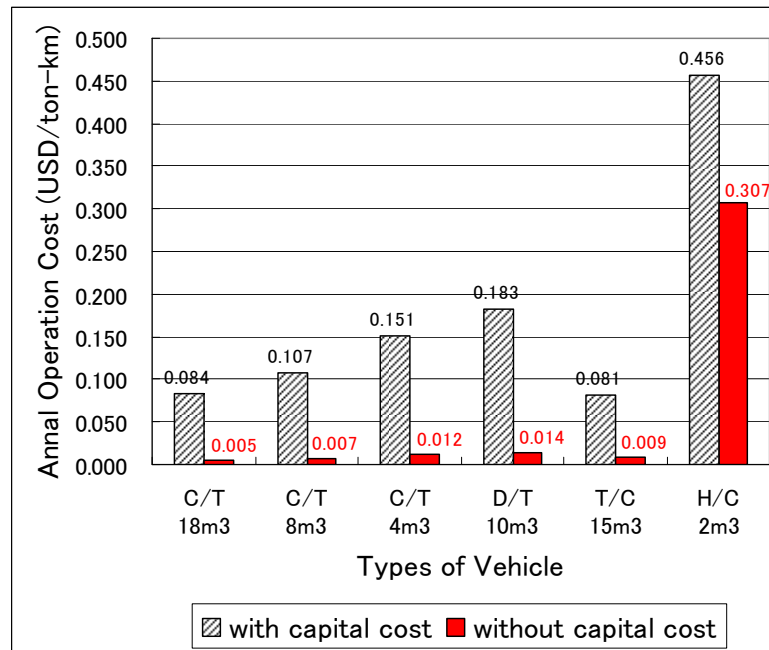


Figure 2.3.4 Estimated Unit Operation Cost per Performance

2) Working hours of collection vehicles

In order to secure adequate time for maintenance work, the average working hours of collection vehicles should be reduced to 8 hours per day from the current 9 hours by increasing the efficiency of collection work. The remaining one-hour is allotted to vehicle maintenance work.

The improvement in work efficiency could be pursued through: (i) improved vehicle performance from proper maintenance, (ii) improved bin conditions and alignments, and (iii) adequate planning of collection routes and intervals.

3) Use of steel waste bins

Two types of bins are considered: the high density polyethylene (HDPE) bins currently in use and steel bins as an alternative. The cost effectiveness of the 2 types of bins is considered to be almost the same. The steel bins cost more at procurement, but have a longer service life, while vice versa in the case of HDPE bin.

Taking into account the following, steel bins will be used henceforward by gradually replacing the present HDPE bins:

- Steel bins can be manufactured in Cuba. While the material has to be imported, this still reduces the foreign currency requirement compared with HDPE. They can also be repaired locally.
- Use of steel bins, which are strong, would reduce the interruption of collection service due to the breaking of waste bins.

(2) Introduction of a segregated collection system

1) Need for the introduction of a segregated collection system

A segregated collection system will be introduced with the objectives of: (i) recovering resources for reuse and recycling, and (ii) reducing waste collection and disposal quantities, (iii) prolonging the service life of landfills, and thereby (iv) raising awareness through segregated discharge.

2) Application of segregated collection

Segregated collection will be introduced to municipalities where UPPH currently collects MSW by C/T. MSW will be classified into 3 categories: kitchen waste, recyclable materials and other wastes as described in Table 2.3.8.

Table 2.3.8 Classifications in Segregated Collection of MSW

Category	Material	Form of Material
Kitchen waste	Kitchen waste	Food waste
Recyclable materials	Glass	Drink bottles
	Aluminum	Drink cans
	Metal	Drink cans, food containers
	Plastics	Bottles*
	Paper	Card board
Other waste	Glass, aluminum, metal, plastics, paper,	All forms that are not defined as recyclable.
	Textiles, rubber, leather, processed wood, yard waste, others	All forms

Note: * Plastic bottles are assumed to be recyclable since UERMP has a plan to promote recovery of plastic bottles, especially PET, HDPE, and PVC bottles for drink or utensils.

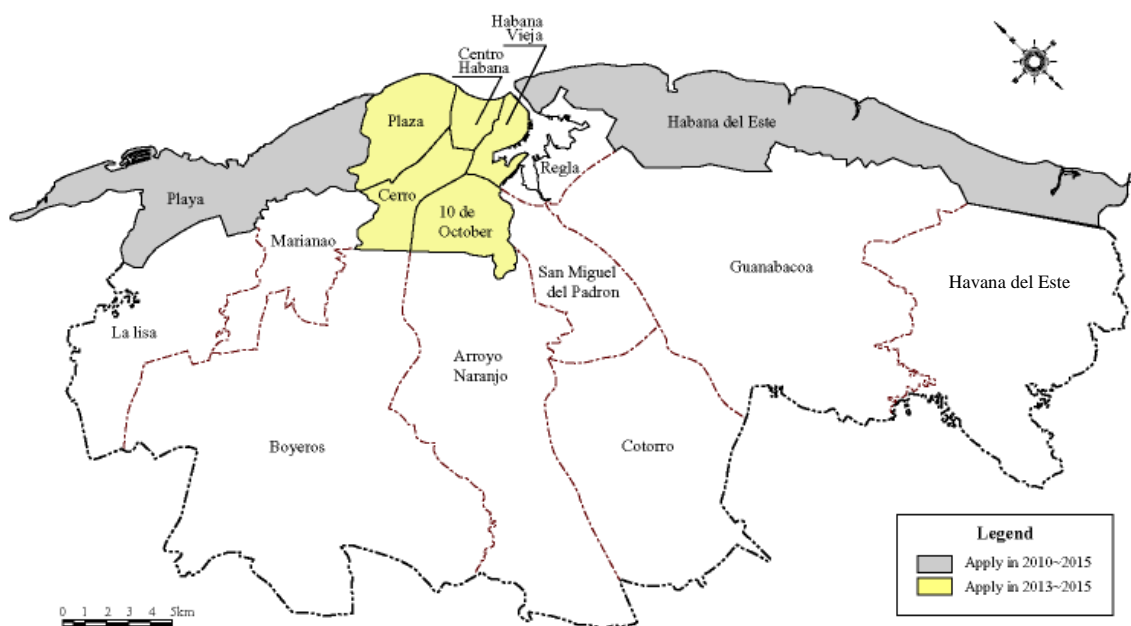
The schedule for introducing segregated collection is shown in Table 2.3.9, together with the estimated quantities of waste collection. To secure adequate lead time, the segregated collection will be introduced initially in 2 urban municipalities in 2010 and subsequently in the other 5 urban municipalities in 2013.

Figure 2.3.5 shows the location of the 7 municipalities where the segregated collection is to be introduced.

Table 2.3.9 Schedule for Segregated Collection and Estimated Quantity of Collected MSW
Unit: tons/day

Municipality (Nos.)	2005-2009	2010-2012	2013-15
UPPH Service Area:			
Playa, Havana del Este (2)	Mix: 200	Kitchen: 89 Recyclable: 29 Others: 82	Kitchen: 89 Recyclable: 29 Others: 82
Plaza de la Revolución, Centro Habana, Habana Vieja, Diez de Octubre, Cerro (5)	Mix: 424	Mix: 424	Kitchen: 209 Recyclable: 58 Others: 157

Note: The total quantity of waste collection by UPPH in 7 municipalities was assumed to be almost constant at 624 tons/day. UPPH also collects the waste from the main streets in semi-urban area. In total, 703 tons/day is collected by UPPH.



Note: Segregated collection will be introduced in an urbanized area along the coast of Habana Del Este Municipality.

Figure 2.3.5 Municipalities where Segregated Collection is to be Introduced

3) Required number of vehicles and procurement cost

(a) Required number of vehicles

The required number of vehicles will increase over time as shown in Table 2.3.10.

Table 2.3.10 Total Number of Collection Vehicles Required (Segregated collection)

Unit: Vehicle (18 m³ C/T)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
7 Municipalities introducing segregated collection	37	51	51	51	51	68	68	68	91	91	91
4 Municipalities not introducing segregated collection	8	8	8	8	8	8	8	8	8	8	8
Total	45	59	59	59	59	76	76	76	99	99	99

Note: Required number in 2005 is actual number used in the City, and that from 2006 to 2009 is based on the mixed collection. Segregated collection will be started from 2010. UPPH will collect the waste from the main streets at 4 Municipalities in semi-urban area with 8 units of 18 m³ C/T.

Introduction of segregated collection in 2010 and 2013 means the required number of collection vehicles will increase. However, number of vehicles and costs were calculated on the assumption that transportation of all segregated waste would be conducted by the same type of vehicle (18 m³C/T). The required number will also increase when Calle 100 landfill is full and waste will have to be transported further to the New Site 1 landfill. However, segregated recyclables and kitchen waste can be transported to a recycling center and composting yard at the Calle 100 landfill, which is closer than the New Site 1 landfill. This can help reduce the number of additional vehicles that DPCS will need.

(b) Comparison of cost requirements between the mixed collection system and the segregated collection system

The total cost required for a mixed collection system for the 9 years of the M/P period (2007-2015) would be approximately US\$18.1 million plus CUP64.1 million, while for segregated waste collection the cost would be approximately US\$22.4 million plus CUP67.9 million. The higher cost of segregated collection is due to the requirement for more collection vehicles and waste bins. The segregated system requires an additional 26 vehicles and 20,802 bins compared with the mixed collection system up to the year 2015.

Table 2.3.11 Cost Comparison of Waste Collection Systems

Collection system	Total cost (2007-2015)				Remarks
	US\$		CUP		
	Initial	O/M	Initial	O/M	
Mixed collection	18.1 million		64.1 million		-----
	11.2 million	6.9 million	0	64.1 million	
Segregated collection	22.4 million		67.9 million		Compared to mixed collection, 26 more collection vehicles and 20,802 more waste bins are necessary
	14.9 million	7.5 million	0	67.9 million	

3.5.2 Collection and Transportation Plan for the Semi-Urban Area under DMSC Service

(1) Replacement of existing horse-driven cart collection

Presently, waste is being transported to the 9 'special period landfill (SPL)' sites by horse-driven cart (H/C). These sites are scheduled to close and their closure will require changing the waste collection and transportation system, either by (i) providing transfer stations (referred to as Option A below), or (ii) changing to a more mobile type of transportation vehicle suited to longer distances (Option B).

1) Option A: Transfer system

Of the 9 special period landfills to be closed, 3 would be selected to be converted to transfer stations. In these areas, H/C would continue to be used for waste collection and transportation to the 3 transfer stations, while motor-driven vehicles (10 m³ D/T proposed tentatively) would transport the waste from transfer stations to the landfills.

2) Option B: Complete replacement of transportation vehicle without transfer stations

The present horse-driven cart system would be abolished completely and motor-driven vehicles (12 m³ C/T) employed for collection and transportation of waste.

3) Comparison of 2 options

As a result of cost comparison, Option B is provisionally adopted for the following reasons:

- The cost of Option B is smaller than that of Option A as shown in Table 2.3.12, though the difference is marginal.
- Management system for Option A is rather complicated than Option B because it has to cover 3 different operation systems for H/C, D/T and transfer stations.

- Land at the 3 SPLs can be used for other purposes for the benefit of people living around the SLP sites.
- Working conditions in Option B are more sanitary than Option A.

Table 2.3.12 Comparison of Options regarding Current Collection/Transportation by H/C

System	Option A	Option B
Collection and Transportation Method	H/C and 10 m ³ D/T (30 nos.) with provision of 3 transfer stations	12 m ³ C/T (24 nos.)
Initial Cost	US\$2.52 million	US\$2.60 million
O/M Cost for 9 years	CUP10.14 million US\$0.25 million	CUP5.20 million US\$0.26 million

4) Schedule for replacement of H/C system

Notwithstanding the above comparison, the Study assumes that the present H/C system will continue for the time being, at least until the SPLs are closed.

The final decision on the selection of Option A or Option B will be subject to the findings of the detailed environmental survey to be conducted henceforward. In the areas not so far from the 3 main landfills (New Guanabacoa, Calle 110 and New Site 1), waste collection by H/C can be continued for a prolonged period if so determined.

Therefore, the present H/C system will remain for the Campo Florido area for the purpose to hand down to posterity.

(2) Selection of type of collection vehicles in semi-urban area other than H/C collection area

In the semi-urban area not subject to H/C collection, there are 2 options regarding the selection of type of collection vehicles; one is the introduction of C/T and the other is continuation of the existing system using T/Cs. A comparison of operation cost of waste revealed that the cost of T/Cs is smaller than that of H/Cs though the difference is marginal (ref. Figure 2.3.4).

In order to avoid the additional administrative work and cost required for changing the system, continuation of the current system; i.e. use of T/Cs, is selected.

3.6 Final Disposal Plan

3.6.1 Final Disposal Plan during the M/P Period

The existing Guanabacoa and 3 SPLs were closed in 2005. Further, the existing Calle 100 (80 ha) and other 6 SPLs are scheduled to close as early as possible. All of these landfills still have 2 to 8-year waste receiving capacity (ref. Section 5.10

of Part 2 of Main Report). The main reason for the closure is environmental problems the landfill sites are causing to the surroundings. The closure of the existing landfills requires expanding 2 existing landfill sites (Calle 100 and Campo Florido) and also constructing 2 new landfills (New Guanabacoa and New Site 1). The schedule for landfill closure and development is shown in Table 2.3.13.

Table 2.3.13 Plan for Closing and Development of Landfills

Existing Landfills	Remained Life (year)	Area (ha)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Calle 100	1.9	80	█					Closing							
Guanabacoa	8.1	28	█		Closing										
Ocho Vias	12.9	30	█												
Barreras	15.2	10	█												
Electrico landfill*	6.1	0.5	█			Closing									
Fraternidad landfill*	8	2	█		Closing										
Guasmas landfill*	6.8	2	█		Closing										
Lugardita landfill*	3.9	1.5	█					Closing							
Prensa Latina landfill*	3.6	2	█					Closing							
Rincon landfill*	2.9	0.5	█					Closing							
Las Canas landfill*	4.8	1	█					Closing							
El Vidrio landfill*	3.6	2.5	█					Closing							
Los Perros landfill*	3.8	2	█					Closing							
Campo Florido landfill*	2	0.5	█					Closing							
Proposed Landfills															
New Guanabacoa	-	(18)													
Campo Florido (Extension)	-	(5)													
Calle 100 (Extension)	-	(24)													
New Site 1	-	(60)													

* : Special period landfill

** : The waste collected by horse carts (H/C) will be dumped to Campo Florido landfill continuously

(): Expected area

As shown above, Calle 100 (existing 80 ha + extension 24 ha) and New Guanabacoa (18 ha) will act as the main disposal sites for MSW during the M/P period. From 2011 onward, New Site 1 will take over the function of Calle 100. Outlines of these main landfills are described in Subsection 3.6.2.

Ocho Vias, Barreas and Campo Florido will be also continuously used. Ocho Vias will receive mainly industrial wastes as it presently does. Campo Florido receives waste collected by H/C in the surrounding area as previously mentioned and also receives the wastes that are used to be disposed of at the closed Guanabacoa Landfill till New Guanabacoa Landfill will be constructed.

Waste quantity disposed at each landfill during the M/P period toward 2015 is shown in Table 2.3.14.

Table 2.3.14 Schedule of Disposal Quantities by Landfill

Unit: tons/day

Landfills	Remained Volume (m ³)	Y2004	Y2005	Y2006	Y2007	Y2008	Y2009	Y2010	Y2011	Y2012	Y2013	Y2014	Y2015
Calle 100	1,200,000	1,672	1,667	1,661	1,657	1,650	1,721	1,655	Closed				
New Site 1	-								1,650	1,640	1,414	1,408	1,399
New Guanabacoa	-						360	323	323	326	383	382	380
Guanabacoa	1,242,000	360	Closed										
Campo Florido	1,550		110	110	110	110	1	1	1	1	1	1	1
Special period landfill	209,550	80	80	80	80	80	Closed						
Ocho Vias (temporary)	-		250	250	250	250							
Ocho Vias	2,210,000	350	350	350	350	350	350	350	350	350	350	350	350
Barreras	349,000	50	50	50	50	50	50	50	50	50	50	50	50
Total	5,212,100	2,512	2,507	2,501	2,497	2,490	2,482	2,378	2,374	2,367	2,198	2,191	2,180
Total (covered by M/P)		2,112	2,107	2,101	2,097	2,090	2,082	1,978	1,974	1,967	1,798	1,791	1,780

Note: Calle 100 shows the quantity of both the existing Calle 100 (80 ha) and the Calle 100 Extension (24 ha)

3.6.2 Development Plan for New Landfills

(1) Construction of new landfills

Havana City is divided into 2 areas with regard to operational aspects of MSWM: the eastern area and western area. At least one large environment-friendly landfill will be constructed in each area.

Guanabacoa landfill was closed in March 2005. To take over the function of Guanabacoa landfill, a new landfill will be required to accommodate the waste from the eastern part of the City. This new landfill is called the New Guanabacoa landfill, and the land has already been acquired.

As for the western part of the City, the existing Calle 100 is presently used as the main landfill, but it is scheduled to be closed within 2008. The Calle 100 site has 24 ha of land for expansion of the landfill area as the Calle 100 Extension and these landfill area is expected to use up to until 2010.

After the Calle 100 Extension is full, a new landfill (called New Site 1) will need to be constructed and put into service by 2011. The New Site 1 is located in the western-most part of the City, relatively far from the collection area. The required landfill area and capacity are shown in Table 2.3.15.

Table 2.3.15 Required Landfill Areas and Capacity

Landfill	Schedule of Landfill Operation	
	First section until Y 2010	First section until Y 2010
Calle 100 (Extension):		
Required area of the landfill (m ²)	100,000	80,000
Required capacity of the landfill (m ³)	1,750,000	1,400,000
New Site 1:	First stage until Y2013	Second stage until Y 2015
Required area of the landfill (m ²)	121,000	76,000
Required capacity of the landfill (m ³)	2,275,000	1,400,000
New Guanabacoa:	First stage until Y2011	Second stage until Y 2015
Required area of the landfill (m ²)	60,000	40,000
Required capacity of the landfill (m ³)	840,000	560,000

(2) Type of the landfills

1) Landfill type

Landfill types are generally classified into 4 levels in regard to structure and disposal method. They are summarized in Table 2.3.16.

Table 2.3.16 Structure and Disposal Method by Landfill Type

Item	Landfill Type			
	Level 1	Level 2	Level 3	Level 4
Final Disposal Method	Controlled landfill with introduction of cover soil	Landfill with dike and sufficient daily cover soil	Level 2 + primary leachate re-circulation system	Level 3 + leachate treatment system

Although the cost would be higher, the Level 4 design is proposed for the New Guanabacoa and New Site 1 from the viewpoint of minimizing environmental pollution. Extension of Calle 100 will adopt the Level 3 design because its service period is relatively short.

The concept of the structure and disposal method proposed above as the measures for environment-friendly landfill is described in 2) and 3) below.

2) Leachate treatment method

There are no standards regarding leachate treatment and discharge in Cuba at present. It is tentatively proposed in this analysis that the 2 parameters of total biological oxygen demand (T-BOD₅) and suspended solids (SS) be adopted to provide guideline criteria for planning the leachate treatment method; T-BOD₅ to be lower than 60 mg/L and SS to be lower than 70 mg/L. To meet the above guidelines, 6 alternative systems were studied as shown in Figure 2.3.6. These alternatives were compared for their effectiveness in the removal of BOD and SS as well as the land and cost required. Consequently, Alternative 6 (Anaerobic pond + Aerated lagoon + Maturation pond) was selected (ref. Section 5.10 of Part 2 of the Main Report for details).

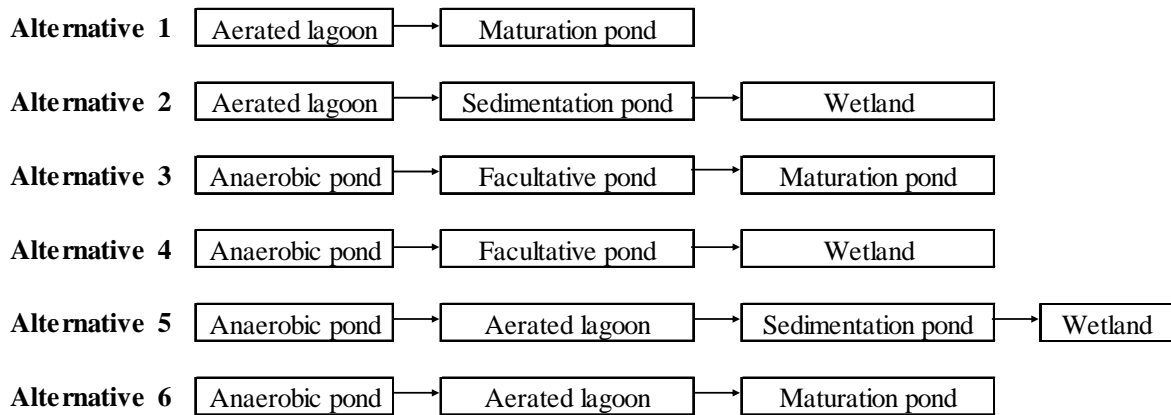


Figure 2.3.6 Leachate Treatment Alternatives

Notwithstanding the adoption of the 2 parameters described above, the monitoring and assessment of other parameters will also be required in the actual operation of the landfill. Among others, parameters relevant to human health include heavy metals, ammonia and total nitrogen, which shall be monitored carefully.

3) Liner facility

A liner facility should be installed to prevent the pollution of public water bodies and/or underground water by leachate. The liner will be placed to the bottom and sides of the landfills.

There are 2 alternative materials for the liner construction: clay layer embankment and membrane sheet installation. If clay is used, it is desirable to have a minimum thickness of 0.75 m and permeability of 1.0×10^{-6} cm/s or less. Of the membrane material options with rubber, PVC and HDPE, HDPE is widely used including Latin American countries.

The cost of the clay layer is estimated to be high because the appropriate material cannot be found in Havana City and hence it would have to be transported from outside the City over a long distance.

The cost comparison for these 2 alternatives revealed that the required cost would be almost the same due mainly to the high transportation cost of clay materials. Therefore, the HDPE liner sheet system is adopted taking advantage of the certainty of material acquisition and the expected quality of liner placing work compared to clay embankment work.

(3) Landfill operation

There are 2 methods of spreading/compacting the solid waste; namely the “push-up” and “push-down” methods. The push-up method is to be adopted for landfill operations in Havana City because it is easier to spread waste in a uniform

landfill layer. The waste will be spread and compacted in segmented cell areas, and the cells so formulated each day will be covered with soil on all waste-exposed surfaces. Daily soil covering minimizes the scattering of waste, offensive odor, generation of insects, and fire outbreaks.

Acquiring cover soil materials is an essential requirement in the landfill operation. Some portion of the solid waste, such as construction waste, bulky waste and other non-organic waste, can also be used as an alternative to cover soil.

Landfill area shall be provided with proper drainage facilities; which include (i) perimeter drainage to stop overland runoff entering the disposal area and (ii) underground drainage below liners. Proper alignment of the approach roads to the disposal sites is also essential. Fencing around the landfill site shall be installed to show the site boundary and to prevent the intrusion of animals and outsiders.

(4) Equipment Required

Heavy equipment will be used to operate the landfill. Table 2.3.17 shows the necessary number of units required together with the specifications of the equipment.

Table 2.3.17 Equipment Required for Landfill Operation

Type of Equipment	Specification	Unit: nos.					
		Calle 100 and New Site 1			New Guanabacoa		
		2009	2010	2015	2009	2010	2015
Bulldozer	228 hp, 28 tons	9	8	8	2	2	2
Wheel loader	2.4 m ³ , 141hp, 13.3 tons	1	1	1	1	1	1
Power shovel	Bucket volume 0.8 m ³ , 145 hp	3	3	3	1	1	1
Dump truck	8 m ³ , 17.9 tons, 270 hp	14	12	12	3	3	3
Water tanker	10 m ³ , with spray gun	1	1	1	1	1	1
Shovel loader	2.2 m ³ , 206 hp, 21.2 tons	1	1	1	1	1	1
Truck scale	Maximum range: 50 tons	2	2	2	2	2	2

3.6.3 Closure and Post-closure Land Use

The landfills that are currently causing environmental problems will be closed with adequate soil covering and other environmental protection measures as early as possible. The closure plan shall be associated with an appropriate post-closure land use plan.

Closure of landfills will be planned in due consideration of the topographic and geological conditions of the sites and environmental monitoring results in the surrounding areas as well. The plan will take into account the land use plan of Havana City so that the land can be used effectively within the framework of the overall City development plan.

In principle, the total thickness of the soil cover layer for the final closure will be more than 60 cm, consisting of a 30 cm clay liner and a 30 cm top soil layer for

vegetation. An outline of the design for landfill closure is presented in Supporting Report C2.

A possible land use after safe-closure is for public parks. Stabilization of the reclaimed land is presumed to need at least 5 to 10 years after its closure. Therefore, continuous environmental monitoring of the landfill gas, leachate and others would be necessary in order to use the land safely.

3.6.4 Maintenance Workshop

UPPH currently owns 65 units of C/T and 180 units of other types of vehicle, of which workable units are 40 C/Ts and 128 other vehicles. Approximately 30-40% of vehicles are out of service. This suggests that reinforcement of the capability for repair and maintenance of equipment is vital. In line with this objective, UPPH is currently constructing a new maintenance workshop for landfill operation at a place in the Diez de Octubre Municipality.

The following programs will be conducted for the maintenance of vehicles and equipment:

- 1) Normal repair and maintenance will be carried out at the central workshop. The workshop will be provided with adequate repair equipment and tools, stocks of spare parts, and will be staffed with competent mechanics and workers.
- 2) Mobile workshops will also be provided to meet the needs for on-site repair and daily maintenance of equipment in the field, including landfill equipment.
- 3) Specific repairs of heavy equipment will be out-sourced to the manufacturers or contractors that have experience in these types of repair works.

Detailed plans for procurement of equipment/tools and staffing of workers are described in Sections 5.9.6, 5.9.7 and 5.9.10 of Part 2 of the Main Report.

3.7 Environmental and Social Consideration Plans

3.7.1 Projects Requiring the EIA

An initial environmental examination (IEE) was conducted during the JICA Study to examine the need for environmental study of the projects under consideration in the M/P. The IEE recommends that environmental impact analysis (EIA) should be carried out for: i) extension of the Campo Florido landfill, ii) construction of environment-friendly landfills at the New Guanabacoa and New Site 1 sites, iii) closing of landfills (special period landfills, Calle 100 and Guanabacoa), and iv) construction of composting yards.

The present EIA system requires improvement in relation to a number of aspects concerning social considerations. The EIA system should require public hearings to be conducted more frequently and more effectively and should require at least one social expert to be assigned to the EIA study team.

3.7.2 Mitigation Measures and Environmental Monitoring Plan

The IEE specified that the designs of the projects proposed in the M/P will consider adequate mitigation measures to reduce the adverse environmental impacts. The mitigation measures for construction/extension of landfills will include controls to ensure proper operation sequences of vehicles and equipment, dust control by water spraying, re-vegetation of construction area, etc.

The environmental monitoring plan will designate the locations, analysis parameters, and frequency of monitoring. The monitoring will cover such areas as water pollution, gas generation, air pollution, offensive odor, and so on. The monitoring should be continued for an appropriate period after the completion of landfill. The Waste Analysis Laboratory (WAL) owned by the DPSC would be the main body dealing with the monitoring work.

3.8 Awareness-raising Plan

3.8.1 Establishment of an Inter-institutional Task Force for Awareness-raising

An inter-institutional multi-stakeholder working group or task force will be established with the objective of reinforcing the coordination of awareness-raising activities for MSWM. The task force will include: CITMA, the provincial government of Havana City and the DPSC, municipal governments and DMSC, ERMP, NGO, and the police. The DPSC will act as the coordinator of the task force.

3.8.2 Information Provision to the Public

Awareness-raising activities will be carried out with dual goals, i.e., (a) to provide relevant information, and (b) to raise awareness among the citizens and promote their active participation. The relevant information to be provided to the public will include: (i) potential problems and their impacts on society, (ii) responsibility to be shared by the citizens for MSWM of the City, and (iii) strategies and solutions for MSWM.

3.8.3 Training of Trainers through a Stratified System

Considering the high demand for instructors and facilitators to carry out awareness-raising activities, training of trainers would be required as the first activity. Firstly, the responsible government staff will be trained at central level, and then they will train other trainers who would work at the community level. The latter group includes the members of NGOs, staff of municipal governments, community leaders, etc. This group will be involved in the training and awareness-raising of the citizens in the field. Key players at the community level, among others, will be the Retired Members' Committees of the Communist Party of Cuba (CPC), Army Veterans' Association, and Committee for Defense of the Revolution (CDR), and Federation of Cuban Women (FMC).

3.8.4 Monitoring of Awareness Level of the Citizens

To effectively achieve the awareness-raising of the citizens and to assure that the activity proceeds in line with actual needs, the monitoring of awareness level should be carried out periodically. Monitoring items will include:

- Knowledge of the citizens about the current situation and problems of MSWM of the City,
- Responsibility of the government and the citizens for MSWM of the City, and
- Strategies of MSWM projects and the solutions to be adopted to achieve a sanitary and healthy environment in the City.

3.8.5 Measures for Promoting Citizen Participation

(1) Collection of information through public hearings

Public hearings provide a good opportunity for collecting public opinions and allaying public anxiety. Public hearings are usually held a number of times during the course of EIA.

A social expert will be included as a member of the EIA study team, then he/she could look into the details of social issues involved in the proposed project from the initial stage of formulating the project concept.

(2) Establishment of a communication system for the public

To enable better communication between the public and the MSWM responsible bodies, a toll-free telephone line will be established. The public will use this phone line to obtain information, to present complaints or to report problems. The phone will be installed at a DPSC office stationed with competent officials on 24

hour basis. A standardized procedure will be established for handling communications over this phone-line.

3.8.6 Awareness-raising Programs for the Introduction of Environment-friendly MSWM System

The awareness-raising programs will be implemented following the principles given below:

- Experience obtained through the PLP carried out in the Havana del Este Municipality will be fully utilized.
- Considering the involvement of a large population in the M/P project, mass media such as radio and TV will be used in order to reach the citizens effectively.
- Reaching the residents will be more effective if a two-step approach is adopted, i.e., reaching residents through existing community organizations such as CPC, Army Veterans' Association, CDR, FMC and Delegates of Electro Districts.

Three awareness-raising programs will be carried out aiming at the successful introduction of environment-friendly MSWM for the City, i.e., (1) segregated collection, (2) environment-friendly landfills, and (3) home composting.

- (1) Awareness-raising program for the introduction of segregated collection
 - Target group will be the households of the 7 urban municipalities.
 - Awareness-raising activities will be carried out at least for 3 years starting one-year ahead of the commencement of segregated collection
 - Awareness-raising workshops will be held so that every household attends at least once.
 - A pamphlet explaining the purpose, classification of segregation with illustrations, etc. will be distributed to every household.
- (2) Awareness-raising program for environment-friendly landfills
 - The target group will be the entire population of the municipalities in which landfills are constructed, but with special emphasis on the communities adjacent to the landfill.
 - The program will be carried out from the early stage of landfill construction planning. Overall awareness-raising of the citizens of Havana City will also be carried out to call for their general understanding of the work.
- (3) Awareness-raising for home composting
 - The target group will be the households in the 8 sub-urban municipalities.

- The program will be carried out continuously in parallel with the staged introduction of home composting, starting from 2007 till 2015.
- An instruction manual for home composting will be prepared based on the experience of the PLP and additional advice from experts of MINAGRI and will be distributed to every household.
- The DPSC/DMSC will establish a contact point for providing technical guidance and will support households by training community leaders who are conducting home composting successfully to help produce better quality compost.

3.9 Implementation Schedule and Cost Estimate

3.9.1 Implementation Schedule

The project in the M/P will be implemented in phases up to the year 2015. The implementation schedule comprehensively takes into account several cross-factors such as urgency of the project, the lead time required, and the annual distribution of financial requirements. The proposed schedule is shown in Figure 2.3.7.

An appropriate lead time is necessary for most of the activities. However, some of the projects, particularly Campo Florido, Calle 100 (Extension) and New Guanabacoa landfills, need the earliest implementation in view of their urgency. Procurement of equipment proposed in the feasibility study will also require the earliest implementation.

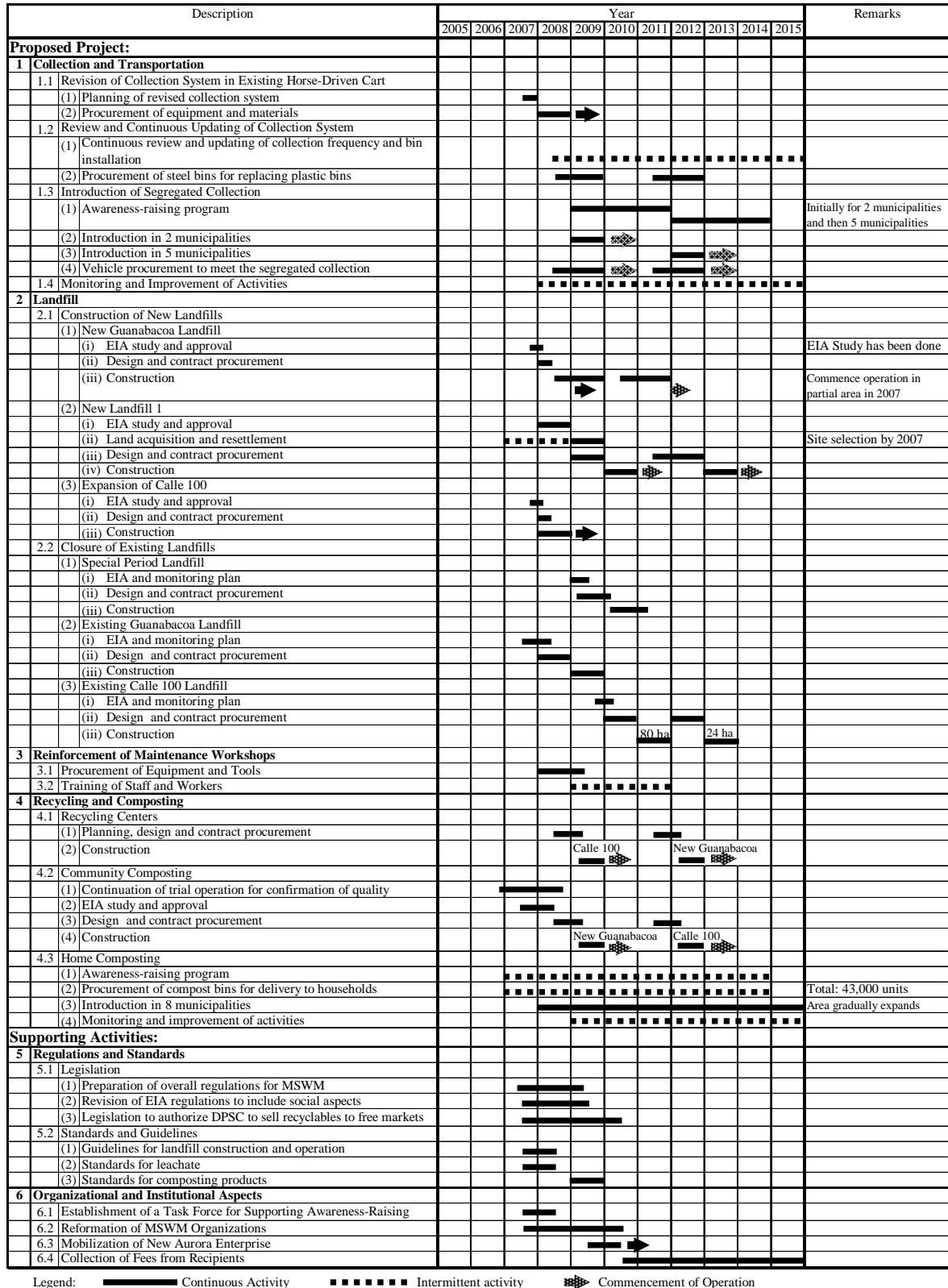


Figure 2.3.7 Implementation Schedule of the M/P

3.9.2 Cost Estimate

The implementation cost of projects in the M/P is summarized as shown in Table 2.3.18.

The capital cost of the M/P amounts to US\$81.9 million and CUP40.0 million, and the recurrent cost (O/M cost) for the M/P period from 2007 to 2015 is US\$14.8 million for Foreign Currency (FC) portion and CUP98.4 million for Local Currency (LC) portion in total. The total cost is US\$96.7 million in foreign currency and CUP138.4 million in local currency.

Table 2.3.18 Summary of Implementation Cost of the M/P

FC: US\$ million, LC: CUP million, 2005 prices

Component	Capital cost		O/M Cost		Total	
	FC	LC	FC	LC	FC	LC
Composing (total)	5.1	4.6	0.3	6.4	5.4	11.0
Recycling (total)	4.3	4.4	0.3	14.2	4.6	18.6
Collection and transportation (total)	24.2	0.0	7.5	65.5	31.7	65.5
Landfill (total)	48.0	30.9	4.3	11.0	52.3	41.8
Awareness raising	0.0	0.0	2.1	1.4	2.1	1.4
Environmental monitoring	0.3	0.1	0.3	0.0	0.6	0.1
Total	81.9	40.0	14.8	98.4	96.7	138.4

Note: 1. FC: Foreign Currency, LC: Local Currency

2. The above represents the cost at 2005 prices without price escalation during the implementation period towards 2015. See Table 2.3.20 hereinafter for total fund requirement including the estimated price escalation amount.

In the above table, the capital cost includes project direct cost including equipment purchase cost, administration cost (3% of direct cost), engineering services (2% for FC and 5% for LC), and physical contingency (10% for civil works and 5% for equipment contract). Costs for land and resettlement were not included on the assumption that they would be arranged as a government responsibility. A large part of the O/M costs is for salaries, which was estimated based on the current average rates of Havana City (DPSC, UPPH, and Auroras).

3.9.3 Disbursement Schedule

The disbursement schedule is summarized in Table 2.3.19. It is noted that a relatively large amount of funds is required in 2008 for construction of landfills and in 2008-2009 and 2013 mainly for the procurement of equipment.

The capital cost will be defrayed until 2015, and some capital assets will still retain salvage values at the end of 2015. Such salvage values are estimated to be US\$21.9 million and CUP9.7 million at 2005 constant price, which were taken into account in the project economic and financial evaluation.

Table 2.3.19 Disbursement Schedule of the M/P at 2005 Price

FC: US\$ million, LC: CUP million, 2005 price

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Capital	FC	0.0	0.4	35.9	9.9	9.2	11.3	4.2	10.6	0.1	0.3	81.9
Cost	LC	0.0	0.2	12.3	11.7	5.0	3.7	4.4	2.8	0.0	0.0	40.0
O/M	FC	0.0	0.4	1.1	1.7	1.8	1.9	1.9	2.1	1.9	1.9	14.8
Cost	LC	0.0	0.3	6.7	8.3	11.1	12.7	12.7	15.6	15.5	15.5	98.4
Total	FC	0.0	0.8	36.9	11.6	11.0	13.2	6.2	12.7	2.0	2.2	96.7
Cost	LC	0.0	0.5	19.0	19.9	16.1	16.4	17.0	18.4	15.5	15.5	138.4

Note: 1. FC: Foreign Currency, LC: Local Currency
2. This table shows the disbursement schedule of cost at 2005 constant price, wherein no price escalation is taken into account

3.9.4 Total Fund Requirement

Actual financing for the implementation shall take into account the likely price escalation that will occur during the M/P period.

In this context, the total fund requirement was calculated by applying the price escalation rate to the basic cost stream at 2005 prices (ref. Table 2.3.19). The escalation rates were assumed at 1.0%/year for the foreign currency portion and 2.3%/year for the local currency portion. The result is presented in Table 2.3.20.

Table 2.3.20 Total Fund Requirement for the M/P

Unit: FC: US\$ million LC: CUP million

Description		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Capital	FC	0.0	0.4	37.0	10.3	9.7	12.0	4.5	11.5	0.1	0.3	85.8
Cost	LC	0.0	0.3	13.1	12.8	5.6	4.2	5.1	3.4	0.0	0.0	44.4
O/M Cost	FC	0.0	0.4	1.1	1.8	1.9	2.1	2.1	2.3	2.1	2.1	15.8
	LC	0.0	0.3	7.2	9.0	12.5	14.5	14.9	18.7	19.1	19.5	115.7
Total	FC	0.0	0.8	38.1	12.1	11.6	14.0	6.6	13.8	2.2	2.4	101.6
Cost	LC	0.0	0.5	20.3	21.8	18.0	18.7	20.0	22.1	19.1	19.5	160.1

Note: 1. FC: Foreign Currency, LC: Local Currency
2. Price escalation rate: 1.0%/year for FC and 2.3 %/year for LC

It is assumed that the State Government would provide the funds stated above since the amount appears to be beyond the capacity of the City government. Most of the O/M cost can be financed from revenues comprised of tariffs (actually subsidized by the City government) and recyclable/compost sales, but the revenues will not be enough to cover the FC portion. The government funding of the FC portion is an essential requirement for the M/P implementation.

3.10 Institution and Organization Plan

3.10.1 Improvement of the Organizational Framework

(1) Reformation of organizations

The prevailing problems for MSWM in Havana City are public nuisance and environmental pollution caused by the MSWM facilities and delays in waste collection resulting in the spread of waste around the waste discharge bins. As one

of the approaches to tackling the present problems and achieving environment-friendly MSWM, a restructuring of the organizational framework in the MSWM sector was examined.

The new organizational framework will be aimed at achieving the following:

- To share properly the responsibility for conducting environment-friendly MSWM among the concerned agencies
- To offer incentives to the operating agencies by enabling them to operate autonomously and actively pursue cost recovery

(2) Model for the new organization

Two public enterprises called Aurora are in operation in Havana City, one in the municipality of Plaza de la Revolución and one in Havana Vieja. Being endowed with certain autonomy of operation, the Auroras have attained high operational efficiency. The Auroras' productivity is 20% higher than that of the other MSWM agencies in Havana City, as shown in Table 2.3.21.

Table 2.3.21 Operational Efficiency of Auroras

Agency	Quantity of Waste Collected (lit/capita/day)	Productivity in Weight of Waste Collection (tons/employee/day)
Aurora Plaza	4.06	0.61
Aurora Havana Vieja	3.54	0.62
Average of Havana City	3.20	0.52

Source: Waste quantity survey conducted during the JICA Study.

The 2 Auroras receive government subsidy for capital investment, but are financially self-reliant in O/M. These existing Auroras are a good model to formulate a new organizational framework for Havana City.

The Aurora type organization seems to have the following advantages, other than the high operational efficiency and self-financing capacity:

- 1) There are many successful cases in the world of public services being provided through enterprise-like institutions that have achieved financially self-reliant operation.
- 2) Auroras have more autonomy in the management of their financial resources, which is a very important feature of an activity-based costing, as is the case of solid waste management.
- 3) The staff is more motivated because the salaries may be set according to the productivity of each worker or group of workers with the government approval, which is different from government-budgeted institutions where salaries are fixed.

- 4) The financial resources come from the organization's own revenues, at least partly, which are tied to the rendered services.
- 5) The Aurora model is already utilized in an existing institutional framework already operating in Cuba, so it is fully compatible with the Government administrative system.
- 6) As indicated in Table 2.3.21, the performance of the Auroras would be higher than the average of the present institutions.

(3) Organization framework in future

The existing organizational framework will be restructured by establishing new Auroras that will share the operational aspects of MSWM. The role of the DPSC and DMSCs will change from service provision to regulation and supervision of the Auroras. The organization plan is summarized below:

1) Three regional Auroras for collection and transportation

Each regional Aurora would be in charge of collection of all kinds of urban wastes and street sweeping activities in the west, center and east of Havana City, respectively. Revenue of these Auroras would basically come from collection charges⁹.

2) Final disposal Auroras

One Aurora would be responsible for the final disposal of MSW at the designated landfills. Revenue for this Aurora would come from a tipping fee imposed on organizations that deposit their solid wastes at the landfills, including the 3 regional Auroras in charge of collection and transportation.

This Aurora would be also responsible for the operation of the recycling plants and composting plants. Revenue from the sale of collected recyclables and produced compost can also be expected.

3) Vehicle and equipment Auroras

Another Aurora would be in charge of providing vehicles, machines and equipment to the other Auroras. It would supply collection trucks and other equipment used for the collection of solid waste to the regional Auroras and bulldozers, dump trucks, wheel loaders and other equipment to the final disposal Auroras. Revenue for this Aurora would be from lease charges for vehicles and equipment.

4) Aurora Group – holding company

A holding company would be set up for the overall administration of

⁹ Payment is substituted by the governments because of the government policy that the tariff is actually not charged to the public.

manpower and finances, especially operational monitoring and budget control of the 5 specialized Auroras. Operational and strategic planning for medium and long-term activities of the 5 Auroras would be formulated by the holding company while the Auroras would make short term plans in their respective fields.

5) DPSC and DMSC

Litter control and inspection of the overall MSWM services rendered by the Auroras would be done centrally by the DPSC in cooperation with the 15 DMSC. The DMSC would be directly in charge of controlling the collection and street sweeping services in their respective areas of responsibility.

The organization structure for MSWM is shown in Figure 2.3.8.

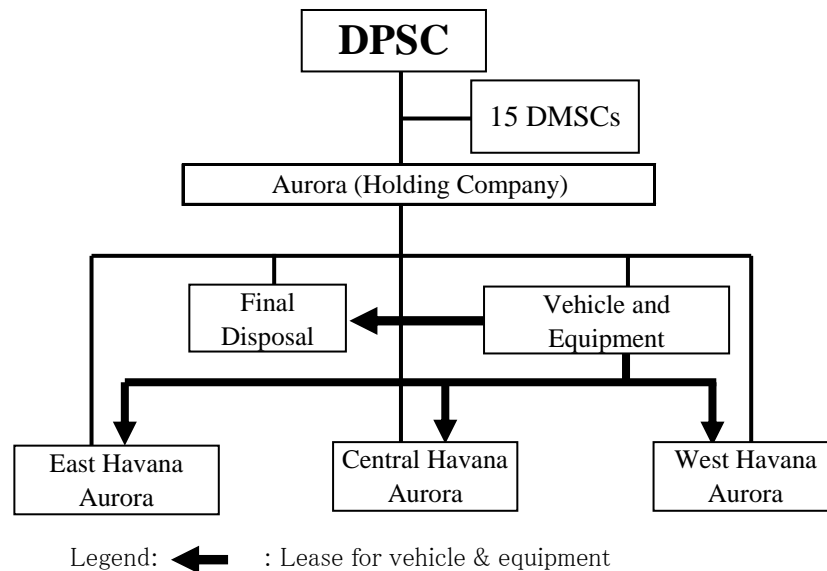


Figure 2.3.8 Proposed Organization Structure for MSWM

(4) Implementation schedule

Taking into consideration the time needed for going through the required procedure for establishing the new organizations as well as the implementation schedule for the planned new facilities and the introduction of segregated collection in 2010, the new organization for MSWM in Havana City should be established by the year 2010. The 2 existing Auroras of Plaza and Havana Vieja, and the operational staff, vehicles and equipment of UPPH and the 15 DMSC will be absorbed into the new Auroras by 2010.

3.10.2 Reinforcement of Regulations and Standards

The regulatory provisions for MSWM in Havana City should be reinforced with a view to adopting a framework for supporting a new environment-friendly system. The major aspects of the system that need reinforcement are as follows:

(1) Revision of the current solid waste disposal guidelines and standards

Specific regulations should be prepared for controlling all aspects of environment-friendly landfills, covering planning, construction, operation and monitoring during and after construction. The revised provisions shall include the following:

- 1) The requirements for the structure of the landfills as well as leachate treatment facilities should be included.
- 2) The present regulation stipulates that landfills should be 1,000 m or more away from urbanized areas. This will be amended so that environment-friendly landfills can be located up to 300 m from inhabited areas if the area lies leeward from the landfill and 500 m otherwise.
- 3) Solid waste disposed of in earlier time will be allowed to be used as cover soil for an environment-friendly landfill, provided that the solid waste is already decomposed to an inorganic state and inert, and does not contain any toxic substances. This will help procure cover soil materials in view of the large volume of cover soil needed in the future landfill operation.
- 4) Leachate treatment operation will need technical standards to be prepared regarding leachate treatment level and water quality of receiving water bodies.

(2) Setting-up of standards for the compost

Standards for the compost made from MSW will be set up to control the quality and safety of compost. Only compost meeting these standards would be used for green areas, parks, and farmland, including farmland used for food production.

(3) Legislation for allowing free marketing of recyclable materials

The existing legislation allows only UERMP to sell recyclables to market. In order to promote recycling, it is proposed to authorize the DPSC, DMSCs, and the proposed Auroras to directly sell recyclables to market. This would provide motivation for the collection and recovery of recyclables. However, the introduction of this concept is subject to the approval of the government.

3.11 Financing Sources

3.11.1 Financing Alternatives

Conceivable sources of revenue to meet the cost of SWM include charging tariffs to the users of the waste collection service, tipping fees, revenue from selling recyclables and compost, garbage tax, property tax, business licenses, and the government subsidy.

Of the above alternative sources of financing, the 2 primary sources are tariffs and government subsidy. Because of the government policy, tariffs are not charged to household recipients. At present, nearly 90% of the SWM expenditure in Havana City are financed by government funds, as recorded in 2003 (ref. Table 2.2.3). The remaining 10% are financed by tariff revenues.

3.11.2 Policy for Charging Tariffs

The government sets forth tariff rates for several types of recipients. Of these, households are actually not charged¹⁰.

The M/P follows the government policy that tariffs will not be charged to households for the foreseeable future. Instead, the City and/or Municipal Governments will subsidize the operating agencies (UPPH/DMSCs and/or Auroras) by an equivalent amount.

3.11.3 State Subsidy

The financing capability of the City Government and the appropriateness of the amount of financing for the M/P implementation can be evaluated by analyzing the ratio of the M/P cost to the City government expenditures. The referential financing indicators are shown in Table 2.3.22.

Table 2.3.22 Financial Indicators of Havana City

Description		Amount (CUP million Equiv)
a)	Cuban GDP (2003)	33,237
b)	Havana City GRP (2003 estimate) *1	12,935
c)	Havana City Spending (2003 budget):	1,352
d)	Havana City Spending on Community Service (2003 budget): *2	340
	- Recurrent Cost	230
	- Capital Investment	110

Note: *1 Estimated as 40% of Cuban GDP; a rule-of-thumb figure used in Cuba

*2 Expenditure covering not only SWM but also other community services

¹⁰ Municipal governments subsidize the equivalent amount to Auroras

The M/P cost is US\$96.7 million for the foreign currency portion and CUP138.4 million for the local currency portions. The total M/P cost can be added up with the exchange rate into the CUP equivalent and annualized or converted into a stream of annual payments of equal amount at a discount rate of 8% per annum¹¹. This annualized payment can be compared with the Havana City GRP, the Havana City expenditure, or the Havana City expenditure on community services so that the impact of the M/P cost against the financial capability of Havana City can be evaluated.

Since foreign currency exchange is strictly controlled by the Government of Cuba, the impact of summing the foreign and local currency portions on the financial capability of Havana City was not estimated in the JICA Study. Considering the actual financial situation of the City, however, the total M/P cost appears to be beyond the financing capacity of the City, and State Government financing is essential for implementation of the M/P.

The implementation of the M/P requires capital expenditure amounting to US\$81.9 million in FC and CUP40.0 million in LC (ref. Subsection 3.9.4). Although part of the cost can be covered by the City government's budget, the majority shall be financed by the State Government sourcing from the state CUC budget and/or partly from foreign aid from several countries.

¹¹ The prevailing CUP long term deposit rate was 8% in May 2005, which was used as the discount rate.

CHAPTER 4 EVALUATION OF THE MASTER PLAN AND RECOMMENDATIONS

4.1 Evaluation of the Master Plan

4.1.1 Method of Evaluation

The soundness of the M/P was evaluated from multiple angles, which included (i) technical adaptability, (ii) economic and financial viability, (iii) institutional adaptability, (iv) community acceptance (social aspect), and (v) environmental aspects.

Economic evaluation was basically based on a concept of comparing the “with-and without-project” conditions; wherein benefit accrued from the M/P projects is compared with the cost of the projects including the O/M cost. Financial evaluation was done in a similar way based on expected revenues and costs.

4.1.2 Comparison of With and Without M/P Conditions

Table 2.4.1 summarizes the comparison of foreseeable conditions of MSWM in the City under scenarios of “with the M/P” and “without the M/P”.

Table 2.4.1 Comparison of “With the M/P” and “Without the M/P” Conditions

Description	With the M/P	Without the M/P
Recycling	<p>A segregated collection system will be put in practice where collection of recyclable materials will be carried out in a more efficient manner under more hygienic work conditions.</p> <p>Utilization of recyclable waste will be promoted and will contribute to the reduction of final disposal quantity.</p>	<p>Without recycling plants and the segregated collection system, recycling will continue at landfill sites under low efficiency and non-hygienic conditions.</p> <p>Recyclable materials collected by the DPSC are sold to UERMP at the current level at best due to unstable and small supply. This situation is unlikely to change, which will not be a strong incentive for the DPSC to further strengthen recycling activities.</p>
Composting	<p>More efficient and hygienic collection of organic materials will become possible by introducing segregated collection and home composting.</p> <p>Organic compost will be used instead of chemical fertilizer.</p> <p>Composting contributes to the reduction of quantity of final disposal.</p>	<p>Compost produced at the existing composting yard will be adulterated with non-organic materials and its quantity is quite small.</p> <p>The working conditions of sorting staff will remain unhygienic.</p> <p>Marketability of compost will continue to be slim.</p> <p>Waste disposal quantity will not reduce and the life of landfills will be short.</p>
Collection /transportation	<p>Solid waste collection service will cover almost all the Havana City area and will be less interruptive and more punctual.</p> <p>littering of waste will decrease.</p> <p>Introduction of segregated collection will contribute to promoting the waste reduction and recycling but the collection cost will increase.</p>	<p>Frequency and care of waste collection service will remain at present levels.</p> <p>Long distance haulage will become necessary after SPLs are closed.</p>

Description	With the M/P	Without the M/P
Final disposal	Existing landfills that currently cause the environmental pollution will be closed in a sanitary manner. As closed landfills can be used as parks or green areas, the resident's amenities will increase. Harmful insect or fire outbreaks will decrease.	Solid waste collected would continue to be dumped in suburban areas without sanitary treatment, which can be considered unacceptable for a modern capital city.
Awareness-raising	New waste bins, new vehicles, domestic waste segregation, and new environment-friendly landfills can sensitize the public to MSWM problems.	The opportunity of self-involvement through segregation of household waste, composting, and recycling will be lost. Objections to constructing new landfills may still continue.
Environmental monitoring	Environmental impacts will be clarified through EIA and the construction of new landfills will be considered as desirable.	Construction of new landfills might be hampered due to a lack of providing scientific evidence.

4.1.3 Technical Adaptability

Overall, the implementation of the projects proposed in the M/P is deemed to be within the capability of existing agencies on the basis that they will be accompanied by an adequate staff training program. People will cooperate with the proposed MSWM activities on the basis that adequate awareness-raising, education, and instruction programs are given. Relevant aspects of the works proposed in the M/P are described hereunder.

(1) Segregated collection and transportation

Because of the poor condition of the vehicles used, the pilot project (PLP) did not fully verify that the collection and transportation system proposed in the M/P segregated collection, would be manageable. However, technically from the viewpoint of vehicle operation, basic skills for driving and maintaining the vehicles have been accumulated through over 20 years of experience. Vehicles will basically be renewed and/or reconditioned versions of the existing types, thus the existing staff can operate them with existing experience and skills.

During the PLP, people were willing to cooperate in segregated discharge of waste. But, the quality of segregation varied depending on people's awareness for the need of waste segregation. The results of the PLP suggested that people's performance in segregating waste could be greatly improved by providing intensive awareness-raising, provided that the program continues until consequences are affirmed. In addition, the provision of a precise waste collection system with an adequate number of vehicles will be necessary to promote the awareness-raising program.

(2) Recycling

Regarding recycling, the skills for collecting and processing recyclable materials have already been accumulated by the existing agencies to a certain extent. The skills could be used in the proposed M/P projects since the processing method is virtually same as at present, and existing staffs are expected to be assigned to the work, although training will still be needed.

(3) Composting

Regarding community composting, the composting yard facilities and equipment are technically simple, but the basic skills¹² required for their operation have not been accumulated in the existing MSWM agencies. With suitable training through further pilot scale trials, smooth operation of composting will be ensured. It is also important that the implementation of composting projects needs to receive technical advice from MINAGRI, on both production and marketing of compost. Close tie-up with MINAGRI is quite indispensable.

It should be noted that there was not enough time allocated to the PLP to fully elaborate the production method and the method to improve compost quality. Further confirmation of compost production methods and improvement of compost quality is needed through an additional pilot study coupled with segregated collection, which should be mobilized prior to the implementation of the M/P project.

Similarly, not fully confirmed by the PLP was the quality of home composting products in quantitative terms, though the compost was observed to be of acceptable quality judging from the smell, moisture and color of compost actually produced at households (ref. Subsection 2.3.3 in Part 3). For further clarification of this uncertainty, the implementation of home composting in the M/P will require the monitoring of quality on a regular basis. Judging from the experience in the PLP, households appear to be capable of conducting home composting on the basis that they receive intensive guidance on the production method.

(4) Landfill Operation

It was recognized through the PLP that the Cuban workers were able to manage the daily operations of cell construction and soil covering, which are essential components of environment-friendly landfill operation. One uncertainty is that the Cuban agencies have no practical experience in leachate treatment works, so technical guidance from experienced foreign experts will be required.

¹² Such as re-segregation of kitchen waste, spreading, mixing, moisture and fermentation control, etc.

4.1.4 Economic Viability

(1) Basic assumptions in analysis

The economic analysis was based on the following conditions:

- (i) Evaluation period: 9 years from 2007 to 2015
- (ii) Conversion factor¹³: 0.90 for the foreign currency portion,
1.04 for capital cost of the local currency portion and,
0.94 for recurrent costs of local currency portion
- (iii) Exchange rate: US\$1 = J¥110¹⁴

(2) Economic cost

Economic cost was calculated firstly by excluding the portion of transfer payments such as tax, subsidy, and interest, and then by applying the conversion factors to the financial cost that was estimated in Section 3.9.

Investment of capital cost continues to the end of evaluation period, i.e., the year 2015. This implies that some salvage values are available from the invested costs. The salvage value at the end of 2015 in the economic cost was calculated as US\$21.9 million in foreign currency portion and CUP9.7 million in local currency portion, respectively. These costs were counted in the economic cost stream as reduction in cost in 2015. Economic cost stream is shown in Table 2.4.6.

(3) Economic benefits

Economic benefits consist of the following 4 items:

1) Household ability to pay

Improvement in MSWM provides various kinds of benefits in the improvement of hygienic condition and people's living environments. However, these benefits are quite difficult to quantify. As the proxy of these benefits, willingness to pay (WTP) is often applied, but the quantification of WTP is also difficult. Therefore, the Study estimated the 'ability to pay' or 'affordability to pay' as a proxy of WTP, which is assumed to be 1% of household income.

On this basis, the ability to pay for the evaluation of the M/P was calculated as shown in Table 2.4.2.

¹³ The ratios were derived from similar study in Cuba

¹⁴ The rate was at September 2004

Table 2.4.2 Estimate of Ability to Pay of Households

	Unit	Value
a. Monthly household income *1	CUP/household	760.0
b. Average number of household members	Persons/HH	4
c. Estimated monthly income per head	CUP/person	190.0
d. Amount of ability to pay (1% of c)	CUP/person	1.90
e. Estimated beneficiaries	1,000 persons	2,176
f. Total ability to pay per year	CUP 1,000	49,613
g. Total (economic value*2)	CUP 1,000	46,636

Note: *1: At 2005 price, *2: A conversion factor of 0.94 was applied

2) Production of compost and recyclables

The production of compost and recyclables is considered as a benefit. The Study assumed that production of both benefits would start in the year 2010. The production quantity and benefit amount were calculated as shown in Table 2.4.3 for compost and Table 2.4.4 for recyclables.

Table 2.4.3 Benefit Accrued from Production of Compost

Year	Production (tons/year)	Sale Ratio*1 (%)	Value*2 (CUP1,000/year)	Economic Value (CUP1,000/year)
2010	16,425	30	2,464	2,562
2011	16,425	40	3,285	3,416
2012	16,425	45	3,696	3,843
2013	39,055	50	9,764	10,154
2014	39,420	55	10,841	11,274
2015	39,420	60	11,826	12,299

Note: *1: Maximum sale ratio is assumed to be 60% of total production. The rest of production is assumed to be non-saleable and used in landfill area

*2: Unit sale value is assumed as CUP500/ton at 2005 price

Table 2.4.4 Benefit Accrued from Recovery of Recyclables

Description	Units	2010	2011	2012	2013	2014	2015
Production							
1) Plastic	tons	246	374	496	1,011	1,280	1,527
2) Paper	tons	828	966	1,110	2,842	3,133	3,421
3) Aluminum	tons	276	325	377	954	1,058	1,161
4) Glass	tons	3,380	4,010	4,688	11,739	13,069	14,387
5) Steel	tons	217	246	287	741	803	886
Value							
1) Plastic	CUP1,000	172	262	347	708	896	1,069
2) Paper	CUP1,000	132	154	178	455	501	547
3) Aluminum	US\$1,000	166	195	226	572	635	696
4) Glass	CUP1,000	270	321	373	939	1,045	1,151
5) Steel	US\$1,000	8	9	10	26	28	31
Total Value	US\$1,000	173	204	236	598	663	727
	CUP1,000	575	737	898	2,101	2,443	2,767
Economic Value	US\$1,000	156	183	212	538	596	655
	CUP1,000	598	767	934	2,185	2,540	2,878

Note: Unit selling prices are assumed as CUP700/ton for plastic, CUP160/ton for paper, US\$60/ton for aluminum, CUP80/ton for glass, and US\$35/ton for steel, all at 2005 prices

3) Saving of landfill cost

Due to the production of compost and recycling, the burden on landfill will be reduced and, hence, the cost of landfill activity will be saved. The saved cost can be considered as one of the economic benefits of the M/P and the amount of saving is estimated as shown in Table 2.4.5.

Table 2.4.5 Saving of Landfill Cost

Description	Units	2010	2011	2012	2013	2014	2015
Saving Volume							
Compost	tons/year	17.2	17.2	17.2	39.1	39.1	39.1
Recycle	tons/year	4.9	5.9	6.9	17.3	19.3	21.4
Total	tons/year	22.1	23.1	24.1	56.4	58.4	60.5
Saving Value*							
FC portion	US\$1,000	157	164	171	400	415	429
LC portion	CUP1,000	236	247	258	603	625	647
Saving Value (economic value)							
FC portion	US\$1,000	141	147	154	360	373	386
LC portion	CUP1,000	246	257	268	627	650	673

Note: *: The unit values for the landfill saving cost by composting and recycling are US\$7.10/tons and CUP10.7/tons, respectively.

(4) Economic analysis

Based on the economic costs and benefits estimated above, these are summarized as shown in Table 2.4.6.

Table 2.4.6 Economic Cost and Benefit Streams

FC: US\$ million, LC: CUP million

Description		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Economic Cost:											
M/P Cost	FC	0.0	0.7	33.2	10.4	9.9	11.9	5.5	11.5	1.8	2.0
	LC	0.0	0.5	19.1	19.9	15.6	15.7	16.5	17.6	14.6	14.6
Salvage Value	FC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-21.0
	LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-10.0
Total	FC	0.0	0.7	33.2	10.4	9.9	11.9	5.5	11.5	1.8	-19.1
	LC	0.0	0.5	19.1	19.9	15.6	15.7	16.5	17.6	14.6	4.6
Economic Benefit:											
Ability to Pay	LC	0.0	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6
Compost Products	LC	0.0	0.0	0.0	0.0	2.6	3.4	3.8	10.2	11.3	12.3
Recycle Products	FC	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.5	0.6	0.7
	LC	0.0	0.0	0.0	0.0	0.6	0.8	0.9	2.2	2.5	2.9
Landfill Saving	FC	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.4	0.4	0.4
	LC	0.0	0.0	0.0	0.0	0.2	0.3	0.3	0.6	0.6	0.7
Total	FC	0.0	0.0	0.0	0.0	0.3	0.3	0.4	0.9	1.0	1.0
	LC	0.0	46.6	46.6	46.6	50.0	51.1	51.7	59.6	61.1	62.5
Cost - Benefit Balance	FC	0.0	-0.7	-33.2	-10.4	-9.6	-11.6	-5.2	-10.6	-0.9	20.1
	LC	0.0	46.1	27.5	26.7	34.4	35.3	35.2	42.0	46.5	57.9

As shown above, the projects proposed in the M/P seem to be economically viable in the local currency portion but not very viable in the foreign currency portion. On the other hand, the above evaluation did not include (i) benefit derived from the willingness to pay by institutions for collection and tipping fees, and (ii) other intangible benefits such as improvement of hygienic condition and livelihood environments in the City and improvement in environmental conservation around landfills, both of which are difficult to quantify. In this type of project, the intangible benefits mentioned in (ii) are considered to be particularly important.

MSWM is an indispensable service for the public, which should by all means be provided by the municipal administration. The municipality does not have the option of not providing a SWM service simply because of low economic viability.

(5) Sensitivity analysis

One of uncertain factors involved in the above economic evaluation is the market price of compost and recyclables. The expected price may not be achieved or, in some cases, higher prices may be achieved. In this context, a sensitivity analysis was conducted by varying the sale prices of recyclables and compost as follows:

Sensitivity analysis for compost price:

- Base Case: Compost price is CUP500/ton as assumed in Table 2.4.3
- Case C-1: Compost price is zero (i.e. not saleable to market)
- Case C-2: Compost price is CUP1,250/ton (saleable of high quality compost)

Sensitivity analysis for recyclable price:

- Base Case: Recyclable prices are as assumed in Table 2.4.4
- Case R-1: Recyclable prices are 20% lower than the Base Case
- Case R-2: Recyclable prices are 20% higher than the Base Case

The results of sensitivity analysis are summarized in Table 2.4.7.

Table 2.4.7 Sensitivity Analysis of Economic Evaluation

FC: US\$ million, LC: CUP million

Case	Present Worth of Economic Cost		Present Worth of Economic Benefit		Net Present Value		Benefit-Cost Ratio (B/C)	
	FC	LC	FC	LC	FC	LC	FC	LC
Base Case	50.4	79.3	2.1	299.4	-48.4	220.1	0.04	3.78
Sensitivity Analysis for Compost Price:								
Case C-1	50.4	79.3	2.1	276.4	-48.4	197.2	0.04	3.49
Case C-2	50.4	79.3	2.1	333.8	-48.4	254.6	0.04	4.21
Sensitivity Analysis for Recyclables Price:								
Case R-1	50.4	79.3	1.8	298.3	-48.6	219.1	0.04	3.76
Case R-2	50.4	79.3	2.3	300.4	-48.1	221.2	0.05	3.79

Note: Calculation method is the same as used in Subsection (4) above
EIRR was not calculated

As shown above, the sensitivity to prices of both compost and recyclables is not so high because sales of these products are a relatively small proportion of the total benefit.

4.1.5 Financial Viability

The financial viability of the potential operating agencies, including the UPPH/DMSC and the proposed Aurora Group (a holding company), was evaluated based on the anticipated cost and revenue streams relevant to the M/P projects. The analysis was performed to confirm whether the operating agency would be able to finance the recurrent O/M costs from the revenues or whether it would need to receive government subsidy even for O/M.

(1) Conditions for the evaluation

The following conditions were assumed in the financial evaluation:

- Cash account for evaluation: Combined cash account of the operating agencies (UPPH + DMSC + Aurora holding company)
- Evaluation horizon: 2007 – 2015
- Cost stream: O/M costs disbursed as expenditure of the operating agencies, for both the cases of excluding and including equipment depreciation cost; see Para. (2) below with regard to the interpretation of depreciation cost
- Revenue stream: Cash revenue flowing in the cash account of the operation agencies, consisting of (i) waste

collection fee¹⁵, (ii) tipping fee at landfills¹⁶, and (iii) revenue from selling recyclables and compost, see Para.(3) below for details

- Currency exchange rate: US\$1 = ¥110 (2004, September)
- Price level: 2005 constant prices, where no price escalation was considered for either cost or revenue

(2) Cost stream

Cost stream estimated in Table 2.3.19 (ref. Subsection 3.9.3) was used for the financial evaluation.

Judging from the foreseeable financial condition of the operating agencies, it is proposed that the government would retain ownership of the project facilities and equipment and bear the depreciation cost under the state account. In this case, the cost stream appearing on the cash account of the operating agencies is basically limited to the O/M expenditures. This case was examined as ‘Case-A: Without depreciation cost’ in the financial analysis.

The Study also examined an alternative case of including the depreciation cost in the account of the operating agencies. In this case, the salvage value of the project facilities and equipment, which still remains at the end of the evaluation horizon, would be taken into account in the cost stream. This case was examined as ‘Case-B: With deprecation cost’ in the financial analysis.

Table 2.4.8 shows the cost stream of the above 2 cases used for financial evaluation. A breakdown of details is presented in the Main Report.

Table 2.4.8 Cost Streams for Financial Evaluation of the M/P Project

FC: US\$ million, LC: CUP million

Description	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Case-A:	FC	0.0	0.4	1.1	1.7	1.8	1.9	1.9	2.1	1.9	1.9	14.8
	LC	0.0	0.3	6.7	8.3	11.1	12.7	12.7	15.6	15.5	15.5	98.4
Case-B:	FC	0.0	0.8	36.9	11.6	11.0	13.2	6.2	12.7	2.0	-19.7	74.8
	LC	0.0	0.5	19.0	19.9	16.1	16.4	17.0	18.4	15.5	5.9	128.8

- Note: 1. FC: Foreign Currency, LC: Local Currency
 2. Case-A: Depreciation is excluded from the cash account. Case-B: Depreciation cost is included.
 3. Salvage value of equipment at year 2015 was estimated to be US\$21.9 million and CUP9.7 million. Cost expressed at 2005 price

(3) Revenue stream

For the purposes of the Study it was assumed that the operating agencies would receive cash revenues from the following sources:

¹⁵ This fee is actually subsidized by the City Government at present. See Para (3) for details.

¹⁶ This fee is also not charged at present. See Para.(3).

1) Waste collection fees:

This would be the main source of revenue for operating agencies. However, the collection of fees from households is actually not possible at present mainly due to the policy of the government, although the tariff is legally set out. For the purposes of the Study evaluation, it was assumed that the government will continue to subsidize MSWM by an equivalent amount. For a conservative estimate, the Study assumes that the government would finance an amount as a subsidy for fee revenue equivalent to only 50% of the serviced population in 2007 at first and that this would gradually increase to 80% by 2015.

The operating agencies will directly receive the waste collection fees from institutions as being collected by the existing Auroras.

The fee rates were assumed to be the currently approved rates described in Section 2.9.

2) Tipping fee at landfills

Tipping fees are presently not collected at landfills although it is legally permitted to collect tariff. The Study assumes that this situation would be rectified by the DPSC within 3 years and the collection would be possible from 2010 onward. The rate of actual fee collection would be equivalent to the amount payable for 50% of the disposed waste initially in 2010, gradually improving to 80% by 2015. The fee will be set at CUP0.5/ton, as currently set forth. The fees will be collected from both commercial and public institutions that dispose of SW at landfills. The tipping fee is not charged to MSWM agencies (Auroras in the future) ¹⁷.

3) Revenue from selling recyclable materials and compost

Sale of recovered recyclable materials and compost produced by community will be revenue sources expected for the operation agency.

The revenue stream so derived is shown in Table 2.4.9.

¹⁷ Tipping fee is not charged to MSWM agencies since the tipping cost is covered by the waste collection fees separately charged. Nevertheless, within the Auroras, an equitable adjustment of revenues will be made between the Regional Enterprises (collection enterprise) and the Final Disposal Enterprise.

Table 2.4.9 Revenue Stream of the M/P Project

Unit: FC: US\$ million, LC: CUP million

Revenue Source	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Collection fee from households*	FC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LC	0.0	5.2	5.6	5.9	6.3	6.7	7.1	7.5	7.8	8.2	60.3
Collection fee from institutions	FC	0.0	0.7	0.8	0.8	0.9	0.9	1.0	1.1	1.1	1.2	8.5
	LC	0.0	3.6	3.8	4.1	4.4	4.6	4.9	5.2	5.5	5.7	41.8
Tipping fee at landfill**	FC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LC	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.3	1.3
Recycling	FC	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.6	0.7	0.7	2.6
	LC	0.0	0.0	0.0	0.0	0.6	0.7	0.9	2.1	2.4	2.8	9.5
Composting	FC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LC	0.0	0.0	0.0	0.0	2.5	3.3	3.7	9.8	10.8	11.8	41.9
Total	FC	0.0	0.7	0.8	0.8	1.1	1.2	1.2	1.7	1.8	1.9	11.2
	LC	0.0	8.8	9.4	10.1	13.9	15.6	16.8	24.7	26.8	28.8	154.9

Note: 1. FC: Foreign Currency, LC: Local Currency

2. Expressed at 2005 price

* Collection fee from households is actually to be subsidized by the City government

** Charge to commercial and public institutions that dispose waste to landfills, but no charge to MSWM agencies.

(4) Financial balance during evaluation period

Table 2.4.10 shows the financial balance up to the evaluation horizon of 2015 for both 'Case-A' and 'Case-B'.

Table 2.4.10 Financial Balance during the M/P Period

Unit: FC: US\$ million LC: CUP million

Revenue Source	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Case-A:												
Cost stream	FC	0.0	0.4	1.1	1.7	1.8	1.9	1.9	2.1	1.9	1.9	14.7
	LC	0.0	0.3	6.7	8.3	11.1	12.7	12.7	15.6	15.5	15.5	98.4
Revenue stream	FC	0.0	0.7	0.8	0.8	1.1	1.2	1.2	1.7	1.8	1.9	11.2
	LC	0.0	8.8	9.4	10.1	13.9	15.6	16.8	24.7	26.8	28.8	154.9
Balance (Revenue-Cost)	FC	0.0	0.3	-0.3	-0.9	-0.8	-0.8	-0.7	-0.5	-0.1	-0.0	-3.7
	LC	0.0	8.5	2.7	1.8	2.8	2.9	4.1	9.1	11.3	13.2	56.5
Case-B:												
Cost stream	FC	0.0	0.8	36.9	11.6	11.0	13.2	6.2	12.7	2.0	-19.7	74.8
	LC	0.0	0.5	19.0	19.9	16.1	16.4	17.0	18.4	15.5	5.9	128.8
Revenue stream	FC	0.0	0.7	0.8	0.8	1.1	1.2	1.2	1.7	1.8	1.9	11.2
	LC	0.0	8.8	9.4	10.1	13.9	15.6	16.8	24.7	26.8	28.8	154.9
Balance (Revenue-Cost)	FC	0.0	-0.1	-36.2	-10.7	-10.0	-12.1	-4.9	-11.1	-0.3	21.6	-63.6
	LC	0.0	8.3	-9.6	-9.9	-2.2	-0.8	-0.2	6.3	11.3	22.9	26.1

Note: 1. FC: Foreign Currency, LC: Local Currency

2. Case-A: Depreciation cost excluded from the cash account of the operating agency,

Case-B: Depreciation cost included

As shown in the table, the annual financial balance of the foreign currency in 'Case-A' is negative during the M/P period and reaches almost zero in 2015. On the other hand, the annual financial balance of the local currency in 'Case-A' is positive every year during the M/P period. This indicates the operating agency could not be financially self-reliant with regard to conducting the O/M work even after extending the capacity of recycling and community composting together with the segregated collection, especially for the foreign currency portion. However,

the accumulated total of the deficit in the foreign currency portion over the 9 years until 2015 (US\$3.7 million) is not an excessively large amount considering the positive amount of the local currency, which may be recoverable in the subsequent separations.

‘Case-B’ shows that the annual financial balance of the foreign currency is negative until 2014 and turns positive in 2015 because of the salvage value. Another balance of the local currency turns positive in 2013. However, the accumulated loss of the foreign currency at the end of 2015 is as large as US\$63.7 million, which is an intolerably large deficit for the operating agency. This suggests that charging of depreciation cost to the operating agency’s account would not be a practical choice. It is hence recommended that the Government allows for the adoption of ‘Cost-A’..

In any case, the above deficits must be subsidized by the State Government in view of the nature of expenditure required for public services related to basic human needs.

If ‘Case-A’ is adopted, the government shall assume the following:

- a) Depreciation cost will not be charged to the operating agency, retaining the accounting of depreciation costs in the state account. This kind of accounting method is admitted widely in the public service operations in many developing countries. Likewise, the depreciation of capital costs is not currently charged to the Aurora’s account. On the other hand, the operating agency will be responsible for the establishment of a financially sustainable O/M work system.
- b) The government will subsidize the corresponding amount of fee revenues presently not being collected from households.

Financial rate of return was not calculated in view of little relevance to this kind of project.

(5) Sensitivity analysis

A sensitivity analysis was made in a similar manner to the economic evaluation (ref. Subsection 4.1.4 (5)). The cases examined are the same with those in the economic evaluation. The sensitivities of the results from Table 2.4.10 are shown as revenue-cost balance in Table 2.4.11 for ‘Case-A’ and Table 2.4.12 for ‘Case-B’.

Table 2.4.11 Sensitivity Analysis for Financial Evaluation (Revenue-Cost Balance) (1/2)

(For 'Case-A: Without depreciation cost')

Unit: FC: US\$ million, LC: CUP million

Case	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Base Case (ref. Table 2.4.10)	FC	0.0	0.3	-0.3	-0.9	-0.8	-0.8	-0.7	-0.5	-0.1	-0.0	-3.7
	LC	0.0	8.5	2.7	1.8	2.8	2.9	4.1	9.1	11.3	13.2	56.5
Sensitivity to Compost Price:												
Case C-1 (CUP0)	FC	0.0	0.3	-0.3	-0.9	-0.8	-0.8	-0.7	-0.5	-0.1	-0.0	-3.7
	LC	0.0	8.5	2.7	1.8	0.3	-0.4	0.4	-0.6	0.4	1.4	14.6
Case C-2 (CUP1,250)	FC	0.0	0.3	-0.3	-0.9	-0.8	-0.8	-0.7	-0.5	-0.1	-0.0	-3.7
	LC	0.0	8.5	2.7	1.8	6.5	7.8	9.7	23.8	27.5	31.0	119.3
Sensitivity to Recyclables Price:												
Case R-1 (-20%)	FC	0.0	0.3	-0.3	-0.9	-0.8	-0.8	-0.7	-0.6	-0.3	-0.2	-4.2
	LC	0.0	8.5	2.7	1.8	2.7	2.8	4.0	8.7	10.8	12.7	54.5
Case R-2 (+20%)	FC	0.0	0.3	-0.3	-0.9	-0.7	-0.7	-0.6	-0.4	-0.0	0.1	-3.1
	LC	0.0	8.5	2.7	1.8	2.9	3.0	4.3	9.6	11.7	13.8	58.4

Note: 1. FC: Foreign Currency, LC: Local Currency

2. See Subsection 4.1.4 (5) for details of 'Case C-1, C-2, R-1 and R-2' assumed in this sensitivity analysis.

'CUP0': compost price is zero, 'CUP1,250': compost price is CUP1,250/ton

3. The figures are expressed in revenue-cost balance

Table 2.4.12 Sensitivity Analysis for Financial Evaluation (Revenue-Cost Balance) (2/2)

(For 'Case-B: With depreciation cost')

Unit: FC: US\$ million, LC: CUP million

Case	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Base Case (ref. Table 2.4.10)	FC	0.0	-0.1	-36.2	-10.7	-10.0	-12.1	-4.9	-11.1	-0.3	21.6	-63.6
	LC	0.0	8.3	-9.6	-9.9	-2.2	-0.8	-0.2	6.3	11.3	22.9	26.1
Sensitivity for Compost Price:												
Case C-1 (CUP0)	FC	0.0	-0.1	-36.2	-10.7	-10.0	-12.1	-4.9	-11.1	-0.3	21.6	-63.7
	LC	0.0	8.3	-9.6	-9.9	-4.6	-4.1	-3.9	-3.4	0.4	11.1	-15.8
Case C-2 (CUP1,250)	FC	0.0	-0.1	-36.2	-10.7	-10.0	-12.1	-4.9	-11.1	-0.3	21.6	-63.7
	LC	0.0	8.3	-9.6	-9.9	1.5	4.2	5.3	21.0	27.5	40.6	88.9
Sensitivity for Recyclables Price:												
Case R-1 (-20%)	FC	0.0	-0.1	-36.2	-10.7	-10.0	-12.1	-5.0	-11.2	-0.4	21.5	-64.2
	LC	0.0	8.3	-9.6	-9.9	-2.3	-0.9	-0.4	5.9	10.8	22.3	24.2
Case R-2 (+20%)	FC	0.0	-0.1	-36.2	-10.7	-9.9	-12.0	-4.9	-11.0	-0.1	21.8	-63.1
	LC	0.0	8.3	-9.6	-9.9	-2.1	-0.6	-0.1	6.7	11.7	23.4	28.0

Note: 1. FC: Foreign Currency, LC: Local Currency

2. See Subsection 4.1.4 (5) for details of 'Case C-1, C-2, R-1 and R-2' assumed in this sensitivity analysis.

'CUP0': compost price is zero, 'CUP1,250': compost price is CUP1,250/ton

3. The figures are expressed in revenue-cost balance

Compost price is added in the local currency and it may slightly show an impact on the financial balance of the local currency portion, but it can be said that the revenue-cost balance is not very sensitive to either compost price or recyclables price in total. In the 'Case-B', however, the accumulated loss at the end of 2015 is quite large, particularly for the foreign currency portion.

4.1.6 Institutional Adaptability

The M/P proposes the reformation of existing organizations (UPPH, DMSCs and Auroras) so that they can share responsibilities in an effective manner (ref. Subsection 3.10.1). The proposed reformation is based on the concept of

streamlining the existing operation incorporating the model of Auroras. UPPH and DMSCs will act as regulator/supervisor and the Auroras as service providers. The workers required for the new organizations can be transferred from the existing organizations. In this context, the influence on present employment would be minimal.

The M/P also proposes the preparation of standards and guidelines on landfills and composting, and also legislation for permitting the free marketing of recyclable materials (ref. Subsection 3.10.2). These would not be difficult tasks and can be handled within the capability of existing organizations.

4.1.7 Community Acceptance

The PLP provided evidence that the cooperation of residents for segregated collection can be promoted with adequate awareness-raising activities. The same is expected for home composting. Community composting will not have a direct influence on communities since the plant is located at landfill sites away from residential areas. Since closure of existing landfill sites where currently environmental pollutions occur can contribute to mitigate those pollutions, closure plan could be naturally accepted by residents. There might be resettlement required in the construction of new landfill sites, but it would be of a manageable scale for the government judging from past experience; however, faithful communication and negotiation with the people concerned would be a vital requirement.

The abandonment of using horse-driven carts will bring about the redundancy of the workers. The DPSC will consider arranging their re-deployment in vehicle collection and landfill operation works.

Awareness-raising and public participation will be essential in the implementation of the M/P. The results of the PLP suggested that using existing community organizations such as CDR and FMC would be effective.

4.1.8 Environmental Impacts

Overall, the projects proposed in the M/P will bring about both favorable and negative environmental effects.

Improvements in waste collection and transportation would give favorable environmental impacts (reduction of waste littering by improved regular collection) and also adverse impacts (increase in the number of vehicles). Recycling and composting will lead to mitigation of environmental load by reducing materials which should otherwise have been disposed of at landfills.

Compost processing in open-air yards will have some environmental impact at the site, and will require EIA.

Landfill operation with leachate treatment reduces BOD load discharging into public waters, but this does not eliminate all factors of causing adverse impact. Thus, EIA will be required to identify the need for mitigation measures and a monitoring system in the subsequent period.

4.1.9 Overall Evaluation of the M/P

The most obvious benefit accrued from the M/P implementation is the improvement of public health and living environments. The benefits include a general increase in amenity accruing from reduced odor and harmful insects, and the reduction of potential health hazards. These benefits are of a nature relevant to basic human needs that should be afforded by the government by all means.

In this context, the implementation of the M/P projects is a vital requirement for Havana City. Though the financial burden to the government is not negligible, the government will seek the financial resources without delay either from the government budgetary fund or foreign aid.

4.2 Recommendations

4.2.1 Promotion of the Master Plan

For the realization of the M/P, it is important for the Cuban Government and the implementation agencies to clarify the following points in order to arrive at an early decision and to take the necessary follow-up actions:

(1) Possibility of increase of state subsidy

As shown in Table 2.4.10, financial support by the State Government is definitely needed especially for the foreign currency portion. This point means that the realization of the M/P depends on the amount of increase of state subsidy. The possibility of an increase in state subsidy should be clarified with MEP and other decision-makers to decide how to implement the M/P.

(2) Prioritized activities

In view of the financial constraints foreseeable, it may not be possible for the Cuban counterparts to implement all of the M/P projects. Priority will be placed on the following activities in consideration of their urgent need and low cost alternative plans recommended in the M/P:

- Procurement of collection vehicles and improvement of repair and maintenance of vehicles and equipment including budget allocation for spare parts
- Improvement of collection work including achievement of higher work efficiency and procurement of waste bins
- Improvement of landfill operation including soil covering, cell construction and budget allocation for operation of heavy equipment.

(3) Operation for recovery of recyclables

Promoting the recovery of recyclables by segregated collection will require preparatory works and consideration of the mode of implementation as follows:

- The proposed system for recovery of recyclable materials from MSW will coexist with the existing recovery operation of ERMP. The DPSC shall coordinate the most efficient share of the work with regard to area, method, and marketing.
- Therefore, verification of the recovery of recyclable materials through the pilot project by UNIDO is crucial because a similar method of segregated collection with 2 categories will be examined by the Cuban side.
- Presently, significant amounts of recovered materials have accumulated at existing recycling centers. The DPSC shall clarify why those stocks remain unsold and seek to market those materials in cooperation with ERMP.
- The collection capacity of the implementation bodies should satisfy the performance of residents in segregating their discharge. Therefore, a prerequisite is to establish a sustainable system of periodic segregated collection through the provision of an appropriate waste collection and transportation system as early as possible.

(4) Community composting plan

The results from the PLP did not confirm that the community composting method is feasible or indicate an appropriate method of quality control. As previously mentioned, the skills required for the management of a community composting plant and equipment have not been acquired within the existing relevant organizations. Considering these facts, the community composting plan will not be promoted until reliable experience can be obtained that verifies the feasibility of community composting. Such experience may come through further pilot scale trials or from examinations such as the of UNIDO project.

(5) Home composting

Monitoring and follow-up activities are also required after the introduction of home composting. The program shall be accompanied by the establishment of a technical guidance and support system regarding home composting method and technology, which shall be initiated by the DPSC.

(6) Selection of waste collection and transportation vehicle

It is proposed in the M/P that C/T be adopted as the most appropriate type of vehicle for collection and transportation of MSW. The transportation efficiency of the various vehicle types presently used were objectively evaluated before arriving at this decision.

However, it is possible that the conditions of the waste collection system existing at the time of the JICA Study may change. Possible features that may change include the location of waste discharge points and stations and discharge conditions such as waste quality and quantity. If such changes do occur, the results and corresponding actions will be addressed accordingly.

(7) Steel bins for waste collection

It should be understood that unlike plastic bins, steel bins tend to corrode due to acid and rain water. Using galvanized steel bins or painting bins with anticorrosive paint are possible measures to prevent corrosion, but these are only effective with frequent cleaning after the bins are emptied. Considering that the cleaning has to be carried out by workers, it is also necessary to secure the cooperation of the local residents to supply and drain the water for doing the cleaning.

Regarding the introduction of steel bins, it is proposed to verify the advantage of using steel bins through trial manufacturing of bins, which will include an examination of reducing their weight, for sale in the domestic market and for use in a pilot area. After confirming the advantage of steel bins, their use will be expanded to wider areas by gradually replacing the HDPE bins.

(8) Segregated collection system

It is proposed in the M/P that segregated collection will be introduced with waste being classified into 3 categories¹⁸: kitchen waste, recyclable materials and other wastes as described in Table 2.3.8.

¹⁸ A UNIDO project currently underway in Playa Municipality envisages 2 categories of segregated collection (kitchen waste and other waste). Depending on the findings in the UNIDO project, an alternative approach may be to firstly commence with 2 categories and later may change to 3 categories.

It was considered that a certain lead time is required for the preparation for introducing the segregated collection work; e.g. selection and procurement of proper vehicles and bins, planning of the work operation, and awareness-raising of residents for segregated collection.

An increase in collection costs is inevitable with the shift to segregated collection because of the additional work required. The increased cost can be regarded as being offset by the benefits accrued in the long term; among others, benefits from the recovery of recyclables and reusable materials and the reduction of final disposal quantity. In addition, to further reduce costs, more appropriate collection systems should be studied through practical trials using the existing trucks other than C/T while referring to similar experiences in other countries.

(9) Schedule for replacement of H/C system

The H/C system was established in connection with the development of the SPLs due to the critical economic conditions prevailing in Havana City and it is recognized that the transportation efficiency of the H/C system is rather low.

Therefore, from a long term point of view, the H/C system should be replaced with a mechanical collection system as proposed in the M/P once the SPLs are closed.

On the other hand, for short-distance transportation of small amounts of collected waste, the H/C system can serve as an important alternative system. Therefore, in the M/P, the present H/C system will be retained for the Campo Florido area as an example of a living cultural heritage.

For the estimation of overall funding requirements in the M/P, it was tentatively assumed that the replacement of the H/C system with other vehicles would start in 2007. However, considering the difficulty of procuring new vehicles, H/Cs can remain in the area close to the designated landfill, New Guanabacoa, Calle 100, New Site 1 and Campo Florido, and be gradually phased out.

(10) Type of landfill

It is proposed in the M/P that the level of the landfill to be newly constructed or expanded should be Level 3 and/or Level 4. However, in case the DPSC faces difficulty in financing the Level 3 and/or Level 4 types, the alternative solution will be to adopt Level 1 or Level 2 type using low cost technologies such as utilization of locally available used goods or bio-materials. Level 1 and 2 type landfills will also be effective in reducing most complaints from nearby residents, such as waste littering, odors, generation of insects, and outbreaks of natural firing,

provided soil covering is conducted properly. In addition, the groundwater and other environmental features should be carefully monitored.

(11) Leachate treatment

It is recommended that the effectiveness of the leachate treatment system proposed in the M/P be verified by implementing laboratory-scale and pilot-scale experimentation in cooperation with the agencies concerned. Only after its effectiveness is confirmed should the leachate system be designed for construction.

Calculation of the leachate generation volume, estimation of leachate treatment volume and plan of leachate regulating reservoir should be carefully conducted at the stage of the feasibility study and basic design. At this time, detailed conditions such as a wider range of climate data, geological conditions, and site restrictions should be taken into account.

For this purpose, technical follow-up by experienced foreign experts will be needed.

(12) Tariffs as a financing source

Generally, regarding the tariff charge to households in the future, there are 2 options:

- (a) Tariffs will not be charged to households for the foreseeable future. Instead, the City and/or Municipal Governments will subsidize the equivalent amount to the operating agencies (UPPH/DMSCs and/or Auroras).
- (b) In the future, the City government will legally authorize the DPSC and operating agencies to collect the tariff from households. The tariff will be collected by adding it to the existing tariff collection system e.g. the water supply tariff, as is the case for the sewerage tariff.

The government should select one of the above options. The financial evaluation was based on Option (a) in the M/P.

At the same time, the Study Team recommends that the DPSC studies the possibility of Option (b) as a measure for financing the self-reliant operation of the operating agency to reduce its dependence on the government in meeting the cost of SWM.

4.2.2 Monitoring of Implementation of the M/P

The implementation of the M/P should be monitored with the objectives of:

- Checking the progress of the implementation of the projects,

- Identifying the difficulties and obstacles preventing realization of the projects, and
- Promoting and coordinating among the ministries/organizations/entities involved in MSWM in Havana City.

For the promotion and monitoring of the implementation of the M/P, it is proposed to establish a 'monitoring committee' with the following plans:

- Chairman: Representative from CITMA or the DPSC (General Director)
- Secretariat: DPSC
- Member Agencies: MEP, CITMA, MINSAP, MINAGRI, DPSC, DMSCs, UERMP, Auroras, representatives of selected communities
- Frequency of the meetings: Annual
- Duties: Preparation of action plans for the realization of the M/P and leadership for the financing, and monitoring and coordination of the activities

An option is that the present Steering Committee (SC) would take over the function of the monitoring committee because the SC involves all the relevant ministries and agencies as members.

Furthermore, the formulation of a 'technical committee' is also proposed to deal with the technical aspects involved in the SC's activities. The C/Ps assigned to the Study are expected to play leading roles in the technical committee.

4.3 Proposals on Industrial and Medical Waste Management

4.3.1 Proposals on the Improvement of Industrial Waste Management

(1) Definition of the responsibility of industries

The national regulations on hazardous waste clearly state that the generators of hazardous waste themselves will be responsible for their own waste management. The industries should be responsible not only for the treatment of their generated hazardous industrial waste, but also for the management of non-hazardous industrial waste as well.

The reason for this is that it is not easy in reality to distinguish hazardous waste and non-hazardous waste if discharged in a mixed condition.

(2) Establishment of organization for industrial waste management

It is desirable that the DPSC be appointed as the organization responsible for the operation of industrial waste disposal and treatment in Havana City. The responsibility would cover not only waste management services, especially

hazardous waste, but also transport, treatment and disposal on a contract basis as required by industries.

It is the responsibility of CITMA to enforce the hygienic-sanitary and environmental requirements set forth in the Government laws and related national regulations.

(3) Monitoring system of industrial waste

CITMA, or the DPSC if it is appointed as the responsible organization, will monitor the hazardous waste generated in the factories, including the operational system of the treatment facilities. Periodic inspection will be conducted with attendance of environmental specialists. The data and information obtained from the monitoring activities will be utilized for the evaluation of environmental impacts caused by the industries.

4.3.2 Proposals on the Improvement of Medical Waste Management

(1) Improvement of in-hospital waste management

Proper waste management is required primarily at the hospital level, where the hospital staff should play the major role. It is necessary for each hospital to prepare its own waste management plan and operational guidelines. MINSAP will take the leading role in this respect.

(2) Collection and transportation plan

UPPH/Auroras, as the agency in charge of collection and transportation of medical waste, will endeavor to establish a firm work system with respect to: (i) use of trained workers, (ii) use of vehicles for exclusive use for collection of medical waste, and (iii) conducting collection and transportation on a daily basis.

Medical waste contains many articles that are hazardous to health. Any improper handling of the waste causes direct threat to the health of workers who are engaged in the collection and transportation. Strict control of medical waste disposal and handling is of paramount importance. Relevant guidelines and work manuals shall be prepared.

(3) Construction of the incineration plant

Small hospitals in Havana City do not have their own incineration plant. Some of the existing plants are already old. To assure the incineration of all generated waste and to eliminate the pollutants generated by old incinerators, it is proposed to construct a modern centralized incineration plant in the earliest stage of the M/P.

PART 3 PILOT PROJECT

CHAPTER 1 FORMULATION OF PILOT PROJECT

1.1 Objectives of Pilot Project

The primary objectives of the Pilot Project (PLP) implementation were as follows:

- To verify the efficiency of the PLP methods for reflecting to the formulation of the M/P

The following considerations were given to the selection and formulation of the PLP:

- It should contribute to the capacity development of counterpart personnel (C/P) and other personnel involved in MSWM in Havana City, and
- It should contribute to the improvement of MSWM in the PLP area and also Havana City if applicable.

1.2 Selection of Pilot Project

1.2.1 Components of Selected Project Package

In consideration of the objectives of the PLP and the configuration of projects contemplated in the M/P, the PLP was proposed to comprise all of the following 4 components: (ref. Main Report Part 2 for details of PLP formulation)

- (1) Segregated discharge and collection of waste
- (2) Composting of segregated kitchen waste; comprising both community composting and home composting
- (3) Awareness-raising on segregated discharge and home composting
- (4) Waste weight measuring by truck scale

The main components are segregated collection and composting, both of which constitute the key components of the proposed M/P

In addition, waste disposal in cells and soil covering operation at landfills, being regarded as the first step towards achieving environment-friendly landfill operation, was included in the PLP operation, aiming chiefly at the capacity development of C/P and the DPSC.

Thus, PLP was eventually formulated to comprise 5 work components, i.e. 1) to 4) above and waste disposal in cells and soil covering operations.

1.2.2 Background of Selecting the Project Areas

The communities of Peñas Altas and Campo Florido in the Havana del Este Municipality were selected as the project areas for the following reasons:

(1) Availability of land and facility

- The existing landfill site, the Campo Florido landfill, was receiving municipal solid waste collected and transported from a relatively wide area.
- The Campo Florido landfill site had enough space to provide the areas for community composting and an available supply of cover soil materials from a nearby hill to enable soil covering operation.
- A DMSC office is located near the landfill sites, and this office could provide a tract of land for installing a truck scale facility with power and water supply.

(2) Types of communities

- The Peñas Altas community is an urban community where the M/P proposes that segregated collection be introduced.
- The Campo Florido community is a semi-urban type community where the M/P proposes that home composting be introduced.

(3) Cooperation by the local communities

- Havana del Este Municipality as well as the Peñas Altas and Campo Florido communities agreed to cooperate positively with the PLP.

(4) Contribution to the improvement of MSWM in the PLP area and Havana City

- The Campo Florido landfill receives MSW from a wide area; not only MSW generated in Peñas Altas community but also part of the MSW which is used to be disposed of at the Guanabacoa landfill (closed in March, 2005). Improved operation of the Campo Florido landfill would contribute to the improvement of MSWM over a wide area.

1.3 Implementation Organization

The Pilot Project was carried out through the collaboration of the Cuban side and the Study Team. On the Cuban side, the C/Ps worked together with the DPSC, DMSCs and other bodies involved in MSWM. The C/Ps and the Study Team collaborated in the planning, design and operation of the PLP.

With the guidance and advice of the C/Ps and the Study Team, the actual operation of segregated collection and community composting was carried out by the

DPSC/UPPH and DMSCs. The DPSC/UPPH took overall responsibility for operation and upkeep of the vehicles and equipment. Weighing of the municipal solid waste by truck scale was carried out by DMSCs including the recording of data in personal computer. Soil covering operations were carried out by employees of UPPH/DMSCs under the guidance of the Study Team.

Awareness-raising was carried out as a joint effort of the C/Ps and the Study Team with the active involvement of local community organizations and local governments as well as the volunteers.

1.4 Procurement of Work Resources

In principle, the foreign currency component was borne by the Japanese side while the local currency component borne by the Cuban side.

The Cuban side provided the manpower, vehicles, and heavy equipment required for waste collection and landfill operation during implementation. Since the heavy equipment used for landfill was old, the Japanese side provided new engines for reconditioning the equipment. The Japanese side also supplied other equipment such as a portable truck scale, 160 waste bins, 40 home composting bins, and a personal computer.

1.5 Implementation Schedule

Implementation schedule of the PLP is shown in Figure 3.1.1. Activities for waste segregation, home and community composting, and landfill operation were started on 4th March 2005 upon completion of the supply of construction equipment (new engines for one unit each of dump truck, bulldozer, and wheel loader), truck scale and compost bins.

The awareness-raising activities started in October 2004, prior to commencing the PLP, based on the initiative of the Cuban C/Ps.

After it was completed, the achievements of the PLP were evaluated for reflection to the formulation of the M/P.

Items	2005																			
	Feb.			Mar.			Apr.			May			Jun.			Jul.				
Preparation of PLP	[Bar]																		Continuation by Cuban side	
Waste segregation				[Bar]																
Home composting				[Bar]																
Community composting				[Bar]																
Awareness-raising	[Bar]					[Bar]														
(Landfill Operation)				[Bar]																

Note: PLP will be continued by Cuban side after July 2005.

Preparation of PLP operation started from September 2004.

Figure 3.1.1 Implementation Period for the Pilot Project

CHAPTER 2 WORKS CONDUCTED IN PILOT PROJECT

2.1 Activities in Phased Periods of Pilot Project

The Pilot Project was carried out during the field work period of the Study from March to June 2005. After July 2005, the work was taken over by the Cuban side to continue as part of ordinary MSWM operation.

Table 3.2.1 Activities in Phased Period of PLP

Stage	Period	Manner of Operation	Works Performed
Program under PLP of the Study	March 2005	Joint operation by the Cuban side and the Study Team	Installation of bins and mobilization of vehicles and equipment
	April 2005	Operation by the Cuban side	Carried out PLP operation by the Cuban initiative (Study Team was in Japan during this period)
	May ~ June 2005	Joint operation by the Cuban side and the Study Team	Identified problems and conducted corrective measures for improving the PLP operation
Continuation by Cuban Side	July 2005 ~	Operation by the Cuban side	The Cuban side decided to continue the operation as part of the normal MSWM operation of Havana City

During the initial period from March to April 2005, the expected outcome was not attained in the segregated discharge and collection. In community composting, the planned operation was not carried out owing to inadequate segregated discharge and a delay in the completion of the community composting yard. The details are described in Section 2.2.

2.2 Segregated Discharge and Collection

2.2.1 Operation for Segregated Discharge and Collection

The concept of the waste segregation into 3 types of waste and segregated collection is shown in Figure 3.2.1.

The PLP initially contemplated the collection of 5.5 tons/day of waste generated from 2,075 households, or 8,300 inhabitants at 80 collection stations covering the area.

Three containers (bins) were placed at each station. All waste generated by every household was to be segregated before being discharged into the waste bins. Residents were requested to do this through a workshop and the distribution of leaflets. Considering that kitchen waste is putrescible and has a high moisture content, a plastic bucket of 10 liter capacity was provided to every house in the PLP area to enable the residents to keep wet kitchen waste separately.

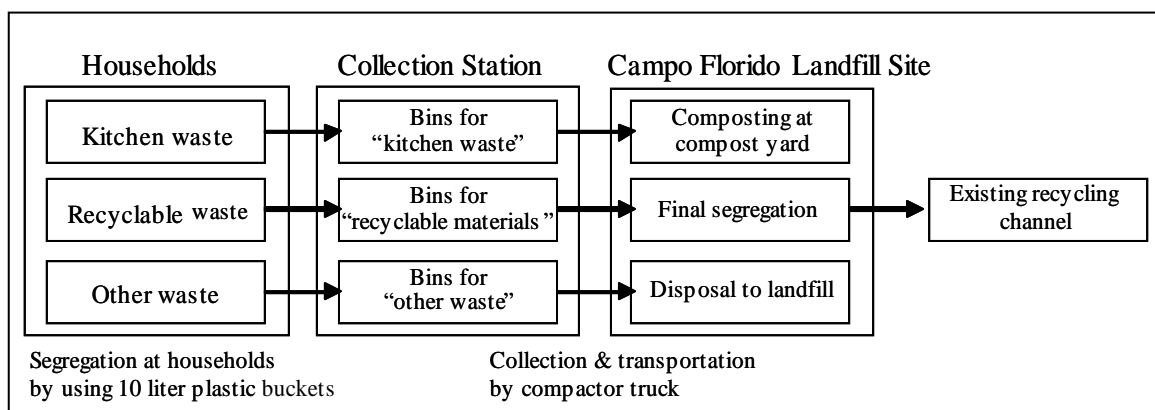


Figure 3.2.1 Concept of Collection and Transportation System

2.2.2 Segregated Discharge

(1) Countermeasures taken for improvement of segregated discharge

Upon the arrival of the Study Team in early May 2005, a joint assessment of the progress and current situation of PLP implementation was done by the Study Team and C/Ps. It was found that the performance of segregated discharge was below the expected level and that improvement would be needed.

To improve the situation of segregated discharge, 4 stations were selected as priority stations to which more intensive awareness-raising of the residents should be carried out with close monitoring of the discharge conditions. The reason for limiting the improvement to 4 stations was the time constraint allowed for the activity. The applied measures for improvement are listed in Table 3.2.2.

Table 3.2.2 Measures Applied for Improvement of Segregated Discharge

No.	Measure	Activity Period (2005)
1	A part of the PLP area covered by 4 waste collection stations was selected as the priority area for intensive improvement	6th - 31st May
2	Additional meetings with residents in the priority area were held to introduce and explain how to perform segregated discharge and collection. Illustrations of revised waste classification and explanation leaflets were distributed to all households.	13th - 14th May
3	Daily monitoring was conducted to evaluate the condition of segregated discharge and collection in the priority stations	21st - 31st May
4	Watch-person were assigned at the priority stations to lead the behavior of residents in discharging MSW to waste bins.	21st - 31st May
5	The design of stickers attached to waste bins was revised so that it would be more explicit to the residents. The classifications of 3 categories of MSW were indicated on the bins with illustrations and text.	21st - 31st May
6	The classification of recyclable material was simplified in consideration of the residents' ability for segregation of recyclable materials.	21st - 31st May

(2) Effect of measures for improvement

Table 3.2.3 shows a comparison of the percentages of waste discharged properly with segregation “during” and “after” the aforementioned improvement measures. The values shown in the column titled “during measures” represent the percentage of properly segregated waste at the 4 stations, while the figures in all the other columns, titled “after measures”, represent the ratios at both the 4 selected stations and all monitored stations, observed on 16 June and 6 July, where no additional improvement measures had been conducted for the latter stations.

The figures in the table show that the ratio of properly segregated discharge for “Kitchen Waste” and “Recyclables” at the 4 selected stations was as high as about 90% and 70%, respectively, during the period when the measures were being taken. However, after the measures were ceased, the values at those stations went down to 50 to 75% on average. On the other hand, the total average values at all stations were much lower than the 4 selected stations, being 25 to 50% on average.

Although the high ratio of properly segregated waste observed during the measures represent the data at a limited number of stations on a particular day, the figures were regarded as representing the potential level of improvement that could be attained if intensive awareness-raising and guidance for the residents are carried out and also precise waste collection frequency is maintained by the DPSC. With this observation in mind, and after discussion with the Cuban side, it was decided to propose segregated waste collection in the M/P on the premise that intensive awareness-raising and guidance for the residents would be conducted in the actual implementation.

Table 3.2.3 Comparison of Ratios of Properly Segregated Discharges with/without Measures for Improvement

Status	At selected 4 collection stations			At all collection stations		
	During measures	After measures		After measures		
Monitoring date	21-31 May	16 June	6 July	16 June	6 July	
					34 stations	49 stations
Kitchen waste	89%	78%	76%	54%	53%	55%
Recyclables	73%	53%	49%	24%	22%	32%
Others	98%	74%	89%	74%	77%	75%
Average	87%	68%	70%	51%	51%	54%

- Note:
1. The figures show the percentage of properly segregated waste as discharged into the designed waste bins. The ratio was assessed based on visual observation by C/P and the Study Team.
 2. The figures in leftmost column represent the highest values observed during while the measures were being taken. The ratio with measures at the selected 4 collection station measures is the peak value during the intensive period, and the other values are the average of those observed at the stations on each monitored date.
 3. On the monitoring day on 6 July 2005, the number of collection stations for segregated collection had been increased to 49 from 34 on 16 June 2005.

In September 2005, JICA official mission visited some stations at which segregated discharge activity should have been in continuation. Actual observation, however, was that the segregated discharge was not conducted and waste was discharged in mixed condition as observed at an early stage of the PLP in May 2005. This fact strongly suggests that in the implementation of the M/P the executing agency will need to deploy continuous efforts on a long term basis until reliable segregated discharge is achieved.

2.2.3 Segregated Collection

(1) Number of collection points

The PLP had originally been intended to collect waste from 80 collection points. In the initial period of operation, however, the number of collection points had to be reduced mainly due to a delay in the procurements of bins. At the beginning of June 2005, the number of collection points remained at 33 points, with the use of 103 bins (3 bins each for 33 collection points plus 4 additional bins). The number was increased to 64 points in the subsequent period to the end of the PLP.

(2) Collection schedule

Based on the actually collected waste quantities, it was found that the bins and vehicles used for PLP had enough capacity of storing and collecting the segregated wastes that were accumulated over the duration of 4 to 5 days. Hence, the interval of collection was reduced as per shown in Table 3.2.4.

Table 3.2.4 Revision of Collection Schedule

Description	Kitchen waste	Recyclables	Others
Original schedule	Daily	Daily	Every 3 days
Revised schedule	Tuesday and Saturday (twice a week)	Tuesday and Saturday (twice a week)	Tuesday and Saturday (twice a week)

2.3 Composting

2.3.1 Operation for Composting

Two types of composting were carried out in the PLP; i.e., community composting and home composting. The former was practiced in the composting yard prepared in the Campo Florido landfill site with a view to processing the kitchen waste collected from the Peñas Altas community. The latter was practiced in 40 households located in the Campo Florido community. The PLP supplied 1 or 2 home composting bins to each household.

An outline of the features of the community composting and home composting schemes are summarized in Tables 3.2.5 and 3.2.6, respectively.

Table 3.2.5 Outline of Community Composting

No.	Items	Description
1	Location of composting yard	Campo Florido landfill site
2	Preparation of composting yard	The yard is paved with base concrete and has a roof for facilitating the fermentation and maturing of compost.
3	Raw material for composting	Kitchen waste collected from Peñas Altas community with segregated collection
4	Preparation of awareness-raising workshop	Conducted by C/P with support from the Study Team
5	Preparation of instruction manual and pamphlets	Prepared by C/P with support from the Study Team
6	Implementation organization	DPSC, UPPH, and C/P, supported by the Study Team
7	Supervision	Chiefly by C/P; where the monitoring and inspection work for composting were conducted jointly by UPPH and C/P
8	Awareness-raising	Conducted for segregated discharge to the residents.
9	Analysis of survey results and preparation of report	Conducted by C/P with support from the Study Team

Table 3.2.6 Outline of Home Composting

No.	Items	Description
1	Location of composting	At 40 households in Campo Florido community
2	Number of composting bins supplied	50 in total (40 containers were imported and 10 plastic buckets procured in Cuba); 10 of the 40 households utilized both types of waste bins
3	Raw material for composting	Kitchen waste generated in each household
4	Preparation of awareness-raising workshop	Conducted by C/P with support of the Study Team
5	Preparation of instruction manuals and pamphlets	Prepared by C/P with support from the Study Team
6	Implementation organization	DPSC, UPPH, and C/P, supported by the Study Team
7	Supervision	Chiefly by C/P; where the monitoring and inspection work for composting were conducted jointly by UPPH and C/P
8	Awareness-raising	Conducted by means of holding workshops and meetings, distribution of handouts, questionnaire surveys, etc.
9	Analysis of survey results and preparation of report	Conducted by C/P with support from the Study Team

2.3.2 Community Composting

Until early May 2005, community composting was not progressing well, requiring heavy final segregation work at the composting yard due mainly to an inadequate level of segregation of kitchen waste.

During intensive awareness-raising for the 4 priority stations, the segregation was improved in the area as shown in Table 3.2.3, with almost 90% of the waste being appropriately segregated¹⁹.

After the intensive awareness-raising period, community composting was continued by using the kitchen waste segregated from the priority stations. The work and fermentation process seemed to be in due progress in June 2005 when the Study Team left Havana. At that time, the yard had not been paved yet. Contamination of composting material with waste inappropriate for composting was visually observed at rates of 16 to 33%, which required labor for re-segregation, but any contamination of hazardous substances like syringe needles or other medical waste was not observed at that time. The temperature in the waste pile increased up to 40 – 60 degrees Celsius by fermentation.

After that, however, the composting operation was not conducted properly. The roof of the composting yard was blown off during a hurricane, making compost production in the designated manner difficult. When JICA official mission and the Study Team visited the site in September 2005, many hazardous materials, such as syringe needles, other medical wastes and batteries, were observed contaminating the wastes collected and piled at the site, and no compost of marketable quality had been produced.

2.3.3 Home Composting

(1) Quantity of kitchen waste utilized in home composting

Twenty nine of the 40 households recorded the volume of kitchen waste utilized for home composting. As a result of monitoring, it was found that the quantity of kitchen waste discharged into the home compost bin was 1.2 kg/household/day. Assuming that the unit generation rate is 0.7 kg/person/day and the average number of people per household is 4, the compost discharge corresponds to about 43% of the domestic waste generated by the average household. This implies that a 43% reduction in domestic waste discharge would be possible from households where home composting is introduced.

(2) Utilization of compost produced by home composting

Judging from the smell, moisture and color of the compost, it was observed that the fermentation of kitchen waste was taking place under relatively good conditions. It appeared that the product of home composting was of an acceptable

¹⁹ As stated in Subsection 2.2.2, this improvement lasted only for a limited period after the intensive awareness-raising activity in May 2005. After discontinuation of awareness-raising, the condition of segregated discharge worsened as observed in September 2005. This was one of the lessons learned that should be rectified in the M/P implementation.

quality for use as a soil conditioner for home farming and gardening. Some house owners said that they had already begun to use the compost that they produced in the PLP. Nevertheless, these were only visual observations made during the PLP and further confirmation of the quality would be required before home composting on a larger scale is introduced.

After the PLP, when JICA official mission and the Study Team visited some households with home composting bins in September 2005, it was observed that home composting was not always done appropriately. This fact suggested the need for follow-up guidance program and continuous monitoring of home composting activities.

(3) Perception of odor caused by home composting

According to the results of the monitoring during the PLP, less than 10% of the residents experienced bad odor originated from the composting. Seventeen of the 29 house owners who responded to the monitoring did not record odors from the home composting. Three house owners experienced bad odors for 20% of days (once per 5 days on average) during the monitoring period.

2.4 Awareness-raising Activities

The following activities were carried out as the awareness-raising program for the PLP:

2.4.1 Pre, Mid-Term and Post Implementation Workshops for the PLP

Four workshops were held before, during and after the implementation of the PLP as described below:

(1) Pre-implementation workshop for the PLP

A pre-implementation workshop was held in October 2004 before the start of the PLP. The workshop was aimed at raising the residents' awareness of MSWM, disseminating an outline and purpose of the PLP implementation, and to obtain the cooperation of the residents, community leaders and other parties involved in MSWM in the PLP area.

(2) Mid-term workshop for the PLP

A mid-term workshop for the PLP was held in March 2005, aiming at further promoting the residents' awareness for the PLP implementation and hearing the opinions of residents with regard to the difficulties being experienced and possible improvement measures. The participants were the residents, community leaders and other parties involved in MSWM in the PLP area.

(3) Post-implementation workshop for the PLP

A post-implementation workshop for the PLP was held in June 2005 after the completion of the operational phase of the PLP, aimed mainly at hearing the opinions of the residents on improvements required for implementing similar projects on a larger scale. The workshop was attended by residents, community leaders and other parties involved in MSWM in the PLP area and Havana City.

(4) Workshop for the primary school children

With the aim of promoting the awareness of young generation, a workshop was held inviting primary school children and teachers in October 2004. The related community leaders also attended.

2.4.2 Materials for Awareness-Raising

The following materials were distributed as tools used for the awareness-raising activity and campaign:

- Pamphlets for introducing the PLP to all households in the PLP area
- Pamphlets explaining the purpose and process of home composting to all participating households
- Campaign materials (300 T-shirts and 1000 calendars) to encourage the people's activities

2.4.3 Pre and Post-Implementation Awareness-Level Survey (Questionnaire Survey)

In October 2004, a pre-implementation questionnaire survey was carried out with a view to knowing the awareness levels of the residents with regard to MSWM. One hundred households were selected for the sampling survey in each of Peñas Altas and Campo Florido communities.

The post-implementation questionnaire survey was carried out in June 2005 after the completion of the PLP to identify any improvement in awareness levels resulting from the awareness-raising activities of the PLP.

2.4.4 Meetings for Awareness-Raising

Besides the above-mentioned workshops, 31 meetings were held with a view to strengthening the awareness of the residents as well as to request their cooperation for PLP implementation.

2.4.5 Additional Awareness-Raising Activities for the Priority Stations

With a view to improving the performance of segregated discharge in the 4 stations (ref. Subsection 2.2.2), additional awareness-raising activities were carried out, which included:

- One meeting with the community leaders (Attendants: 11)
- One meeting with CDR members in the project area (Attendants: 57)
- One meeting with CPC (Communist Party of Cuba) district nucleus of the project area (Attendants: 7)
- Three neighborhood debates with CDR members (Attendants: 61)
- One neighborhood debate at the Public Health local office (Attendants: 31)
- One meeting with students and teachers from the Council's secondary school (Attendants: 12)
- Visits by C/P to the households for explanation and guidance
- Guidance of volunteer work in the area, e.g. for cleaning of the area by the volunteer residents

2.5 Waste Weight Measurement

The PLP included the measurement of waste hauled to the Campo Florido landfill site. The main objectives were to grasp the waste quantity for control of cell formation and soil covering operations at the landfill and also for assessment of the bulk density of waste.

2.5.1 Establishment of Measuring Site

Waste was weighed using a portable truck scale installed at the DMSC office approximately 6 km from the Campo Florido landfill site. The truck scale was originally planned to be installed at the Campo Florido landfill site where the community composting yard and final disposal of waste hauled from the PLP area were planned. Since it was foreseen that the power supply to the landfill site would not be possible within the scheduled PLP period, the DMSC office was selected because it had adequate space for placing the truck scale, a building to accommodate the staff, and a power and water supply facility.

2.5.2 Installation of Portable Truck Scale

A portable truck scale of 40-ton weighing capacity was used in the PLP. The truck scale consisted of 2 weighing mats to mount 2 truck tires (1 wheel load), a signal converter with a printer set, cables and protectors. The measured data was

transmitted via sensor cables to a personal computer with printer for recording and printing the measured weights.

Two weighing mats were installed on 2 steel plates set up on the ground to secure the accuracy of the scale.

When JICA official mission and the Study Team visited the site in September 2005, however, these plates were removed together with the truck scale because purpose for use of this truck scale was for only tentative weighing the quantity of waste disposed during the JICA Study. In future, when the DPSC uses this portable truck scale to obtain data on solid waste quantity as well as the PLP of the JICA Study, steel plates should be again prepared for safety and accurate measurement.

2.5.3 Measurement of Hauled Waste Quantity

All waste collection vehicles hauling the waste to Campo Florido landfill (except for H/Cs) were weighed by the truck scale; firstly the front-wheel load was weighed by mounting 2 tires on 2 weighing mats, and then the rear-wheel load similarly. The total weight of the front and rear tires of the vehicle was automatically calculated and recorded on the recording sheet. H/Cs were not weighed since the truck scale site was too far away from the H/C hauling route. Instead, the weights of H/C loads were separately estimated based on volume measurement and bulk density derived from other survey data.

The format of the recording sheet included the date and time of arrival of trucks, drivers' name, vehicle number, classification of vehicle, total, empty and net weight, percent of loading by visual check, classification of waste, collection area, and name of organization that owns the vehicle. The DPSC and C/P conducted the weighing and data recording.

2.6 Soil Covering Operation at Landfill

2.6.1 Works Conducted

The PLP did not include a component for construction and comprehensive operation of an environment-friendly landfill due to time and financial constraints. Nevertheless, an important aspect of environment-friendly landfill operations, cell formation and daily soil covering, was carried out simultaneously with the PLP, with the main objective of capacity development of the Cuban personnel involved.

The work comprised: i) construction of a dyke to form a disposal area for the PLP, ii) cell formation for daily waste disposal, iii) soil covering of waste placed in cells, and iv) leveling and compaction operations.

Details of the work method adopted were as follows:

- Landfill method: cell method
- Hauled waste: 150 m³/day
- Dimensions of a cell after compaction with cover soil: 10 m long x 6 m wide x 1.4 m high
- Cover soil quantity before compaction: 16 m³/day (20 tons/day)
- Heavy Equipment for landfill operation: 1-bulldozer, 1-wheel loader, 1-shovel loader, and 1-dump truck; all of them were mobilized by the DPSC.

2.6.2 Cell Construction and Daily Soil Covering

The following operation was carried out:

(1) Vehicle arrival and unloading

When a waste collection vehicle arrived at the landfill, a field inspector checked the hauled waste and filled in the data on a recording sheet. After the check, the collection vehicle unloaded the waste at the area designated by the inspector.

(2) Measuring the volume of unloaded waste

After unloading the waste, the dimensions of the unloaded waste pile were measured and the volume was calculated. The calculated volume was used to estimate the requirement for heavy equipment and the necessary volume of daily cover soil.

(3) Pushing-up the waste and creating a cell

In the disposal area, a bulldozer spread the unloaded waste in a 30-50 cm thick layer and pushed in the direction of the reclaimed cell slope by the push-up method. The bulldozer created a cell with a maximum slope of approximately 20 degrees. The bulldozer continued this operation until the cell height reached approximately 120 cm.

(4) Soil covering

Cover soil was obtained from a small hill in the neighboring area. A bulldozer excavated the soil, and a wheel loader loaded it on a dump truck for hauling to the cell area.

At the cell, a bulldozer spread and pushed the soil to cover the surfaces of waste until the compacted cover soil layer reached approximately 20 cm.

CHAPTER 3 VERIFICATION OF ACHIEVEMENTS IN THE PILOT PROJECT AND FEEDBACK TO THE MASTER PLAN

3.1 Verification of Achievements in Pilot Project

3.1.1 Waste Segregation and Segregated Collection

(1) Segregated discharge

As stated in Subsection 2.2.2, the performance of waste segregation in the priority stations showed potential for improvement depending on the consciousness of the participating residents. The results from the priority stations revealed that the introduction of waste segregation in the communities would be possible provided that sufficient awareness-raising measures, such as the ones taken to improve the PLP (ref, Subsection 2.2.2), are implemented in advance.

(2) Segregated collection

1) Variation of waste quantities by collection station

PLP faced difficulty in conducting segregated collection in some instances. The main reason was the failure of collection at the designated time due to the breakdown of collection vehicles. Another reason was the variation in waste quantity discharged at stations. As shown in Figure 3.3.1, the quantity of waste collected in the 3 categories varied greatly between stations and waste category. At 9 stations, the quantity of waste of a particular category exceeded the capacity of the designated waste bin (770 L), which caused the overflow of waste from that bin and resulted in mixed discharge by resident.

This lesson learnt from the PLP suggested the need for proper planning and management of the collection schedule and the allocation of waste bins to meet the actual quantities discharged in each area.

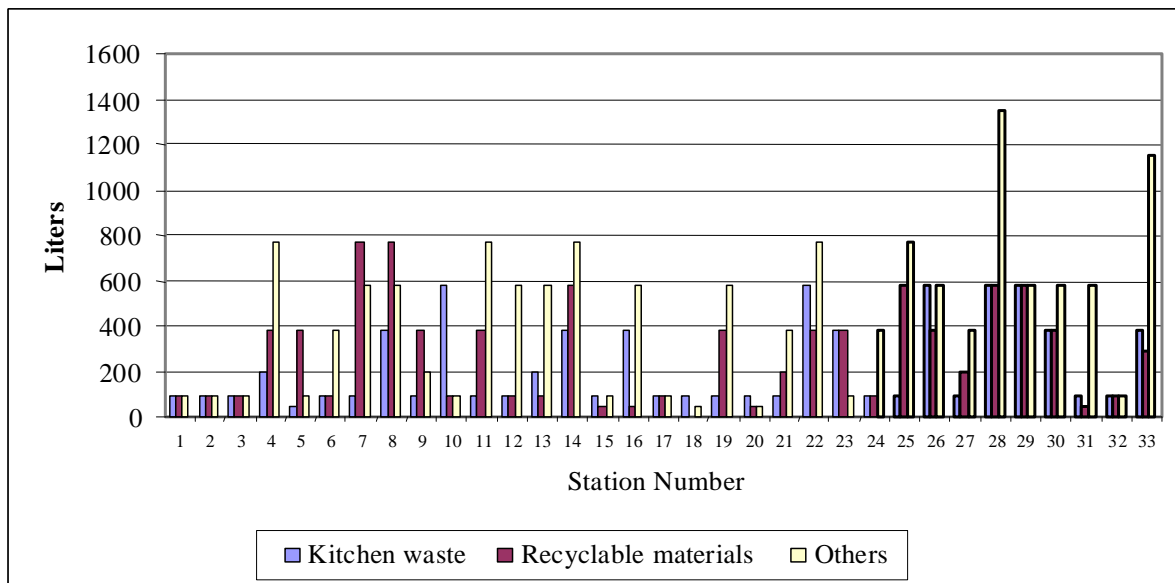


Figure 3.3.1 Quantities of Collected Waste by Collection Station (Surveyed on June 4 2005)

2) Impact of equipment condition on collection efficiency

A 10 year-old Pegaso 18 m³ C/T vehicle equipped with a mechanical lifting and compacting system was mobilized by UPPH for the PLP. The vehicle had no difficulty in performing the work, but it had several mechanical breakdowns such as hydraulic pump malfunctions and flat tires during the PLP operation. This caused delays in the collection work.

In addition, it was found that maintenance of bins was important to keep up high collection efficiency. (The difficulty of handling the bins resulted in a longer time being spent for performing collection.)

3) Post PLP observation

JICA official mission and the Study Team observed the following during the monitoring in September 2005:

- Implementing segregated collection appeared to be rather difficult for the Cuban side since it was conducted virtually by the sole effort of C/Ps from the implementation bodies of the PLP without well-structured governmental support. Although the C/Ps were quite willing to maintain segregated collection at the level achieved during the intensive awareness-raising period, they faced difficulties in practice because of a lack of human resources, budget, and commitment.
- It was also pointed out that the residents who participated in the PLP sometimes also found it difficult to keep motivated to cooperate with the segregated collection because the collection frequency was not regular and the delay of collection caused waste littering around the station.

These findings suggested the need for well-structured arrangements for segregated discharge and collection with government support and also highlighted the importance of waste collection on a regular basis.

3.1.2 Composting

(1) Community composting

The followings were verified through the implementation of the PLP:

- Raw material for community composting: kitchen waste can be obtained through the segregated collection provided that an adequate level of waste segregation should be achieved through awareness-raising of the residents.
- Re-segregation of collected kitchen waste would be required at the composting yard to remove materials unsuitable for composting before the composting process.

Owing to an insufficient level of segregation of kitchen waste (low quality of raw materials) and delay of completion of the community composting yard facility (lack of adequate facilities) until May 2005, the PLP was not able to completely confirm the quality of compost produced during the PLP period. Prior to development of the main projects, the Cuban side needs to conduct another pilot level community compost production project to confirm that the required quality of compost can be achieved.

(2) Home composting

The following matters were verified by the implementation of the PLP:

- Residents are capable of producing home compost through using kitchen waste if adequate instruction is provided.
- Reduction of the domestic wastes generated from households can be achieved through the introduction of home composting in households.
- Home composting at households that keep domestic livestock may not be very effective, since some of the kitchen waste would be fed to livestock.
- Households appeared to need appropriate technical guidance and support with provision of detailed guidelines describing the method of home composting.

3.1.3 Awareness-raising Activities

(1) Indices for verification

Awareness-raising was done by means of workshops and meetings as well as the distribution of pamphlets and campaign materials. In total, 4 workshops and 35 meetings (including small workshops and 8 meetings for priority stations) were

held. These meetings and workshops were considered to have contributed greatly to promoting the awareness of the residents in the PLP area and to obtaining the active participation of residents in the PLP activities.

The effectiveness of the awareness-raising activities carried out in PLP was verified by the following indices:

- Improvement of the level of understanding of the residents for the objectives and contents of the PLP, and
- Improvement of the degree of willingness of the residents to cooperate in the PLP

These 2 indices were checked by the observations and information as described hereunder:

(2) Residents' attitude observed at workshops and meetings

In general, the attitudes of residents participated in workshops and meetings were very positive, getting better each time. In the latter stage of the PLP, most of the participating residents were of the opinion that environment-friendly MSWM of the kind carried out in the PLP should be expanded into full-scale operation throughout the whole City. Some residents provided suggestions for improvement measures that could be taken for the City-wide activities. These attitudes of the residents seemed to have been created through the awareness-raising efforts conducted in the PLP.

(3) Results of pre- and post-implementation questionnaire surveys

Table 3.3.1 shows a comparison of the levels of the understanding and the residents' willingness to cooperate as revealed in questionnaire surveys conducted before and after the PLP implementation. As seen in the table, significant improvement was attained in both the understanding and willingness in all the components of the PLP. This owes much to the awareness-raising activities performed during the PLP period.

Table 3.3.1 Comparison of the Result of the Attitude Survey Before and After the PLP (Whole PLP Area)
Unit: %

Issues	Pre Survey Questionnaire	Post Survey Questionnaire	Improvement (%)
1.Segregated collection (discharge)			
1) Understanding	56.7	98.0	41.3
2) Willingness for cooperation	91.6	96.0	4.4
2.Landfill			
1) Understanding	44.9	94.4	49.5
2) Willingness for cooperation	52.2	84.5	32.3
3.Composting			
1) Understanding	26.0	90.0	64.0
2) Willingness for cooperation	52.8	92.8	40.0
4.Recycling			
1) Understanding	80.2	98.3	18.1
2) Willingness for cooperation	90.4	95.5	5.1
5.Awareness-raising			
1) Understanding	57.3	95.0	37.7
2) Willingness for cooperation	87.3	94.0	6.7
Average			
1) Understanding	53.0	95.1	42.1
2) Willingness for cooperation	74.9	92.6	17.7

Regarding the landfill, however, the willingness for cooperation is about 10% lower than the level of understanding, which is different from the figures appearing in other components of the PLP. This indicates a need for strong awareness-raising efforts to acquire the acceptance of the residents for landfill construction.

(4) Achievement in segregated discharge

The ratio of appropriate segregation achieved in the 4 priority stations (ref. Subsection 2.2.2) was 87% at maximum, on the whole, which was 36% higher than the average of all stations. This improvement was attained by the additional awareness-raising activities carried out in the priority stations. This also indicated that the residents' performance could be improved considerably by intensive and continuous awareness-raising efforts.

(5) Achievement in home composting

The attempt at introducing home composting showed an acceptable level of results, though some aspects need to be confirmed (e.g. compost quality). Before starting the home composting in 40 households in Campo Florido community, intensive meetings were held to explain the benefits of home composting and how to go about it by distributing handouts. Guidance by the C/Ps was also provided during the period. These activities are considered to have contributed much to the fair achievement of the home composting. The subsequent observation suggested the need for continuation of these efforts until the home composting work would become firmly rooted in the area.

3.1.4 Waste Weight Measurement

The following were noted in the PLP:

- Weight measuring was done properly by using truck scale and other related equipment.
- Waste weight data are essential for efficient planning and operation of MSWM.
- The measurement needs to be carried out in an area with adequate space close to the landfill area, where power and water are available, and preferably where the truck scale is installed under roofing.
- Competent operating staffs need to be stationed at the facility so that they can guide the vehicles properly and record the data correctly.

3.1.5 Soil Covering Operation for Environment-Friendly Landfill

Waste disposal operation with cell formation and daily soil covering was conducted fairly satisfactorily. The following observations on the operations were made:

(1) Cell formation and soil covering

Facilities required for the operation including dikes and storm water drainage were properly constructed. Cell formation and soil covering were also properly done with leveling and compaction.

(2) Control of cover soil quantity

The work required careful control of cover soil quantity so as to meet the requirement as determined from the waste volume and cell areas to be covered with soil. This will be more important when full-scale operation commences.

(3) Equipment operation

Unlike the current open-dumping method, waste disposal with cell formation and soil covering required more intensive operation of vehicles and equipment, which consumed more fuel. Operation of vehicles and equipment would need the elaborated planning in such manners as minimizing the moving distance of equipment and dispatching the right type and number of equipment adequate for the scheduled work quantity.

3.2 Feedback to the Master Plan

Summarizing the findings and observations in the PLP as described in Section 3.1, the followings lessons were learned from the PLP. These lessons have been reflected to the formulation of the M/P.

3.2.1 Waste Segregation

(1) Segregated discharge

- Classification of waste segregation will be as simple as possible so that the residents can understand and comply.
- Waste bins of different colors will be used for each category of segregated waste so as to be explicit to the residents. Further, the classifications will be clearly shown on the waste bins with illustrations.
- Awareness-raising activities will be carried out to inform the residents of the benefits of segregated collection in due advance of the project commencement and on a continuous basis afterwards.
- The M/P assumes that a certain time period would be required until the quality of segregated discharge by residents reaches an acceptable level to meet the requirements for composting and recyclable materials recovery.

(2) Segregated collection

- The frequency of collection and number of stations/bins will be planned for each area considering the volume of waste under each category, in addition to the consideration of collection efficiency and resident's convenience.
- Efficiency of collection work depends largely on the condition of bins. Of importance is to keep the condition of bins in a good state by periodical inspection and maintenance.
- Frequent breakdown of equipment was experienced during the PLP. In view of the importance of efficient performance of equipment, the M/P will consider the improvement of equipment condition by procuring equipment and reinforcing the capability for repair and maintenance.
- Segregated collection would generally require more vehicles compared with the present mixed collection. To deal with this, the M/P will examine the appropriate number of vehicles required, taking into account possible measures for reducing the number of vehicles, such as (i) reinforcing vehicle repair and maintenance capability, (ii) maintaining bins in good condition, and (iii) proper planning of collection routes and frequency.
- Under the condition of bins being kept in good condition, a team of 3 workers per unit of C/T, including a truck driver, can conduct the collection work. The

M/P assumes this number of work crew for each 18 m³ C/T collection unit.

- An appropriate vehicle maintenance system is needed to secure a system of regular collection.
- Introduction of segregated discharge and community composting will require a certain time period for preparatory planning and pre-arrangement, presumably at least 3 years, to assure the success of segregated collection before commencement of the actual work.

3.2.2 Composting

(1) Community composting

- The M/P includes community composting plans on the premise that the performance of segregated discharge would be improved to an acceptable level (ref. Subsection 2.2.2). This implies that proper conduct of segregated collection is a prerequisite to the commencement of community composting.
- Even under the improved performance of segregated discharge, re-segregation of kitchen waste would be required at the composting site to remove materials unsuitable for composting. Related to this, adequate guidance must be provided to people through a campaign to prevent the contamination of kitchen waste with medical waste.
- Composting will be done at a yard with a roof structure for facilitating fermentation and moisture control.
- There are presently no technical standards regarding the quality of compost product. The M/P recommends the necessity for establishing quality standards by the relevant authority.
- As stated above, the feasibility of community composting will depend largely on the quality of the segregated discharge of kitchen waste. Planning of the community composting in the M/P takes into account the time frame required for gradual improvement of segregated discharge.
- It was not possible to fully confirm the quality of compost actually produced in the PLP due to the limited time available. The M/P provides for a sufficient time period for investigating the quality of compost production and also a time frame for gradual improvement of compost production quality. The marketability of produced compost is also a subject of further study in the M/P.
- As mentioned above, at least 3 years will be needed before the community composting system in conjunction with segregated discharge and collection, can be verified and the project proposed in the M/P commenced.

(2) Home composting

- Home composting is recommended for households in the semi-urban municipalities. Most of the households in the semi-urban area have adequate garden space with plants and trees to which compost can be applied.
- Consideration will be made for households that keep domestic livestock. Kitchen waste usable for home composting might be limited in such households and, therefore they might be excluded from the home composting plan in the M/P.
- Judging from the fact that only 29 out of 40 households actively participated in the composting in the PLP, it must be assumed in the M/P that not all households would be willing to participate in the home composting activities. The M/P takes into account the expected extent of home composting in estimating the likely volume of producible compost.
- A concern is whether households could actually produce home compost of quality acceptable to their use. Some households may fail to produce an acceptable quality of home compost. To minimize this, it is indispensable to conduct intensive guidance to the households regarding the proper procedure for composting. With this aspect in consideration, the M/P shall formulate a home composting program on a conservative basis; i.e. assumption of a moderate number of households that would actually succeed in proper home composting and also gradual expansion of home composting activity.
- Implementation of home composting will require distributing about 43,000 compost bins to households. The area and time schedule of bin distribution shall be planned properly in advance of the implementation.

3.2.3 Awareness-raising

- The awareness-raising program carried out in PLP was assessed fairly successful. Similar attempts will be made in the M/P. In addition, awareness-raising in the M/P will consider the use of mass media such as radio and TV in view of the size of the population involved, since the target area of the M/P covers several municipalities or the whole City.
- The experiences of the community organizations and residents involved in the PLP will be fully utilized for working out the awareness-raising programs for the other areas. Videos and photos taken during the PLP operation will be useful tools.
- With regard to the awareness-raising for segregated discharge, the following will be taken into account:

- Before the full-scale introduction of segregated collection, awareness-raising activities should be commenced one year ahead and continued at least 2 years after its introduction..
- Awareness-raising workshops will be held everywhere as required so that every household would attend at least once. Also, a pamphlet with illustrations of the categories of municipal waste will be distributed to every household.
- Instruction leaflets for home composting similar to those prepared and used in the PLP, will be distributed to every household in the sub-urban municipalities.
- With regard to environment-friendly landfill, awareness-raising will be carried out for the entire municipality where the landfill will be constructed. Special emphasis will be placed on the communities adjacent to the landfill, since the agreement of the municipal government as well as the residents would be essential. Awareness-raising of all citizens of Havana City will also be carried out to convince them of the benefits of the concept of environment-friendly landfill.

3.2.4 Waste Weight Measuring

- Truck scales will be installed at all landfill sites, recycling plants, and composting yards. It will be of a stationary type on which a whole truck can be loaded at once and weighed in a single operation.
- Measuring and recording of the waste weight and sharing the data among the relevant departments/units are recommended for efficient management of the operation and also for the future planning of MSWM.

3.2.5 Environment-friendly Landfill Operation

The following items, verified through the landfill operation in the PLP have been reflected to the M/P:

- Waste disposal operation with cell formation and daily soil covering is an integral component of environment-friendly landfill operation, which is proposed as an essential requirement of the M/P.
- Detailed surveys and studies are recommended to determine the availability of cover soil material for each of the planned landfills.
- Operation for cell formation and soil covering will require extra equipment and fuels for their operation. A cost minimizing operation method is proposed in the M/P.

PART 4 FEASIBILITY STUDY

CHAPTER 1 SELECTION OF PRIORITY PROJECT

1.1 Selection of Priority Project

Among the projects included in the M/P, the following 3 were raised as candidate projects for feasibility study, mainly from the viewpoint of urgency:

- 1) Development of unused area of Calle 100 landfill to expand the landfill area
- 2) Construction of the new Guanabacoa landfill
- 3) Procurement of equipment; consisting of collection vehicles, heavy equipment for landfill, and repair and maintenance equipment for workshops

Comparing the 3 candidates, project 3) was selected as the project for feasibility study under the Study through discussion between the DPSC and the Study Team.

1.2 Selected Priority Project

The M/P lists a number of equipment that would be needed for proper operation of MSWM during the period towards 2015. Among the equipment, those listed in Table 4.1.1 were selected for their need of urgent procurement.

Table 4.1.1 List of Equipment for Priority Project

	Category	Equipment	Specification	Quantity
1	Equipment for landfill operation	Bulldozer	228 Hp, 28 ton	9 units
		Dump truck	8 m ³ , 270 Hp	6 units
		Water tank truck	10 m ³	3 units
		Power shovel	0.8 m ³ , 145 Hp	4 units
		Shovel loader	2.2 m ³ , 206 Ps	2 units
		Wheel loader	2.4 m ³ , 141 Hp	2 units
		Tow truck	Payload 30 ton	1 unit
2	Collection vehicle	Compactor trucks	18 m ³ ; G.V.W.20-26 ton	12 units
3	Equipment for repair and maintenance workshops	Workshop equipment for vehicles; such as welding machines, engine arc welders, etc.	Refer to Subsection 5.9.6 of Part 2 of the Main Report	62 items
		Workshop equipment for heavy equipment; such as engine generators, air compressors, hydraulic jacks, bench drills, etc.	Refer to Subsection 5.10.8 of Part 2 of the Main Report	28 items

CHAPTER 2 FEASIBILITY STUDY ON THE PRIORITY PROJECT

2.1 Procurement Schedule

Of the proposed equipment, equipment for landfills and workshops need the earliest procurement since they experience the most serious shortage at present. The number of collection vehicles must be increased when segregated collection of wastes is commenced, which is scheduled to be in 2010 in the M/P.

Accordingly, the Study planned tow packages for a two-phased procurement as stated below:

Package-1: Equipment for landfills will be procured to be ready for use from 2009 when the new Guanabacoa and new Calle 100 (extension) landfills are put into service adopting environment-friendly landfill operation. Equipment for the workshops will be procured simultaneously.

Package-2: Collection vehicles are to be ready for use in 2010 when the segregated collection would start.

Figure 4.2.1 shows the proposed procurement schedule. The procurement for Package-1 will need to proceed with in the shortest period.

Items	Months	1	2	3	4	5	6	7	8	9	10	11	12
Detail Design													
Field survey		■											
Tender document		■	■										
Procurement													
Tendering			■	■									
Evaluation				■	■								
Contract					■				5.5 months				
Manufacturing					■	■	■	■	■	■	1.5 months		
Transportation & Installation										■	■	■	
Delivery												■	■
Installation													■
Training													■

Figure 4.2.1 Equipment Procurement Schedule

2.2 Implementation Cost

The financial cost required for the project was estimated to be US\$13.7 million in foreign currency and CUP15.3 million in local currency, respectively, covering the procurement cost and O/M cost incurred for the period from 2007 to 2015. The estimated cost is shown in Table 4.2.1.

Table 4.2.1 Summary of Implementation Cost

Equipment		Fund Requirement	
		US\$1,000	CUP1,000
1	Equipment for Landfill	10,356	10,157
2	Collection Vehicles	2,215	2,727
3	Equipment for Repair and Maintenance Workshops	1,112	2,424
Total		13,683	15,308

Note: The cost was estimated at 2005 price level. CUP: Cuban local Peso

2.3 Evaluation of the Priority Project

2.3.1 Concept of Evaluation

The Study evaluated the feasibility of the project from 3 aspects, i.e., (i) technical soundness, (ii) financial viability, and (iii) socio-environmental considerations.

The economic evaluation was considered to be not relevant in this case for the reasons that (i) procurement of the equipment is by all means required for proper conduct of MSWM in the City, irrespective of the economic viability, and (ii) the project is a part of the overall M/P projects, for which a separate evaluation of the economic viability was thought difficult. The economic viability of the overall M/P projects is already assessed in Part 2 of this Report.

2.3.2 Technical Soundness

Technical soundness of the project was assessed from the following 3 aspects:

- 1) The need for procurement of the equipment was justified in the M/P. The equipment are essential for conducting the works proposed in the M/P: collection vehicles for segregated waste collection, heavy equipment for environment-friendly landfill operation, and workshop equipment for proper repair and maintenance of vehicles and equipment.
- 2) The equipment to be procured under this project will all be of conventional types and similar to the existing equipment currently in operation. Technology for operation and maintenance (O/M) of the equipment is already within the knowledge of present workers. No special training of operators and mechanics seems to be required other than the initial training to be provided by the suppliers.
- 3) All the equipment to be procured consists of durable items, and the benefit of the project will accrue throughout the service life of the equipment. According to UPPH manual, both the collection vehicles and heavy equipment must be in

service for a period of 9-10 years. Moreover, a longer service life is expected if proper O/M is conducted.

As a whole, no technical difficulty is envisaged in the process of procurement and also in the O/M of the equipment after procurement.

2.3.3 Financial Viability

The financial viability of the operating agency, either UPPH or new Auroras (a holding company) after its establishment, was evaluated in a similar manner to the evaluation adopted for the M/P.

The financial evaluation in this F/S project involves a difficulty in the analysis since the project is only a fraction of the overall undertaking of the M/P. Hence, the evaluation included several hypothetical assumptions as stated hereunder:

(1) Cost stream

Table 4.2.2 shows the cost stream of the project covering both the procurement and O/M costs.

Table 4.2.2 Cost Stream of the F/S Project

Unit: FC: US\$1,000, LC: CUP1,000

Description	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Heavy Equip. for Landfill	FC	0	109	5,857	658	622	622	622	622	622	622	10,356
	LC	0	0	0	1,451	1,451	1,451	1,451	1,451	1,451	1,451	10,157
Collection Vehicle	FC	0	0	0	1,747	78	78	78	78	78	78	2,215
	LC	0	0	0	390	390	390	390	390	390	390	2,727
Equipment for Workshops	FC	0	15	832	38	38	38	38	38	38	38	1,112
	LC	0	0	303	303	303	303	303	303	303	303	2,424
Total	FC	0	125	6,688	2,443	738	738	738	738	738	738	13,683
	LC	0	0	303	2,144	2,144	2,144	2,144	2,144	2,144	2,144	15,308

Note FC: Foreign currency, LC: Local currency; expressed at 2005 price level
The above cost covers both the initial procurement cost and O/M cost.

As for the M/P, the Study analyzed both the cases of 'Case-A: Without depreciation cost and 'Case-B: With depreciation cost'.

- Case-A: The operating agency will bear only O/M cost, while the equipment depreciation cost is retained in the State Government account.
- Case-B: The operating agency will bear all costs including the depreciation cost.

Table 4.2.3 shows the cost streams for the above 2 cases. The breakdown details are presented in the Main Report.

Table 4.2.3 Cost Streams for Financial Evaluation of the F/S Project

Unit: FC: US\$1,000, LC: CUP1,000

Description	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Case-A:	FC	0	0	148	774	738	738	738	738	738	738	5,349
	LC	0	0	303	2,144	2,144	2,144	2,144	2,144	2,144	2,144	15,308
Case-B:	FC	0	125	6,688	2,443	738	738	738	738	738	-976	11,969
	LC	0	0	303	2,144	2,144	2,144	2,144	2,144	2,144	2,144	15,308

Note: 1. FC: Foreign currency, LC: Local currency; expressed at 2005 price level

2. Case-A: Depreciation cost excluded from cash account; Case-B: Depreciation cost included
Salvage value of equipment at year 2015 was estimated to be US\$1.7 million, which was regarded as minus cost in 2015. Cost expressed at 2005 price

(2) Revenue stream

The revenue stream was also formulated in a similar manner as for the M/P. The estimation of revenues relevant only to this F/S project was practically difficult. The amount of revenue was therefore derived by calculating the proportional amount to the total revenues estimated in the M/P by multiplying a ratio of the cost of this project to the total cost of all the M/P projects (pro-rata estimation). The revenue stream so derived is shown in Table 4.2.4.

Table 4.2.4 Revenue Stream of the F/S Project

Unit: FC: US\$1,000, LC: CUP1,000

Revenue Source	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Collection Fee from household*	FC	0	0	0	0	0	0	0	0	0	0	0
	LC	0	0	0	0	941	997	1,053	1,108	1,164	1,220	6,482
Collection Fee from institutions	FC	0	0	0	0	133	141	149	157	165	173	919
	LC	0	0	0	0	652	692	731	771	811	851	4,508
Tipping Fee at landfill**	FC	0	0	0	0	0	0	0	0	0	0	0
	LC	0	0	0	0	27	30	33	33	36	39	198
Recycling	FC	0	0	0	0	26	140	169	402	462	520	1,718
	LC	0	0	0	0	86	110	134	313	363	412	1,416
Composting	FC	0	0	0	0	0	0	0	0	0	0	0
	LC	0	0	0	0	366	489	550	1,452	1,612	1,759	6,228
Total	FC	0	0	0	0	159	281	318	559	627	693	2,636
	LC	0	0	0	0	2,071	2,317	2,501	3,678	3,987	4,280	18,833

Note FC: Foreign currency, LC: Local currency; expressed at 2005 price

* Collection fee from households is actually to be subsidized by the City government for the period until the fee collection is introduced.

** Charged to commercial and public institutions (except for MSWM agencies) that dispose of waste to landfills

(3) Financial balance during operation

Table 4.2.5 shows the financial balance during the evaluation horizon towards 2015, for both 'Case-A' and 'Case-B'.

Table 4.2.5 Financial Balance during Operation

Unit: FC: US\$1,000, LC: CUP1,000

Revenue Source	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Case-A: Without depreciation cost												
Cost stream	FC	0	0	148	774	738	738	738	738	738	738	5,349
	LC	0	0	303	2,144	2,144	2,144	2,144	2,144	2,144	2,144	15,308
Revenue stream	FC	0	0	0	0	159	281	318	559	627	693	2,636
	LC	0	0	0	0	2,071	2,317	2,501	3,678	3,987	4,280	18,833
Balance (Revenue-Cost)	FC	0	0	-148	-774	-593	-482	-449	-229	-167	-107	-2,949
	LC	0	0	-303	-2,144	-258	-34	133	1,204	1,486	1,753	1,838
Case-B: With depreciation cost												
Cost stream	FC	0	125	6,688	2,443	738	738	738	738	738	-976	11,969
	LC	0	0	303	2,144	2,144	2,144	2,144	2,144	2,144	2,144	15,308
Revenue stream	FC	0	0	0	0	159	281	318	559	627	693	2,636
	LC	0	0	0	0	2,071	2,317	2,501	3,678	3,987	4,280	18,833
Balance (Revenue-Cost)	FC	0	-125	-6,688	-2,443	-593	-482	-449	-229	-167	1,607	-9,569
	LC	0	0	-303	-2,144	-258	-34	133	1,204	1,486	1,753	1,838

Note: 1. FC: Foreign currency, LC: Local currency
2. Case-A: Depreciation cost excluded from the cash account of the operating agency,
Case-B: Depreciation cost included

As shown in the table, the annual financial balance in the foreign currency in 'Case-A' will not become positive even in 2015 and the accumulated loss in the foreign currency at the end of 2015 is US\$2.95 million. On the other hand, the accumulated surplus in the local currency at the end of 2015 is only CUP1.85 million. Considering this balance, the operating agency would need financial support for O/M cost.

In 'Case-B', the annual financial balance turns positive in 2015 due to the salvage value. However, the accumulated loss at the end of 2015 is US\$9.57 million in the foreign currency portion, which must be subsidized by the State for the same reasons as stated for the M/P.

The financial internal rate of return was not calculated in view of little relevance to this kind of project.

(4) Sensitivity analysis

Sensitivity analysis was made in a similar manner as in the M/P (ref. Subsection 4.1.4 (5) of Part 2). The results are shown as revenue-cost balance in Tables 4.2.6 and 4.2.7 for 'Case-A' and 'Case-B, respectively.

**Table 4.2.6 Sensitivity Analysis for Financial Evaluation
(Revenue-Cost Balance) (1/2)**

Case-A: Without depreciation cost Unit: FC: US\$1,000, LC: CUP1,000

Case	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Base Case (ref. Table 4.2.5)	FC	0	0	-148	-774	-593	-482	-449	-229	-167	-107	-2,949
	LC	0	0	-303	-2,144	-258	-34	133	1,204	1,486	1,753	1,838
Sensitivity for Compost Price:												
Case C-1 (CUP0)	FC	0	0	-148	-774	-593	-482	-449	-229	-167	-107	-2,949
	LC	0	0	-303	-2,144	-591	-479	-368	-118	18	152	-3,833
Case C-2 (CUP1,250)	FC	0	0	-148	-774	-593	-482	-449	-229	-167	-107	-2,949
	LC	0	0	-303	-2,144	243	633	883	3,188	3,688	4,155	10,343
Sensitivity for Recyclables Price:												
Case R-1 (-20%)	FC	0	0	-148	-774	-598	-508	-479	-302	-251	-201	-3,261
	LC	0	0	-303	-2,144	-273	-54	109	1,148	1,420	1,678	1,580
Case R-2 (+20%)	FC	0	0	-148	-774	-589	-457	-418	-156	-83	-12	-2,636
	LC	0	0	-303	-2,144	-242	-14	157	1,261	1,552	1,828	2,095

Note: 1. FC: Foreign currency, LC: Local currency
2. The figures are expressed in revenue-cost balance
3. CUP0: Compost price is zero, CUP1,250: Compost price is CUP1,250/ton

**Table 4.2.7 Sensitivity Analysis for Financial Evaluation
(Revenue-Cost Balance) (2/2)**

Case-B: With depreciation cost Unit: FC: US\$1,000, LC: CUP1,000

Case	Currency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Base Case (ref. Table 4.2.5)	FC	0	-125	-6,688	-2,443	-593	-482	-449	-229	-167	1,607	-9,569
	LC	0	0	-303	-2,144	-258	-34	133	1,204	1,486	1,753	1,838
Sensitivity for Compost Price:												
Case C-1 (CUP0)	FC	0	-125	-6,688	-2,443	-593	-482	-449	-229	-167	1,607	-9,569
	LC	0	0	-303	-2,144	-591	-479	-368	-118	18	152	-3,833
Case C-2 (CUP1,250)	FC	0	-125	-6,688	-2,443	-593	-482	-449	-229	-167	1,607	-9,569
	LC	0	0	-303	-2,144	243	633	883	3,188	3,688	4,155	10,343
Sensitivity for Recyclables Price:												
Case R-1 (-20%)	FC	0	-125	-6,688	-2,443	-598	-508	-479	-302	-251	1,512	-9,882
	LC	0	0	-303	-2,144	-273	-54	109	1,148	1,420	1,678	1,580
Case R-2 (+20%)	FC	0	-125	-6,688	-2,443	-589	-457	-418	-156	-83	1,702	-9,256
	LC	0	0	-303	-2,144	-242	-14	157	1,261	1,552	1,828	2,095

Note: 1. FC: Foreign currency, LC: Local currency,
2. Other notes: Same as described for Table 4.2.6

As indicated above, considering the accumulated loss in the foreign currency though the impact of the compost price is not small on the financial balance in the local currency, both the compost price and recyclables price are not very sensitive to the financial balance in both 'Case-A' and 'Case-B'.

2.4 Socio-environmental Aspects

The proposed project is virtually only the procurement of equipment, and hence the project itself does not have any adverse impacts in social and environmental terms.

The following aspects are noted as the socio-environmental conditions after the equipment is put into service:

- 1) With the procurement of heavy equipment for landfills, it is expected that the new Guanabacoa landfill and Calle 100 extension landfill will commence environment-friendly landfill operation with soil covering. This will bring about a beneficial effect on the environments around the areas by reducing the odor, propagation of insects, littering of plastics, and fear of fire outbreaks. The direct beneficiaries will be the people living in the vicinity of the landfills; estimated at 38,000 people, who live within one kilometer around the 2 landfills.
- 2) Heavy equipment for landfills is operated mostly in the landfill sites that are isolated from the residential areas. Nevertheless, the operation will require special attention not to cause noise and dust problems to the surrounding area.
- 3) Supply of 12 units of new collection vehicles (18 m³ C/T) will increase the total number of vehicles operated for waste collection in the City. When these vehicles are operating, care needs to be taken to ensure they do not cause traffic jams and to reduce exhaust gases, noise and dust. The equipment will be maintained in a good state so as not to breakdown or cause any nuisance on public roads.
- 4) Equipment for the workshops will be used in a confined workshop area and will have no direct relevance on the socio-environmental conditions outside the workshops.

As stated above, socio-environmental impacts of the project are minor.

PART 5 CAPACITY DEVELOPMENT

CHAPTER 1 OBJECTIVE AND PROGRAM FOR THE CAPACITY DEVELOPMENT OF THE CUBAN COUNTERPARTS

1.1 Objectives

The objective of the capacity development program was to reinforce the capacity of the Cuban counterparts (C/Ps) for preparing the M/P for solid waste management. The capacity development program (CDP) envisaged that the following outcomes would be achieved:

- The Cuban C/Ps would come to have a sense of ownership of the Study by formulating the elements of the M/P through active participation and initiative.
- The Cuban C/Ps would acquire the knowledge and management capacity to implement environment-friendly MSWM.
- The Cuban C/Ps would acquire the ability to revise the M/P when and as the need arises in the future and to formulate a new M/P for cities other than Havana, possibly with some assistance from foreign advisers/experts.

1.2 Counterpart Personnel

The Study consisted of 10 expertise areas, for each of which a counterpart was assigned. The team of C/Ps was comprised of personnel from the DPSC and CITMA. One C/P, Ms. Odalys Garcia, assumed 2 roles: Leader and Organization/Institution expert. For each C/P, a Study Team member was attached to lead the capacity development activity in the respective expertise areas.

Table 5.1.1 List of C/Ps and Team Members

Responsibility	C/P	Study Team
1. Leader	Odalys Garcia	Masatoshi Akagawa
2. Sub Leader	Juan Herrera	Shigeru Kanaya
3. Collection & Transportation	Wladimir Fraguela	Satoshi Shibasaki
4. Recycle/Quantity & Quality Analysis	Odalys Goicochea	Takahiro Kamishita
5-1 Final Disposal (Planning)	Aymara Infante	Tetsuo Izawa
5-2 Final Disposal (Operation)	Andres Ruiz	Tetsuo Izawa
6. Cost Estimation	Marilyn Diaz	Koichi Iwamoto
7. Organization/Institution	Odalys Garcia	Luis Costa Leite
8. Economic/Financial Analysis	Teresita Recio	Mitsuhiro Doya
9. Social Considerations	Elida Rosa	Alexandra Tribocchi, Michiel Meijer
10. Environmental Considerations	Barbara Cordoves	Tetsuo Kuyama

Note: As Mr. Andres Ruiz joined the team at a later stage, 10 C/P in total worked for the Study.

1.3 Capacity Development Program

1.3.1 Method of Capacity Development

The methods adopted for the capacity development were as follows:

- Lectures
- On-the-job training
- Workshops and discussion meetings
- Overseas training in Japan

On-the-job training (OJT) was carried out in the form of co-working of C/Ps and Study Team members so that the C/Ps could acquire the knowledge and experience from the Study Team members. The OJT was conducted in the following study activities:

- Field surveys, including a solid waste quality/quantity survey, a time and motion survey, a water quality survey, and others,
- Sector studies, such as solid waste volume projection, optimum collection/transport plan, environment-friendly landfill plan, review of existing organization and legal structure,
- Preparation of future long-term vision and scenario for MSWM and the M/P integrating the sector studies, and
- Formulation and implementation of a pilot project (PLP), including the preparation of project selection criteria and cost estimate.

The workshops and discussion meetings were considered as a vehicle for exchanging views and opinions among the attendants of government officials, local residents, relevant organizations, Steering Committee members, C/Ps and Study Team members.

At the occasion of overseas training in Japan, 2 C/Ps learned the practices and experiences in Japan through visits to MSWM facilities, lectures, and discussions with personnel involved in MSWM.

1.3.2 Evaluation of the Achievements of the Capacity Development Program

The degree of achievement of capacity development was evaluated in the following 3 steps:

- 1) Self-evaluation by the C/Ps themselves
- 2) Evaluation by the Team member who was responsible for capacity development of the respective C/Ps
- 3) Final evaluation by an Evaluation Committee comprised of C/Ps and the Study Team, taking into account the evaluations 1) and 2).

The degree of achievement was scored at 4 levels; A: Excellent, B: Good, C: Fair, and D: Not sufficient. The evaluation was done twice: a mid-term evaluation in late November 2004 and final evaluation in early July 2005 at the end of the Study Team's last assignment in Cuba.

CHAPTER 2 IMPLEMENTATION OF CAPACITY DEVELOPMENT PROGRAM

2.1 Capacity Development Workshops

2.1.1 First Capacity Development Workshop

The first Capacity Development Workshop on 15 March 2004 was held at the beginning of the Study with the following objectives:

- To inform and disseminate the objective and contents of the Capacity Development Program (CDP) of the Study, and
- To exchange opinions on the contents of the CDP and evaluation method

The workshop was carried out under the initiative of the C/Ps with cooperation and advice from the Study Team. Spanish was used as the main language. One of the C/Ps acted as the Master of Ceremonies. The attendants at the workshop were the C/Ps, the Study Team, Steering Committee members, personnel from the Ministries/Organizations involved in MSWM, and representative of JICA official mission in Cuba.

In the workshop, the Study Team introduced the structure of the CDP prepared in the form of a project design matrix (PDM). Three C/Ps presented their individual capacity development programs as examples. After these presentations, all the participants were divided into 3 groups to discuss the CDP and its evaluation method. After the group discussion, a representative of each group presented the view of the group. This workshop procedure was adopted for other workshops in the subsequent studies.

As a consequence, a PDM-based CDP was agreed by all the groups. It was also agreed that the three-step evaluation approach (ref. Subsection 1.3.2) would be adopted.

2.1.2 Second Capacity Development Workshop and Mid-term Evaluation of Achievement

A second Capacity Development Workshop was held in late November 2004 to evaluate the mid-term achievements of capacity development of each C/P. The degree of achievement ranged from 'fair' to 'good' varying by C/P. Most of the C/Ps expressed their hope to spend more time in on-the-job training (OJT) and to have more technology transfer workshops.

With regards to the overseas training, they expressed their desire to be given with training opportunities in a Spanish speaking country in Latin America where environment-friendly landfills are in operation.

2.1.3 Third Capacity Development Workshop and Final Evaluation of Achievement

The third Capacity Development Workshop was held on July 11, 2005 to evaluate the achievement of capacity development of the 10 C/Ps. The degree of achievement ranged from excellent (1 C/P), to good (6 C/P), to fair (3 C/P). All 10 C/Ps expressed satisfaction with their involvement in the CDP and their willingness to use the experience to contribute to MSWM in the country in the future.

2.1.4 Capacity Development in Dissemination Workshops

Capacity development on 13 November 2004 was also attempted at the opportunities of having other workshops for disseminating the Study activities. All those workshops were programmed so that the C/P should take the initiative as part of their capacity development program.

The First Dissemination Workshop was held in March 2004 with a view to disseminating the purpose and major outputs as well as the implementation schedule of the Study. At the workshop, the Chief C/P explained the components and work-flow of the Study as well as the structure of the M/P, and the Vice Chief C/P presented the selection criteria and candidate projects of the PLP. The Second Dissemination Workshop was organized in late October 2004 to announce the implementation of the PLP. Included in the objectives was the awareness-raising of the community with respect to environmental protection, particularly in relation to MSWM.

The workshop attendants included various parties and organizations at the central level and community level, including CITMA, the DPSC, community leaders, CDR and others.

In late October, another workshop was held for the awareness-raising of children and teachers of primary schools located in the PLP area.

2.2 **On-the-job Training**

2.2.1 Field Surveys and Data Analysis

The Study involved the following field survey activities:

- Quantity and quality survey of solid waste (dry and rainy seasons)
- Survey on recycling activities
- Time and motion survey
- Awareness survey on solid waste
- Water quality survey (dry and rainy seasons)
- Social survey for the candidate sites of new landfills

- Finance and management study

During the survey, the Study Team conducted technology transfer regarding the objective, method of field sampling and analysis, interpretation of data, and incorporation of results in the planning, either by means of carrying out the surveys jointly or through discussion in the office.

2.2.2 The Master Plan Formulation

Major items of technology transfer in the M/P formulation included:

- Structure and components of the M/P for MSWM,
- Workflow and interrelationship among the work items for the M/P,
- Methodology of sector studies,
- Methodology for formulation of an integrated M/P, such as the formulation of economic scenarios, target setting, working out strategies, project formulation and phased implementation.

2.2.3 PLP Formulation and Implementation

Formulation of the PLP was carried out jointly by the C/Ps and the Study Team. Meetings between the C/Ps and Study Team members were held more than 20 times. After intensive discussion and planning works by both sides, the final implementation plan for the PLP was formulated.

In the process of the project selection and formulation process, technology transfer was achieved on the aspects of plan formulation, setting of criteria in due consideration of the constraints and objectives, and evaluation of the project outputs.

2.3 Training in Japan

Two C/Ps, the Chief C/P and Vice Chief C/P, were invited by JICA official mission for training in Japan for about 3 weeks during July - August 2004. The training program was prepared with due attention to their positions in their organizations; i.e., technical area and management level, and also incorporating the requests from the 2 C/Ps.

In Japan, opportunities of visits to various SWM facilities were arranged, including those for collection/transportation, incineration, recycling, environment-friendly landfill, and industrial waste treatment. Members of JICA actively conducted lectures on various items of MSWM including the legal and institutional framework for SWM in Japan, practices/experiences in other developing countries, and industrial waste management. The Study Team also provided lectures on methods for the M/P formulation and collection/transportation systems.

CHAPTER 3 EVALUATION OF ACHIEVEMENTS OF CAPACITY DEVELOPMENT PROGRAM

3.1 Evaluation of Achievements by the Individual Cuban Counterparts

The degree of capacity development of the 10 C/Ps achieved through the CDP was evaluated based on the capacity development records of the respective C/Ps. Among the items contained in the records, the main items of evaluation were: (i) degree of attainment of CDP targets initially set forth for each individual, (ii) degree of participation and contribution to the Study, and (iii) contents of technology actually transferred. The evaluation was made following the process described in the earlier Subsection 1.3.2.

Of the 10 C/Ps, one was evaluated as “Excellent”, 7 as “Good”, and 2 as “Fair”. None were evaluated as “Not sufficient”. Nine C/Ps expressed their intention to continue the similar effort in their current job and utilize the knowledge and experience they had obtained. One C/P was to be transferred from the City to a planning ministry as a specialist, so the knowledge and experience he gained would be utilized for the work at the ministry level. As a whole, achievement of capacity development of the 10 C/Ps was evaluated as fairly satisfactory.

3.2 Evaluation of Achievements by Counterpart Group

Six of the 10 C/Ps were assigned from the DPSC and the other 4 from CITMA. The targets of the CDP were set for each of the 2 groups. The evaluation results by target items are shown in Table 5.3.1. The degree of achievement of the targets was evaluated as either ‘A: Excellent’ or ‘B: Good’. In general, it was evaluated that the targets set forth initially were satisfactorily achieved.

Table 5.3.1 Evaluation of Capacity Development by C/P Group

Target of CDP	Result of Evaluation		
	Self-evaluation*	Objective Evaluation	
		Study Team	Evaluation Committee
DPSC Group:			
Upgrading of the management capacity for MSWM	A	B	B
Strengthening of the basic knowledge of environment-friendly MSWM	B	A	A
Acquiring the capacity for planning, design and operation and maintenance of environment-friendly landfills	A	B	B
Acquiring the planning capacity for efficient collection and transportation	A	B	B
Acquiring the planning capacity for segregated collection	B	B	B
Acquiring the planning capacity for middle and long term planning of MSWM	B	B	B
Acquiring the basic knowledge of the 3Rs	B	A	A
Overall	B	B	B
CITMA Group:			
Capacity development for establishing legal system to enable environment-friendly MSWM	B	B	B
Capacity development for the promotion of research and implementation of the 3Rs	A	A	A
Capacity development for working out an environment-friendly technology for landfills suitable to Cuba	B	B	B
Capacity development for working out the criteria for the establishment of environment-friendly landfills	B	A	A
Capacity development for working out the criteria for the leachate treatment	B	B	B
Overall	B	B	B

Note: * The DPSC group was evaluated by the Chief C/P (personnel of DPSC) and the CITMA group by the Vice Chief C/P (personnel of CITMA)

As evaluated in the table, the CDP appeared to have contributed to developing the knowledge and management ability of each group in the various aspects of environment-friendly MSWM. It should be noted that the PLP for environment-friendly MSWM was planned and implemented under the initiative of the Cuban C/P groups.

It is noteworthy that the 2 groups collaborated well; the DPSC group fulfilled the responsibility for operational aspects while the CITMA group contributed to the environmental monitoring and awareness-raising. The PLP, though small in scale, is regarded as a forerunner of future environment-friendly MSWM. The experience obtained through PLP implementation is considered to be a valuable step towards the implementation of full-scale environment-friendly MSWM in the future.

Further, the 2 groups, either separately or in collaboration, gave presentations of the Study outputs at various workshops and community meetings. They also played the role of facilitators in the workshops. These experiences will also be useful in conducting the various communications required for implementing environment-friendly MSWM in Havana City.