

5.10 Final Disposal Plan

5.10.1 Planning Policy

The aim of solid waste disposal was defined historically as being to remove solid waste immediately from the urban community to reduce the risk of hygiene related and environmental problems for the community. Nowadays, however, it can be said that it has been redefined by intending a more positive contribution to environmental conservation. According to the JICA Study Team, for example, the “planning and design guideline for construction of land disposal sites (Japan Waste Management Association, 1989, 2000)”, Japan, defines the aim of solid waste disposal as “to store solid waste properly by means that do not cause obstruction to the living environment and to stabilize and defuse the solid waste by utilizing natural metabolic functions”.

A final disposal plan is closely related to an efficient collection/transport plan and also to an intermediate treatment plan to reduce the amount of waste to be disposed of, extend the life of landfills and reduce the risk of hygiene related and environmental problems for the community. There are two major components of the final disposal plan, namely, closure of existing landfills and establishment of new landfills.

In preparing the closure plan for the landfills, the following policies were mainly considered:

- To estimate the remaining years of life of each existing landfill
- To propose a closure procedure, taking account of measures for reducing the risk of hygiene related and environmental problems, the financial situation and level of technology within the organization responsible for MSWM, and also land use after the stabilization of reclaimed land.

In preparing the construction plan for new landfills, the following policies were mainly considered:

- To estimate the area necessary for landfills at least until 2015
- To propose structural and disposal plans, based on type, form and composition of MSW, regional geological, hydrological and climate conditions, along with reducing the risk of hygiene related and environmental problems, and also considering the financial situation and the level of technology within the organization responsible for MSWM.

5.10.2 Estimation of the Remaining Capacity of Existing Landfill Sites

Although there is no reliable data available relating to the remaining capacity of each existing landfill, the life of each existing landfill was roughly estimated as shown in Table 5.10.1.

Table 5.10.1 Rough Estimation of Life of Existing Landfills, assuming insufficient heavy equipment and cover soil

Landfill	Classification	In 2004		Area (ha)	Average height (m)	Total volume (m ³)	Available factor for landfill	Effective volume (m ³)	Starting year	Average before Y2004				Reduction rate by recycle, reuse, composting	Average after Y2004			
		Hauled volume (m ³ /day)	Bulk density (ton/m ³)							Hauled volume (m ³ /day)	Compacted bulk density (ton/m ³)	Accumulated Compacted waste (m ³)	Remained Volume (m ³)		Hauled volume (m ³ /year)	Bulk density at landfill (m ³)	Volume at landfill (m ³ /year)	Remained Life (year)
Calle 100	Provincial	3,857	0.39	80	20	16,000,000	0.80	12,800,000	1976	2,893	1.0	11,580,000	1,220,000	6.2	1,320,000	0.80	646,000	1.9
Guanabacoa	Provincial	1,145	0.31	28	20	5,600,000	0.70	3,920,000	1976	858	1.0	2,678,000	1,242,000	10.0	376,000	0.75	153,000	8.1
Ocho Vias	Provincial	1,363	0.24	30	21	6,300,000	0.75	4,725,000	1976	1,022	1.0	2,515,000	2,210,000	0.0	497,000	0.70	171,000	12.9
Barreras	Municipal	196	0.24	10	8	800,000	0.90	720,000	1975	147	1.0	371,000	349,000	0.0	72,000	0.75	23,000	15.2
Electrico	SPL	25	0.11	0.5	7	35,000	0.95	33,250	1990	21	0.60	21,000	12,250	0.0	9,000	0.50	2,000	6.1
Fraternidad	SPL	45	0.10	2	3	60,000	0.95	57,000	1990	38	0.60	33,000	24,000	0.0	16,000	0.50	3,000	8.0
Guansimas	SPL	21	0.10	2	1.5	30,000	0.95	28,500	1990	18	0.60	15,000	13,500	0.0	8,000	0.50	2,000	6.8
Lugardita	SPL	43	0.10	1.5	3	45,000	0.95	42,750	1990	36	0.60	31,000	11,750	0.0	16,000	0.50	3,000	3.9
P.Latina	SPL	91	0.15	2	7	140,000	0.95	133,000	1990	77	0.60	97,000	36,000	0.0	33,000	0.50	10,000	3.6
Rincon	SPL	49	0.10	0.5	10	50,000	0.95	47,500	1990	42	0.60	36,000	11,500	0.0	18,000	0.50	4,000	2.9
Las Canas	SPL	26	0.10	1	3	30,000	0.95	28,500	1990	22	0.60	19,000	9,500	0.0	9,000	0.50	2,000	4.8
El Vidrio	SPL	119	0.10	2.5	5	125,000	0.95	118,750	1990	101	0.60	86,000	32,750	0.0	44,000	0.50	9,000	3.6
Los Perros	SPL	184	0.16	2	15	300,000	0.95	285,000	1990	157	0.60	216,000	69,000	0.0	67,000	0.60	18,000	3.8
Campo Florido	SPL	9.1	0.10	1.8	0.5	9,000	0.95	8,550	1990	7.8	0.60	7,000	1,550	0.0	3,300	0.50	1,000	2

5.10.3 Closure Plan for the Existing Landfills

As seen in Table 5.10.1, the majority of existing landfills have a remaining service life of less than several years and will have to be closed sometime before 2015. It is noted that, even though the special period landfills still have remaining capacity, three of the ten special period landfills (Electrico, Fraternidad and Guasmas) and Guanabacoa provincial landfill have already been closed because of the complaints from the neighboring residents about hygiene and environmental problems. As the existing Guanabacoa landfill site was closed in March 2005, waste that used to be hauled to Guanabacoa is to be hauled to Ocho Vias and Campo Florido from 2005 to 2008. The closing year of each existing landfill is shown in the previous Table 5.6.4.

Closures are generally planned according to a city's land-use M/P and topographic and geological data of all existing landfills, but in this instance there is no topographic or geological data and no land-use M/P. Therefore, the concept of a closing plan for the existing landfills was proposed under the assumption that they will be flat and be used as parks after stabilization of the land.

The concept of closure works consists of:

- Ensuring the total thickness of cover layers is 60 cm. According to Article 6.12.2 of Norma Cubana Obiligatoria 135, 2002, soil cover shall consist of a 30 cm thick clay layer for prevention of rain water ingress into the waste layer and resulting leachate into the ground and a 30 cm thick final cover layer for vegetation.
- Installation of gas vents with 30 m pitch to promote decomposition of organic matter in the reclaimed waste layer
- Preparation of the reclaimed waste layer and provision of drainage for rain water outside the reclaimed waste layer
- Environmental monitoring of surrounding areas and evaluation of the results.

Existing landfills have high potential for redevelopment in the future because they are located near residential areas. In case of redevelopment, effective and appropriate measures should be taken considering that they once were used as landfills. With time, the fact that they once were used as landfills tends to be forgotten and inappropriate excavation may be carried out. Therefore, topographic and geological surveys for each existing landfill should be carried out immediately in order to ensure that the exact boundaries of the reclaimed land are permanently recorded for land use records.

(1) Plan and execution of closure works

From the results of environmental monitoring of surrounding areas and topographic and geological surveys for each existing landfill site, specific closure work focusing on safety and environmental preservation of the reclaimed land for each landfill should be planned and executed along with consideration of the

financial aspects of the City. Installation of gas vents is a must to avoid explosions from the gasses produced in the reclaimed land.

(2) Continual environmental monitoring

Stabilization of the reclaimed land is said to need at least five to ten years. Therefore, continual environmental monitoring of the gas composition such as CH₄, H₂S, NH₃, CO, CO₂ and O₂ and their levels are necessary in order to ensure the safety of land redevelopment.

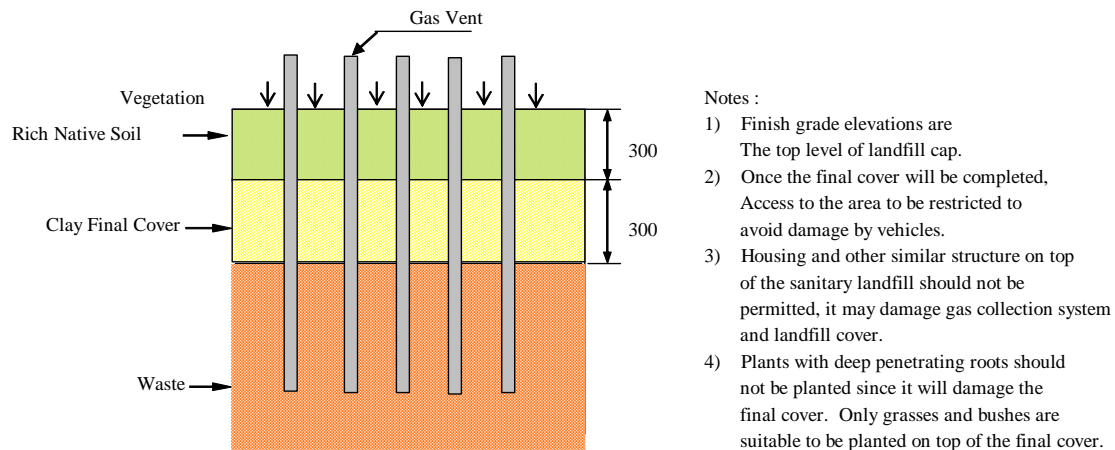


Figure 5.10.1 Structure of Closure Work

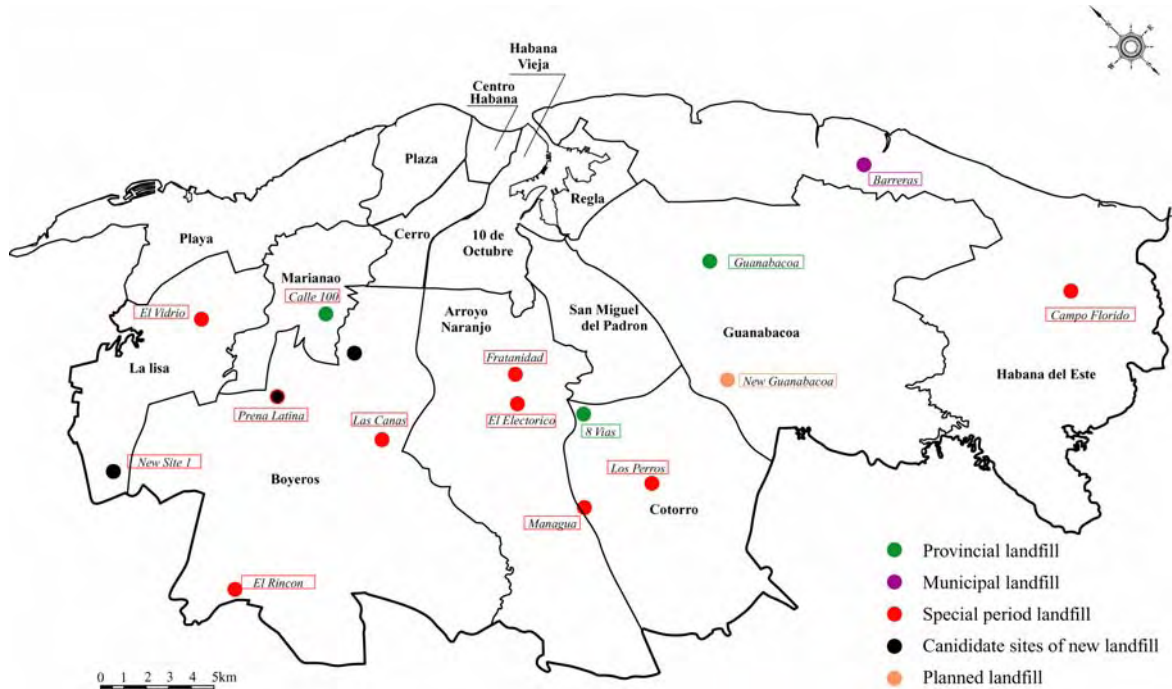
5.10.4 Development Plan for New Landfills

(1) Necessity for two main landfills

For the future landfill plan after closing the special period landfills, DPSC has a plan to divide the city into two areas, the eastern and western areas, and establish one large sanitary or environmentally friendly final disposal site in each area. One is New Guanabacoa in the eastern part and the other New Site 1 in the western part as shown in Figure 5.10.2.

- As described above, Guanabacoa landfill was closed in March 2005 although it still had remaining capacity. The waste that was hauled to Guanabacoa is now being hauled to Ocho Vias and Campo Florido. However, the combined landfill volume of these two landfills is not enough to accept all waste continually till 2015.
- Therefore, a new final disposal site instead of Guanabacoa for the eastern part of the City is urgently needed. This is called the New Guanabacoa landfill.
- As for the western part of the City, Calle 100 still has 24 ha for expansion. Its life is estimated as 4 years if its operation is carried on as a sanitary landfill. After that, a new final disposal site, called New Site 1, is necessary for the eastern part of the City.
- Land acquisition for New Guanabacoa and the expansion of Calle 100 is already completed, but they are currently only at the planning and conceptual design work stage.

- The location of New Site 1 landfill has not been fixed, although the City is studying three candidate sites. The location of candidate sites is shown in Figure 5.10.2 and the outlined features of each site are described in Table 5.10.2.



Information source: DPPF

Figure 5.10.2 Candidates for New Landfill Sites

Table 5.10.2 Outline of Candidates for New Site 1

Candidate	Location	Access	Land use	Topographical Condition	Surrounding environment	Expected area (ha)	Remarks
1	Boyeros	Very Good	Orchard	Flat	Near Residential area	80 ha	Strong opposition from IT college nearby
2	Boyeros (Prensa latina)	Good	Special period dumping site	Flat	Near Residential area	30 ha	Expansion of existing special period dumping site, border of water source preservation area
3	Boyeros	Good	Sugar cane	Flat	Not so many residents	30 - 40 ha	Permission from Ministry of Agriculture is necessary

The neighboring residents' perceptions of a final disposal site often pose a difficulty with land acquisition. Those perceptions are as follows:

- Natural combustion, bad smell, and dust due to open dumping
- Concerns for the pollution of the natural environment and water resources due to lack of liner systems, leachate collection and treatment systems, and gas vent systems.

Therefore, the following should be taken into account in the implementation:

- Plan of environmentally friendly landfills
The city should explain to the neighboring residents that the City intends to construct environmentally friendly landfills to cope with environmental and hygiene concerns as much as possible.
- Introduction of quantitative and scientific EIA
Looking at the current EIA, it seems that qualitative descriptions are employed a lot and there is insufficient quantitative description and analysis. More scientific and quantitative study is necessary to persuade and reach an agreement with the residents.
- Easing the regulation for landfill sites
The regulation says that landfill sites should be 500 m away from residential areas. Under this regulation, finding landfill sites is becoming more difficult. Construction of a sanitary landfill with environmental and hygiene considerations by applying a more scientific and quantitative EIA will ease the required set back distance.
- Investing incentive
The city can demonstrate effective land use after closure of the landfills by construction of the likes of parks, community centers, sports centers and so on. The City could give direct financial support to the municipality or promote employment from the neighboring areas.

(2) Specifications of landfill area

Considering the required capacity of final disposal sites, the specifications of landfill areas were estimated as shown in Table 5.10.3.

Table 5.10.3 Specifications of Landfill Areas

Calle 100 (Expansion)	First section	Second section
Area of cell (m ²)	560	560
Total number of cells in flat area	180	150
Total area (m ²)	100,800	84,000
Required area (m ²)	100,000	80,000
Average height of cell (m)	1.75	1.75
Number of cells in vertical direction	10	10
Total height of cells (m)	17.5	17.5
Total volume of waste layer with cover soil (m ³)	1,764,000	1,470,000
Required volume for landfill (m ³)	1,750,000	1,400,000
Dimension of cells	560m ² x 180 x 1.75mH x 10	560m ² x 150 x 1.75mH x 10

New Site 1	First stage until Y2013	Second stage until Y 2015
Area of cell (m ²)	560	560
Total number of cells in flat area	240	150
Total area (m ²)	134,000	84,000
Required area (m ²)	121,000	76,000
Average height of cell (m)	1.75	1.75
Number of cells in vertical direction	10	10
Total height of cells (m)	17.5	17.5
Total volume of waste layer with cover soil (m ³)	235,000	1,470,000
Required volume for landfill (m ³)	2,275,000	1,400,000
Dimension of cells	560m ² x 240 x 1.75mH x 10	560m ² x 150 x 1.75mH x 10

New Guanabacoa	First stage until Y2011	Second stage until Y 2015
Area of cell (m ²)	135	135
Total number of cells in flat area	450	300
Total area (m ²)	60,700	40,500
Required area (m ²)	60,000	40,000
Average height of cell (m)	1.75	1.75
Number of cells in vertical direction	8	8
Total height of cells (m)	14	14
Total volume of waste layer with cover soil (m ³)	850,000	567,000
Required volume for landfill (m ³)	840,000	560,000
Dimension of cells	135m ² x 450 x 1.75mH x 8	135m ² x 300 x 1.75mH x 8

5.10.5 Classes of Final Disposal Sites

(1) Landfill type

Landfill types are classified into four levels according to structure and disposal method. They are summarized in Table 5.10.4.

Detail general description of landfill systems are also shown in the Data Book of the Final Report of the JICA Study.

Table 5.10.4 Structure and Disposal Method by Landfill Level

Items	Landfill Level			
	Level 1	Level 2	level 3	Level 4
Final Disposal Method	Controlled tipping with introduction of cover soil	Sanitary landfill with a dike and sufficient daily cover soil	Level 2 +primary leachate circulation system	Level 3 + Leachate treatment system

Table 5.10.5 Necessary Civil Works by Landfill Level

Items	Landfill Level				Remarks
	Level 1	Level 2	Level 3	Level 4	
1 Site Development					
1.1 Main facilities					
a. Enclosing structures					
Enclosing dikes		A	A	A	
Dividers		B	A	A	B requires a dike made of waste and soil
b. Drainage System					
Surrounding drains		A	A	A	
On-site drains (surface rain water)		A	A	A	
On-site drains (spring)		A	A	A	If necessary
Drains for reclaimed area		A	A	A	

Items	Landfill Level				Remarks
	Level 1	Level 2	Level 3	Level 4	
c. Access					
Approach roads	A	A	A	A	
On-site roads	A	A	A	A	
Others	A	A	A	A	Improvement of existing road network to access the sites
1.2 Environmental Protection Facilities					
Buffer zones		A	A	A	
Litter control facilities		B	A	A	Movable fence, etc.
Gas removal facilities		B	A	A	
Leachate collection facilities			A	A	
Leachate circulation facilities			A	A	
Seepage control facilities			B	A	
Leachate treatment facilities				A	
1.3 Buildings and Accessories					
Site office	B	A	A	A	
Truck scales	A	A	A	A	
Store			A	A	
Safety facilities		A	A	A	Gate, fence, lights, etc.
Fire prevention facilities		B	A	A	Water tank, extinguisher, etc.
Monitoring facilities			A	A	Monitoring well, etc.
Car washer			A	A	

Note: A: necessary

B: necessary under certain conditions, or may be omitted when budget is limited

Table 5.10.6 shows a comparison of construction cost and environmental protection for each landfill level together with the main conceivable countermeasures.

Table 5.10.6 Comparison of Construction Cost and Environmental Protection Level of Landfill Level

		Level 1	Level 2	Level 3	Level 4	Main counter measures					
Construction Cost	million peso	1.47	4.17	7.00	7.40	Drainage system	Sufficient cover soil	Buffer Zone	Safety facilities	Leachate collection system	Leachate treatment system
	Ratio of the cost	1	2.8	4.74	5.02						
Environmental Protection level	Surface water pollution	×	○	○	○	⊙	○				
	Groundwater pollution	×	△	○	○	○	○				
	Breeding of insects and rodents	×	○	○	○		⊙				
	Littering of wastes	×	△	△	△		○	○			
	Outbreak of Fire	×	△	○	○		⊙		○		
	Odor	×	△	△	△		○	○	○		
	Dust	×	△	△	△			○	○		
	Unpleasant view of landfill	×	○	○	○			⊙	○		
	Noise	×	△	△	△			⊙			
Leachate pollution	×	×	△	○	○				○	⊙	

Remarks ○: Fair Improvement

△: Improvement

×: Poor Improvement

Remarks ⊙: Great contribution to environmental protection

○: Good contribution to environmental protection

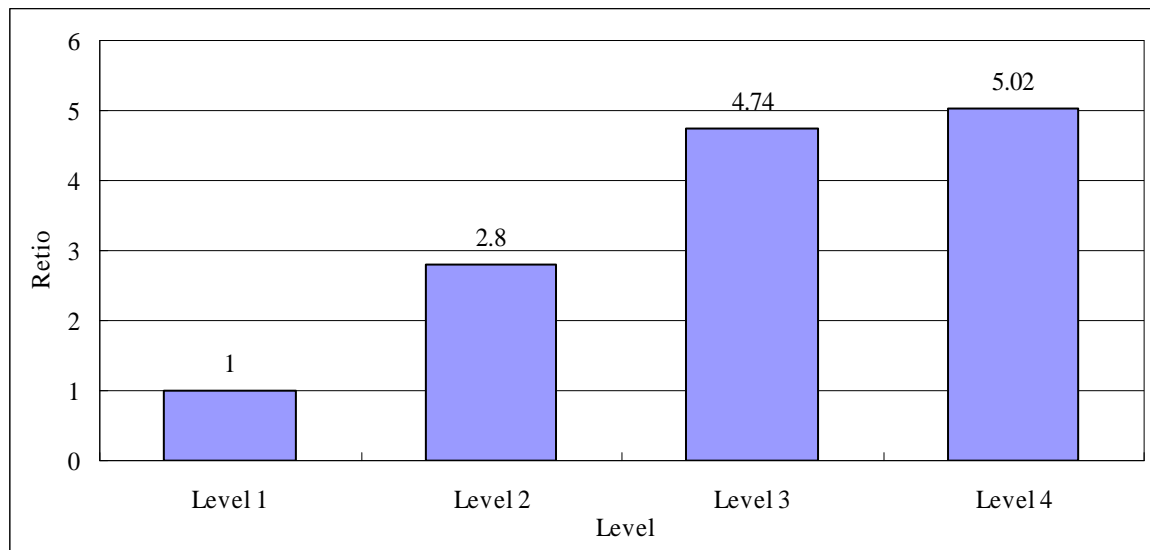


Figure 5.10.3 Cost Comparison by Landfill Level (in the case of New Guanabacoa)

Seeing the cost difference among the respective landfill levels, the following are noted:

- The construction cost of Level 2 is 2.8 times higher than that of Level 1.
- There is little difference in construction cost between Levels 3 and 4. The difference comes from the leachate pond volume. Level 3 has only one pond for storing leachate for recirculating it to the landfill site, while Level 4 has three ponds for leachate treatment.
- There is also a relatively large difference between Level 2 and 3. This is because Level 3 needs a liner system.

In addition, the following are noted from an environmental point of view:

- With provision of daily soil covering and most facilities needed for sanitary landfill, Level 2 can prevent or reduce the outbreak of fire, surface water pollution, breeding of insects such as flies and mosquitoes, littering of waste, and odor, most of which are the main complaints from neighboring residents. However the concern of water pollution from the leachate still remains.
- The difference between Level 3 and Level 4 is whether it has a leachate treatment facility or not, the former without the facility and the latter with the facility.
- Level 3 has only a leachate recirculation pump, but no leachate treatment facility. During the dry season, leachate is recirculated to the landfill site and has little chance of flowing out to the environment due to the low rate of leachate generation and its evaporation during recirculation of the leachate to the landfill site. However, in the rainy season, leachate flows out to the environment without treatment.
- Level 4 has a leachate treatment facility to mitigate the pollution risk when the leachate is discharged into the surrounding environment.

Level 4 should be adopted for New Guanabacoa and New Site 1 and Level 3 for the extension of Calle 100 because its life is expected to be shorter than the other two.

In case the DPSC faces difficulty in financing the Level 3 and/or Level 4 types, however, an alternative solution will be the choice of Level 1 or Level 2 type for the three landfills. Level 1 and 2 will also be effective for reducing most complaints from nearby residents, such as those relating to waste scattering, odor, insects, and spontaneous combustion, provided soil covering is conducted properly.

(2) Estimation of leachate generation

Leachate generation volume was estimated with the following equation:

$$Q = C/1000 * I * A$$

where:

Q: Leachate volume (m³/day)

C: Leachate coefficient (determined in consideration of topography of landfill area, vegetation, etc.)

I: Rainfall intensity (mm/day) (storm recurrence interval of 10 to 15 years)

A: Landfill area (ha)

The leachate coefficient C is greatly influenced by land surface conditions. In this Study, C = 0.4 was adopted considering the absorption of rain in the cover soil and evaporation during the time lag of rain water seeping into the soil and waste layer. The data of rainfall intensity, I, is not available for the field survey period of the JICA Study Team from 2004 to 2005. Therefore, it was obtained from the available precipitation records during 2000 to 2002 for Havana city and assumed it to be 11.3 mm/day, which is the average daily value of the month of greatest precipitation, 338 mm in September 2002

For finalization of leachate volume, Q, a safety factor of 1.6 was taken into account.

Table 5.10.7 shows the calculation result of leachate generation at Calle 100 Extension, New Site 1 and New Guanabacoa landfills, for each development (ref. Table 5.10.3)

Table 5.10.7 Estimated Leachate Generation (m³/day)

Final Disposal site	First Stage	Second Stage
Calle 100 extension	730	610
New site 1	970	610
New Guanabacoa	440	290

Note: Refer to Table 5.10.3 for definition of First Stage and Second Stage

Due to the land limitations at New Guanabacoa, no leachate regulating reservoir will be constructed. The priorities in land allocation are higher for the waste

dumping area and leachate treatment ponds than for the leachate regulating reservoir. When rainfall is high during the hurricane season, increased leachate will be recirculated and stored in the landfill area. This temporary storage may raise the risk for infiltration of leachate into the ground under the liner sheet, but the risk would be tolerable for Havana City in view of the construction cost of a large reservoir, in addition to consideration to securing a long life span for the landfills as much as possible while achieving appropriate treatment of the leachate.

(3) Level of leachate treatment

To plan a leachate treatment system, standard values of leachate and leachate discharge quality are necessary. However, there is no leachate discharge standard in Cuba at present.

On the other hand, there is a standard for industrial wastewater in terms of T-BOD₅, COD, SS (Suspended Solid), T-N and T-P and EC (electric conductivity). As a substitute for a leachate standard, the industrial wastewater standards were applied as a reference to decide the most suitable leachate treatment system.

Table 5.10.8 shows the estimated leachate quality, industrial wastewater discharge criteria, and the required removal rates to meet the criteria.

Table 5.10.8 Parameters and Required Removal Rates for Adopting Industrial Wastewater Discharge Criteria to Leachate Discharge

Parameter	Unit	Estimated Leachate Quality	Industrial Wastewater Criteria*	Required Removal Rate (%)
T-BOD ₅	mg/L	920	60	94
COD	mg/L	1,700	120	93
SS	mg/L	540	5	100
T-N	mg/L	540	20	97
T-P	mg/L	64	10	85
EC	μ S/cm	9,500	3,500	64

Note: *Criteria for industrial wastewater discharged to public water body, corresponding to Class of River and Dams in NC27 (Table 3.8.4)

The required removal rates was evaluated to determine the leachate treatment system to be adopted. The results are as follows:

- To lower the EC to the level of the industrial wastewater discharge criterion, a high class physical-chemical treatment system such as the RO (reverse osmosis) or NF (nano-filtration) system is necessary. These systems are costly and need highly experienced technicians. This parameter was eliminated from inclusion in the guideline.
- To satisfy the SS level of the industrial wastewater discharge criterion of 5 mg/L, a high class physical-chemical treatment system such as an MF (micro-filtration) system is necessary. This system is also costly and needs highly experienced technicians. Regardless of whether this criterion is met in

industrial wastewater, reduction to the level of 5 mg/L is not realistic comparing with the target level of T-BOD₅ being 60 mg/L. Therefore, the target level of reduction of SS is set to be 70 mg/L. (Removal rate of SS is 87 %)

- As for T-BOD₅, it is impossible to achieve 60 mg/L-T-BOD₅ without solid-liquid separation such as sedimentation tanks or maturation ponds.
- As for T-N, T-P and COD, a biological treatment system alone (including the pond system proposed in this Study) cannot reduce the pollutant load to a level meeting the industrial wastewater discharge criteria. If reduction to such a level were required, a physical-chemical treatment system such as chemical oxidation and coagulation to remove COD or T-P and another biological treatment to remove T-N would be needed. However, the facilities are costly and the operation would need highly experienced technicians.

Reviewing these aspects, the targeted parameters are set for T-BOD₅ and SS and target levels are 60 mg/L and 70 mg/L, respectively, as the tentative guideline to be applied for the moment. In the future, however, it is important to consider the installation of a more sophisticated treatment system having the capacity to remove more pollutants.

(4) Leachate treatment system

There are two types of leachate treatment system, treatment plant system and pond system.

In this M/P, the pond system was adopted for leachate treatment for financial and technical reasons. If leachate is treated continuously in a treatment plant that uses the activated sludge process, a leachate regulating reservoir is required, increasing the total cost. On the other hand the pond itself can be considered as a leachate regulating reservoir and treatment plant. Therefore, the pond needs to have sufficient volume to cope with large fluctuations in leachate flow and to treat organic matter to achieve the target level of BOD₅.

Six alternatives for the leachate treatment system were studied as shown in Figure 5.10.4.

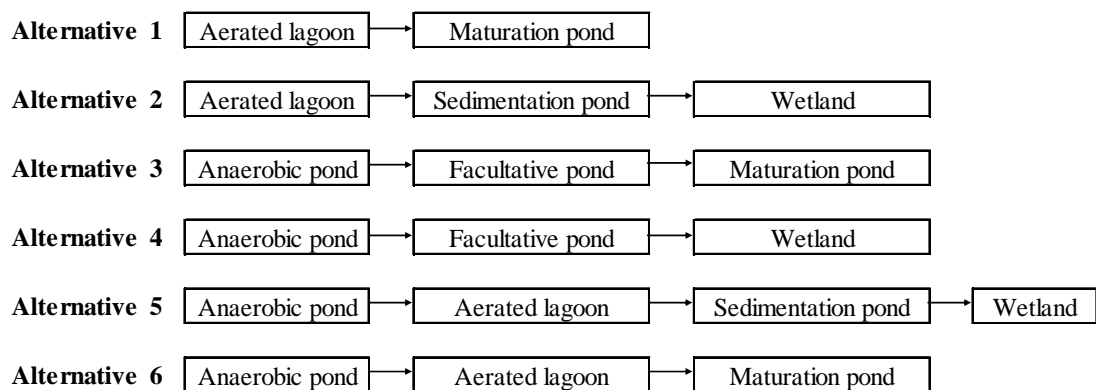


Figure 5.10.4 Alternatives of Leachate Treatment System

The comparison of alternatives is shown in Tables 5.10.9 and 5.10.10.

Table 5.10.9 Comparison of Alternative Leachate Treatment Systems

Unit of Cost : Thousand US\$

Alternatives	Const- ruction Cost	Procurement Cost of Heavy Equipment	O/M Cost	Total cost	Cost Evaluation	Easiness of O/M	Water Quality	Conclusive Evaluation	Remarks
1	525	457	25.8	1,008	5	△	△	6	
2	519	455	26.4	1,000	4	△	○	5	Need test
3	981	42.2	3.9	1,027	6	○	○	3	
4	985	44.4	4.0	1,033	7	○	△	7	Need test
5	622	295.1	17.6	933	2	△	⊙	4	Need test
6	598	295.8	17.2	911	1	△	○	1	
3-(2)	981	17.9	0.6	999	3	⊙	○	2	without recirculation pump

Note: 1) In all cases, a leachate recirculation pump is included, except 3-(2).

2) Evaluation of water quality is based on Table 5.10.8 including T-N, T-P and COD.

3) Total cost represents the cost for New Guanabacoa incurred during the M/P period.

Table 5.10.10 Treatment System and Expected Performance⁶

Alternatives	Parameters				
	T-BOD ₅	COD	SS	N	P
1	○	△	○	△	△
2	⊙	△	⊙	⊙	○
3	○	○	○	○	⊙
4	△	○	△	△	△
5	⊙	○	⊙	⊙	○
6	○	○	○	○	⊙
3-(2)	○	○	○	○	○

⊙ : confidently expected, ○ : moderately expected, △ : partly expected, × : almost not expected

Expected performance with T-BOD₅, T-N and T-P is based on Table 5.10.11.

Table 5.10.11 Treatment System and Expected Removal Rate

Treatment System	Parameter	Removal rate (%)
Aerated lagoon with sedimentation	T-BOD ₅	95
	T-N	Not expected
	T-P	Not expected
Maturation pond with facultative pond	T-BOD ₅	95
	T-N	80
	T-P	70
Wetland (SFS)* after facultative pond	T-BOD ₅	73
	SS	70
	T-N	90
	T-P	60
Wetland (Floating duckweed)* after facultative pond	T-BOD ₅	75
	SS	80
	T-N	85
	T-P	50 to 60

Note: * Estimation

In general, wetland systems seem to be slightly superior to natural pond systems supplemented by a facultative pond for the removal rate of T-N, but seem to be

⁶ Information for leachate treatment in this section is summarized by the JICA Study Team from various sources listed in the Data Book of the Final Report of the JICA Study

inferior to pond systems in the removal rate of T-P. Removal rates of T-N and T-P by wetlands depend on species, system, and distance of plantation. They should be determined by experiments in a pilot scale site. At this time, adoption of a wetland system is not recommended. (Alternative 2, 4 and 5)

Considering the other three alternatives, Alternative 6 (Anaerobic pond + aerated lagoon + Maturation Pond) was concluded as the best option from the viewpoints of cost and removal of T-BOD₅ and SS. However, it is noted that Alternative 6 has a risk of being useless in the case of power failure, which often occurs in Cuba at present.

In this regard, Alternative 3 (Anaerobic Pond + Facultative Pond + Maturation Pond) was concluded as the second option from the viewpoints of advantages in water quality and ease of maintenance. The disadvantage of this system is that it is a little costly because it needs huge liner sheets. If the ground consists of impermeable clay, the cost will be reduced.

The parameters and levels of removal and treatment systems proposed here are tentative due to the lack of experience. They should be re-checked through operation and continuous monitoring and be adjusted/modified according to the results.

Notwithstanding the adoption of two parameters (T-BOD₅ and SS) in the above analysis, the monitoring and assessment of other parameters are also required in the actual operation of landfill. Other parameters relevant to human health include heavy metals, ammonia and total nitrogen, which shall all be monitored carefully.

5.10.6 Liner Facility

A liner facility is very important to prevent the pollution of public water areas and/or underground water by leachate and to mitigate adverse impact of such pollution to surrounding areas.

(1) Type of liner facility

There are no detailed topographical, geological and hydrological or soil data for the New Guanabacoa landfill site for use in selecting the type of liner facility or whether to choose a vertical or surface liner. However, considering the existing data that shows that there must be a high water level in some areas of the site, a surface liner system was considered for the New Guanabacoa landfill site. As for New Site 1, the location is not determined yet, therefore a surface liner facility is considered for it as well as for the New Guanabacoa for cost estimation as a reference.

(2) Liner sheet

An artificial membrane liner sheet is adopted for the New Guanabacoa landfill site because natural clay for the liner with the required water permeability of less than 10^{-5} cm/sec has not yet been identified in Havana City. Furthermore, using a membrane sheet as a liner is now common in many Latin American countries.

The concepts of liner designs can be considered not only for the landfill area but also for the leachate treatment ponds.

1) Membrane liner system

There are many membrane liner systems with materials such as rubber, PVC and HDPE. Here in the M/P, HDPE, which is widely used in other parts of the world, is considered for the system as shown in Figure 5.10.5.

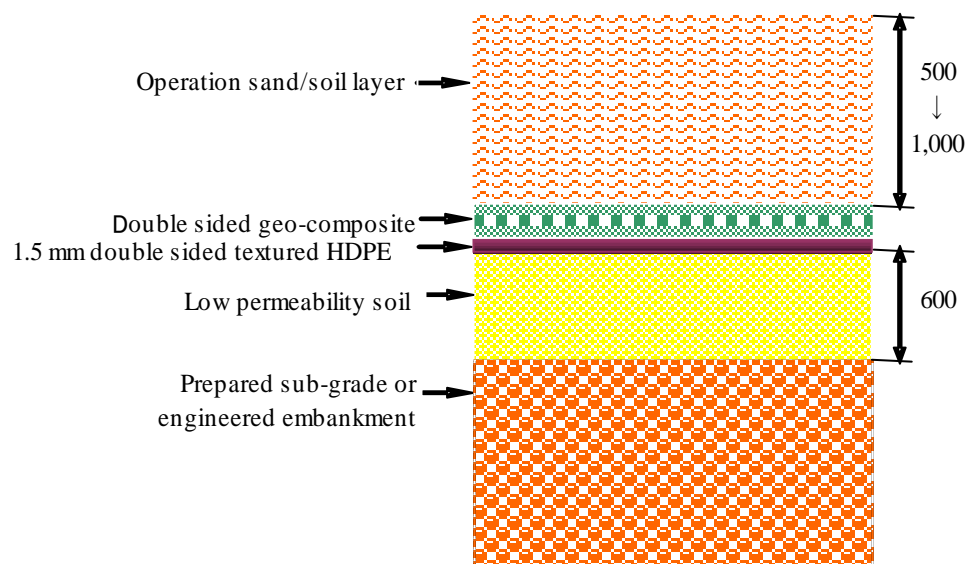


Figure 5.10.5 Composition of HDPE Sheet Liner System (Bottom)

The membrane sheet liner system is composed of an underlying 60 cm layer of compacted low permeability soil with a 1.5 mm HDPE geo-membrane. The composite of soil and geo-membrane results in a liner system that has a much lower leakage potential than either material alone. In areas that have the potential for high groundwater, an under-drain trench filled with gravel around a pipe will be installed. This will prevent rising groundwater, so that pore pressures do not build up under the liner.

The liner system will be built in stages by jointing together as the landfill area expands. In the design of geo-synthetic liners, international standards shall be duly taken into account to assure the qualities of material properties, manufacturing and construction method, and testing procedures.

2) Clay liner

In the event that clay is used, even though it is difficult to find within and near Havana City, the clay layer has a minimum thickness of 0.75 m and the clay material should have a permeability of 1.0×10^{-6} cm/sec or less.

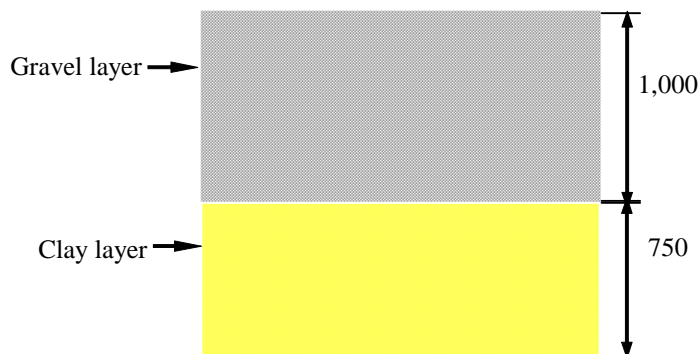


Figure 5.10.6 Composition of Clay Liner System (Bottom)

5.10.7 Operation of Landfill

For the operation of the landfill, “land-filling work” means the whole series of works from delivery of solid wastes into the landfill site, spreading and mixing the waste, applying the final cover soil, and all related temporary measures. A detailed description of the landfill works described below is provided in Supporting Report C1 of the Final Report of the JICA Study:

(1) Order of land-fill process

There are two methods of carrying out the landfill operation, namely, landfill from upstream down or landfill from downstream up.

For the New Guanabacoa landfill, Calle 100 Extension and New Site 1 in this M/P, Land-filling from downstream up was adopted from the viewpoint of rain water control in the landfill area.

(2) Spreading/compacting method

There are two methods of spreading/compacting solid waste, namely “push up” and “push down” on the waste slope with a bulldozer or a loader.

The push up method was adopted because it is easy to make a uniform landfill layer. Compaction is also easy and preferable when the compaction layer has to be established as soon as possible.

(3) Cell construction

Cell construction is classified into the sandwich method, cell method and dumping method.

The cell method is adopted because it is suitable for preventing current problems such as fire outbreak and propagation, scattering of waste, offensive odor and harmful insect generation. The cell method was implemented along with the push up method in a pilot project (PLP) under the JICA Study in 2005.

The possibilities of alternative cover materials for daily cover soil are as follows:

- Use of waste construction materials (estimated at 240 tons/day)
- Use of a portion of the bulky waste (estimated at 260 tons/day)
- Use of a portion of the decomposed waste layers at existing landfill sites.

The following points need to be confirmed if decomposed waste is used:

- Stability of the land to be reclaimed
- Leachate test of soil to be reclaimed.

When waste disposal first began in the existing landfills, many kinds of waste, including hazardous waste, were mixed together for disposal. Therefore the decomposed waste should be checked for contamination with hazardous substances before it can be used as cover material.

Details of the survey items for closure works, improvement and the possibility of using cover soil from existing landfills are shown in Supporting Report C1 of the Final Report of the JICA Study.

(4) Cover soil

1) Necessary daily cover soil volume

The ratio of cover soil was planned at 20% of compacted waste. A 25 cm covering of soil over a daily compacted waste layer of 150 cm was proposed. Also the slope of the waste layer would be covered by soil.

2) Procurement of cover soil

Cover soil is the most fundamental element for an environment-friendly landfill. With cell construction by the cell method and proper cover soil, fire outbreak and propagation, waste littering, offensive odor and harmful insect generation are expected to be prevented. Considering the result of the PLP under the JICA Study in 2005, that only 16 m³ (20 tons) of cover soil was necessary every day, 537 m³ (698 tons) of cover soil will be necessary every day on average in the M/P.

(5) Necessary heavy equipment

Heavy equipment is essential for landfill operation.

Table 5.10.12 shows the necessary heavy equipment and its specifications.

Table 5.10.12 Necessary Heavy Equipment for Proper Landfill Operation

Name of Heavy Equipment	Specification	Purpose	Expansion of Calle 100 and New Site 1								
			Y2007	Y2008	Y2009	Y2010	Y2011	Y2012	Y2013	Y2014	Y2015
Bulldozers	228 Hp, 28 ton	Spreading, pushing and compaction of waste and cover soil	-	-	9	8	8	8	8	8	8
Wheel Loader	13.3 ton, 141 Hp, bucket volume 2.4 m ³	Excavation and loading of cover soil	-	-	1	1	1	1	1	1	1
Power Shovel	Bucket volume 0.8 m ³ , 145 Hp, 19.3 ton	Excavation and loading of cover soil	-	-	3	3	3	3	3	3	3
Dump Truck	8m ³ , 17.9 ton, 270Hp	Loading and delivery of cover soil	-	-	14	12	12	12	12	12	12
Water Tanker	10m ³ , with spray gun	Preventing dust	-	-	1	1	1	1	1	1	1
Truck scales	Maximum range: 50 tons	Measuring waste and cover soil weight	-	-	2	2	2	2	2	2	2

Name of Heavy Equipment	Specification	Purpose	New Guanabacoa								
			Y2007	Y2008	Y2009	Y2010	Y2011	Y2012	Y2013	Y2014	Y2015
Bulldozers	228 Hp, 28 ton	Spreading, pushing and compaction of waste and cover soil	-	-	2	2	2	2	2	2	2
Wheel Loader	13.3 ton, 141 Hp, bucket volume 2.4 m ³	Excavation and loading of cover soil	-	-	1	1	1	1	1	1	1
Power Shovel	Bucket volume 0.8 m ³ , 145 Hp, 19.3 ton	Excavation and loading of cover soil	-	-	1	1	1	1	1	1	1
Dump Truck	8m ³ , 17.9 ton, 270Hp	Loading and delivery of cover soil	-	-	3	3	3	3	3	3	3
Water Tanker	10m ³ , with spray gun	Preventing dust	-	-	1	1	1	1	1	1	1
Truck scales	Maximum range: 50 tons	Measuring waste and cover soil weight	-	-	2	2	2	2	2	2	2

Note: Above figures represent net number of required equipment without consideration of replacement and spares for emergency use.

(6) Environmental monitoring system

For environmental monitoring as one of the usual landfill operation, the following equipment is proposed:

- Portable gas monitoring equipment for generated CH₄, H₂S, CO and O₂ for laborers' safety.
- Portable water quality analyzer for leachate and surrounding water bodies. It can measure pH, DO (dissolved oxygen), temperature, EC (electric conductivity), and turbidity.
- Portable microscope for determining treated leachate quality.

Parameters of leachate, such as T-BOD₅, SS, T-N, COD, T-P and heavy metals and so on should be measured at reliable laboratories such as WAL. It is not necessary to install a water quality laboratory at each landfill site.

Water quality can be approximated by observing the species living in the water, including treated leachate. This would provide reference information to judge the environmental conditions, but a chemical analysis will still be necessary to confirm the quantitative level of each parameter.

5.10.8 Central Workshop for Landfill

In order to improve the capability for repair and maintenance of equipment, UPPH has constructed a central workshop for heavy equipment in Diez de Octubre Municipality. This workshop will function as the main facility in the subsequent period and hence shall be reinforced with provision of machines and equipment for repair and maintenance work. Reinforcement of staff and workers is also required.

The equipment list for general repairs and maintenance to be provided at the central workshop is shown in Table 5.10.13.

In addition to the repair and maintenance equipment for the central workshop, two units of mobile workshop (truck type) will also be provided to meet the needs of repair and daily maintenance of equipment at landfill sites. Of the two units, one is for Guanabacoa landfill and the other for Calle 100 Extension initially and New Site 1 subsequently. A list of equipment and tools to equip a mobile workshop is detailed in Table 5.10.14.

With the provision of the above equipment at workshops, most of the repair and maintenance can be handled at the workshops. In cases where special types of repair are required, they will be outsourced to the manufacturer's agent shop.

Table 5.10.13 List of Equipment for the Central Workshop for Landfill

No.	Name of Equipment	Specification	Workshop	
			Units	Kw/hr
1	AC Arc Welding Machine	Rated output 250 A/input 12.7 kw 220 V60hz, 75-250 A, 2.6-5.0 steel electrode	1	25.4
2	Air Compressor	360L/min, 14 kg/cm ² , 260 L Airtank, 3.7 kw 220 V/60 hz w/10m air hose	2	3.7
3	Oil – changer W/compressor	70 L –on tank, 5 kg/100 L – Mm All, suction capacity 12 L/min	1	0
4		17 L/min, 6kg/cm ² , 1.5kw 220/60hz w/10m air hose	1	1.5
5	Grease pump	Manual, 16 kg grease capacity	1	0
6	Battery charger	Input 110 V/60hz, output 18-24 V, charge 60 min, w/battery checker, 2.5 m cable	1	0.5
7	Battery tester (handy)	12 V, dynamo/battery	1	0
8	Tool Kits	Manual wrench for engine	2	0
9	Changer (1550)	Max size 1550 mmdia, width 700 mm, hub size 110 – 480 mmdia, oil motor 2.0 kw 220 V/60 hz, w/disc tool	1	2
10	Tires repair kit	Rubber/glue/tools	1	0
11	Jack (20 t manual)	Manual, 20t	2	0
12	Jack for transmissions	Manual 0.7 t	1	0
13	Extensio type jack	Manual 1t, 1000 mm long	1	0
14	Impact wrench	Air bolt size 14 mm, torque 30-300 N.m	1	0
15	Impact wrench	Air bolt size 20 mm, torque 150-650 N.m	1	0
16	Electric trolley chain block	Electric 3.0t, 4m-lifting, wind 3.4 m/min (3.75 kw), travel 12-24m/min (0.75 kw)	1	4.5
17	Car washer	20 L/min, 5km/cm ² , 0.5kw/110V w/hose and gun	1	0.5
18	Lathes	Semi-auto, C/C 1500 mm, 38kw 220 V/60hz	1	38
19	Radial Drilling	Manual, C/C 1000 mm, 2.1 kw 220/60hz	1	2.1
20	Horizontal surface finishing grinder	Manual, C/C 500mm, 10kw 220/60hz	1	10
21	Bench grinder	Manual, 255 mmdia, 1 kw 220/60hz	1	0.75
22	Electric Saw	Manual, horizontal, 25 mmdia, 3.5 kw 220/60hz	1	3.5
23	Electric cutter (handy)	Steel 1.6 mm, 0.5 kw, 110/60hz	1	0.5
24	Bench drilling machine	1-6.5 mmdia, 5000 rpm 1kw, 110/60hz	1	1
25	Electric drill (handy)	6.5 mmdia, 0.5 kw, 110/60hz	1	0.4
26	Electric drill (handy)	10mmdia, 2500 rpm 0.5 kw, 100/60hz	1	0.5
27	Electric grinder (handy)	180 mmdia, 5000 rpm 0.4, 100/60hz	1	0.5
28	Disc grinder (handy w/discs)	100 mmdia, 0.7 kw, 10,000 rpm, 110/60hz	1	0.7
TOTAL			31	96.1

From DPSC June 18 2005

Note: The above table lists machine tools required for repair and maintenance of heavy equipment mainly used at landfill sites. Some of the items are common to the items listed in Table 5.9.15 and 5.9.16 in Subsection 5.9.5.

Table 5.10.14 List of Equipment, Accessories and Main Tools in Mobile Workshops

No.	Equipment and Accessories	Specifications	No.	Main Tools	Specifications
1	Engine Generator	5.5 kVA	1	Hydraulic Jack	5 Ton
2	Air Compressor	5 HP	2	Oil Jack	15 ton
3	Bench Drill	25 mm	3	Socket Wrench Set	1/2"(6-32) and 3/8"(6-19)
4	Bench Vice	4"	4	Offset Wrench Set	6 pieces
5	Bench Grinder	205 Mm	5	Open Wrench Set	6 pieces
6	Battery Charger	24 Volt 30 Amp	6	Adjustable Wrench	4", 6" and 12"
7	Electric Arc Welder	AC 380 Volt 250	7	Ralch Handle Wrench Set	1/2" and 3/8"
8	Multi Tester		8	Hex Wrench Set	9 pieces
9	Battery Tester		9	Pipe Wrench	18"
10	Diesel Timming Light	Digital	10	Ball Hammer	Big, Medium and small
11	Tire pressure Gauge		11	Combination Pliers	8"
12	Air hose	10 Mts 16 Mm	12	Side Cutting Pliers	8"
13	Electric Wire Reel	50 Mts	13	Long Nose Pliers	8 "
14	Working Lamp Stand		14	Vice Pliers	10 WR
15	Fire extinguisher	ABC 6.5 kgs	15	Screw Driver Set	4", 8" and 12"
16	Test lamp	24 Volt	16	File Set	10 pieces
17	Tool Box	Metallic	17	Grease Gun	
18	Out of sign marker		18	Jump Cable	7 Mts
19	Ladder		19	Starter Cable Set	4 Mts
20	Manual Hoist	1 Ton	20	Vernier Calipers	300 Mm
21	Angle Grinder	SI 2500	21	Convex Rule	10 Mts
			22	Safety Rope	6 Mts
			23	Air Drill	SI 5305
			24	Air Impactor Set	3/8", 1/2", 3/4" and 1"
			25	Impact Adapter Set	1/2", 3/4", 3/8" and 1"
			26	Heavy Duty Box Set	1"(27-50) and 3/4"(22-46)

5.10.9 Staffing Plan

The number of staff currently working at Calle 100 and Guanabacoa landfills is 56 and 30, respectively. There is a workshop in Calle 100 with 49 staff members, including heavy equipment operators and maintenance technicians. The necessary number of operational staff members for Calle 100 Extension, New Site 1 and New Guanabacoa landfills and for the workshop were estimated as shown in Table 5.10.15.

Table 5.10.15 Operational Staff

Breakdown of Staff	Number of Staff	
	Calle 100 and New site 1	New Guanabacoa
1. Final Disposal Site		
Equipment operators	32	10
Workers for helping hauling vehicles to drop garbage	30	14
Maintenance and repair of equipment	4	2
Directors of Maintenance	2	1
Truck scales operators/recorders	6	4
Environmental monitoring	1	1
Computer operators	2	1
Administrators	3	2
Security guards, disaster prevention personnel	10	6
Total for Final Disposal Sites	90	41

Breakdown of Staff	Number of staff
2. Maintenance Workshop	
Directors of maintenance	2
Mechanical engineers	18
Computer operators	1
Mobile workshop	4
Warehouse manager	1
Equipment manager	1
Total for Workshop	27

5.10.10 Implementation Schedule and Cost Estimate

(1) Implementation schedule

Figure 5.10.7 shows the Implementation schedule for the landfill components of the M/P.

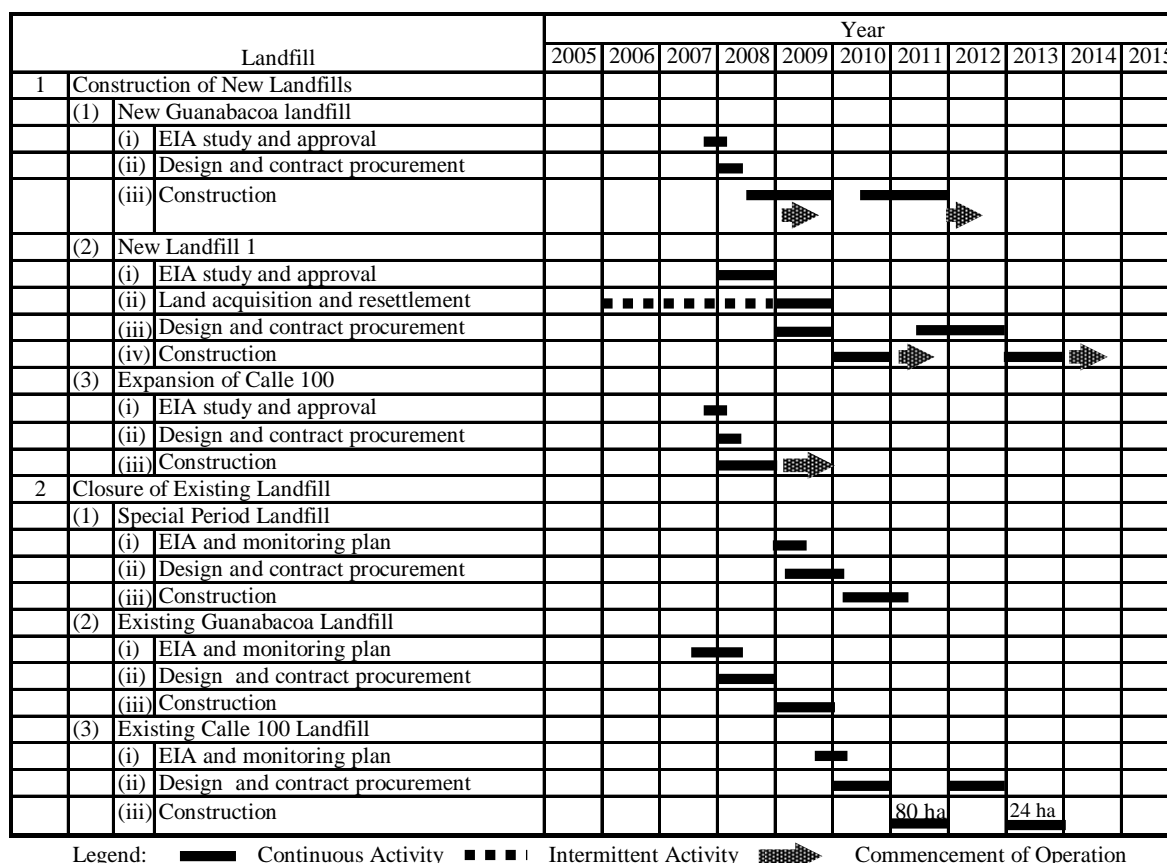


Figure 5.10.7 Implementation Schedule of Landfill Work

(2) Cost Estimation

A cost estimate of the landfill construction and closure works was prepared based on the following design concept:

1) New Construction and Expansion of Landfills

New Site 1, New Guanabacoa, and Expansion of Calle 100 are to be divided into two stages and constructed depending on actual waste volume hauled to the landfills. Facilities required for operation and maintenance of equipment, and approach roads to the waste disposal areas will be constructed in the first stage.

Common facilities of the three landfills are:

- Enclosure embankment:
In cases where an enclosure bank (dyke) is to be constructed, it will be built with a terraced enclosure embankment at a height of 3.5 to 5 m for storage of reclaimed waste. The embankment slope will be 1:2 (vertical: horizontal). Each enclosure bank will have a berm with a width of 2 m with rainwater drainage. The surface of the slope will be covered with sods to prevent erosion from rainwater.
- Road Facility:
Approach and maintenance roads are to be paved with asphalt or

macadam. The width of asphalt-paved road will be 8 m up to the site and 7 m on site. The width of macadam maintenance road will be 6 m and 5 m respectively.

- **Liner Facility:**
HDPE liner is to be installed to prevent leachate from penetrating into groundwater. On the liner, a sand protection layer of 30 cm will be laid. The bottom layer after excavation is to be compacted and leveled in order to provide a solid and impervious layer for the foundation of the liner.
- **Leachate collection facility:**
The leachate collection facility consists of perforated concrete main pipes of 600 mm diameter and perforated PVC branch pipes of 200 mm diameter. These pipes are to be protected by cobble. Leachate collection pipes will be connected with gas vents to provide air and promote leachate drainage. Branch leachate pipes will be laid every 30 m.
- **Gas Vent Facility:**
Perforated PVC gas vents with 300 mm diameter will be laid every 30 m. The vent pipes will be protected by cobbles filled to a thickness of one meter around the pipes.
- **Storm water drainage facility:**
To reduce rainwater flowing into landfill areas, storm water drainage facilities will be constructed at the top of enclosure embankments and around the landfill areas. No storm water storage ponds are to be constructed.
- **Leachate treatment ponds:**
As for New Site-1 and New Guanabacoa landfills, an anaerobic pond, an aerated lagoon and two maturation ponds will be constructed. As for expansion of Calle 100 Extension landfill, only one pond for storage of leachate, having the same volume as for an anaerobic pond, will be constructed, considering that its life is only four (4) years.
- **Leachate recirculation facility:**
Leachate stored in the anaerobic pond will be re-circulated to the landfill area by using PVC pipe of 75 mm diameter.
- **Wire Fence:**
A wire fence will be installed along the boarder of the landfill site to keep waste disposers and animals away.
- **Truck scales and associated office:**
Since there are many waste hauling vehicles, two sets of truck scales with a measurement capacity of 50 ton will be installed at each landfill site in order to weigh the loaded and empty vehicles without wasting time. The recorder of the truck scales will be cabled with a computer in the administration office for compiling and analyzing the recorded data for calculating hauled waste volume and required volume of cover soil.

- Operation and maintenance facilities:
A parking lot for heavy equipment and work space for the mobile workshop, as well as a fuel supply facility and car washing facility will be constructed.

- 2) Closure work of existing landfills
 - Gas vent:
After excavating the waste reclaimed area to a depth of 4 m, perforated PVC pipe of 300 mm diameter with cobble fill around the pipe will be laid every 30 m.
 - Final Cover Soil:
To reduce rainwater seepage, 30cm of clay layer and 30 cm of soil layer will be laid on the existing waste reclaimed layer. A storm water drainage facility with 2% slope will be constructed in order to promote swift drainage to the outside of the reclaimed land. Also, sods will be laid to prevent surface soil eroding.
 - Wire fence:
A wire fence will be installed along the boarder of the closed existing landfill to keep waste disposers and animals off the area.
 - Entrance gate:
At the entrance of the landfill site, a fence with approximately 3 m height and a gate will be constructed.

3) Cost estimate for landfills

Tables 5.10.16 to 5.10.21 present cost estimates for each landfill site.

Table 5.10.16 Construction Cost of New Site 1 Landfill

CUP/US\$ 1,000, constant prices

Items	1st stage (2010)		2nd stage (2013)		Total	
	CUP	US\$	CUP	US\$	CUP	US\$
Civil Work	2,179	1,890	1,382	1,576	3,561	3,466
Architectural Work	576	384	0	0	576	384
Overhead	1,601	1,322	804	917	2,405	2,239
Total	4,356	3,596	2,186	2,493	6,542	6,089

Note: Total cost does not include procurement of equipment and the physical contingency.

Table 5.10.17 Construction Cost of New Guanabacoa Landfill

CUP/US\$ 1,000, constant prices

Items	1st stage (2008)		2nd stage (2011)		Total	
	CUP	US\$	CUP	US\$	CUP	US\$
Civil Work	2,704	4,271	907	2,189	3,611	6,460
Architectural Work	367	245	12	8	379	253
Overhead	351	745	515	1,264	866	2,009
Total	3,422	5,261	1,434	3,461	4,856	8,722

Note: Total cost does not include procurement of equipment and the physical contingency.

Table 5.10.18 Construction Cost for Expansion of Calle 100 Landfill

CUP/US\$ 1,000, constant prices

Items	1st stage (2008)		2nd stage (2008)		Total	
	CUP	US\$	CUP	US\$	CUP	US\$
Civil Work	2,154	4,422	2,299	4,103	4,453	8,525
Architectural Work	123	82	0	0	123	82
Overhead	1,322	2,618	1,336	2,385	2,658	5,003
Total	3,599	7,122	3,635	6,488	7,234	13,610

Note: Total cost does not include procurement of equipment and the physical contingency.

Table 5.10.19 Construction Cost for Closure of Landfills

CUP/US\$ 1,000, constant prices

Items		Total	
		CUP	US\$
1) Special Period Landfill	Electrico	123	83
	Fraternidad	469	314
	Guansimas	469	314
	Lugardita	346	232
	Prensa Latina	469	314
	Rincon	123	83
	Las Canas	247	166
	El Vidrio	593	397
	Los Perros	469	314
		3,308	2,217
2) Calle 100 (80ha)		2,852	1,945
3) Calle 100 (24ha)		303	202
4) Guanabacoa		1,742	1,175
Total		8,205	5,539

Table 5.10.20 Procurement Cost for the Central Workshop Equipment for Landfill

CUP/US\$ 1,000, constant prices

Items	Total	
	CUP	US\$
Central Workshop Equipment	0	275

Table 5.10.21 O/M cost for Landfill and the Central Workshop for Landfill

CUP/US\$ 1,000, constant prices

Items	Total	
	CUP	US\$
A. New Site 1 Landfill	4,597	2,234
B. New Guanabacoa Landfill	2,891	1,009
C. Expansion of Existing Calle 100 Landfill	1,706	946
H. Central Work Shop (Maintenance Equipment)	1,757	132
Total	10,951	4,321

For the entire cost including capital cost and O/M cost, refer to Supporting Reports C4.7 and C4.8.

5.11 Environmental and Social Considerations

5.11.1 EIA Procedure

(1) EIA procedure

The Environmental Impact Assessment (EIA) procedure in Cuba includes an Environmental Impact Study (EIS) to be carried out by environmental consultants and an Estimation of Environmental Impact (EEI) to be carried out by CITMA.

According to the Cuban EIA procedure, projects that have potential for serious environmental impact require an EIS. Projects that do not require an EIS will be determined by CITMA based on the type and nature of the project.

According to JICA Guidelines, for reference, all projects will be analyzed and classified into one of the three categories shown in Table 5.11.1. An Initial Environmental Examination (IEE) study for environmental and social aspects is required for Category A and B projects.

Table 5.11.1 Project Categories in JICA Environmental Consideration Guideline

Category	Project
A	Projects are classified as Category A if they are likely to have significant adverse impact on the environment or society. Projects with complicated impact or unprecedented impact, which are difficult to assess or which have a wide range of impact or irreversible impact, are also classified as Category A. Projects are also classified as Category A if, by environmental law or the standards of the recipient governments, they require a detailed environmental impact assessment. The impact may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors (i.e., characteristics that are liable to cause adverse environmental impact) and projects located in or near sensitive areas.
B	Projects are classified as Category B if their potential adverse impact on the environment and society are less adverse than those of Category A projects. Generally they are site-specific; few if any are irreversible, and in most cases normal mitigation measures can be designed more readily.
C	Projects are classified as Category C if they are likely to have minimal or little adverse impact on the environment or society.

Source: JICA Guidelines for Environmental and Social Considerations, 2004 JICA

(2) Social Consideration in EIA Process

The present system of EIA seems to contain a number of issues requiring improvement. More attention should be given to the need for conducting public hearings for multiple objectives; (i) to collect opinions and learn about the anxieties of the population, (ii) to elaborate better provisions for reduction of potential social impacts, and (iii) to obtain active participation of people wherever desirable.

Another need for the improvement is the composition of the EIA study team. EIA study teams very often do not possess an expert on social impact assessment. The social expert, if included in the team, can look into deeply potential social issues from the planning stage of the project to identify and plan how to deal with potential constraints to project implementation.

CITMA, as the responsible government agency for EIA, shall set forth these criteria as essential requirements in the EIA study and issuing of an environmental permit.

5.11.2 Projects Requiring EIA

Based on the criteria of EIA necessity in the Cuban EIA guidelines and JICA Environmental Consideration Guidelines, the projects requiring an EIA, among the projects proposed in this M/P, are i) extension of landfill (Campo Florido), ii) construction of a environment-friendly landfill (New Guanabacoa and New Site 1), iii) closing of landfills (special period landfills, Calle 100 and Guanabacoa landfills), and iv) construction of a composting yard and recycling plant. The projects requiring an EIA are summarized in Table 5.11.2 and detailed descriptions of the projects are shown in Table 5.11.3.

Table 5.11.2 Projects Requiring EIA Procedure in This Study

No	Project	Cuban Guideline		JICA Guideline	
		EIS	EEI	EIA	IEE
1. Collection and Transportation System					
1	Review of storage system including bins	×	○	C	×
2	Renewal of vehicles including compactor trucks	×	○	C	×
2. Landfill System					
1) Improvement					
3	Extension of landfill (Campo Florido)	○	○	B	○
2) New Environment-Friendly Landfill					
4	Construction of environment-friendly landfill system including liner sheets, gas pipe, leachate pipe (New Guanabacoa and New Site 1)	○	○	B	○
3) Closing					
5	Closing of special period landfills	○	○	B	○
6	Closing of Existing Calle 100 and Guanabacoa landfills	○	○	B	○
3. Maintenance Workshop					
7	Construction of a centralized maintenance workshop	×	○	C	×
4. Recycling					
8	Construction of a composting yard (Large scale fermentation plant)	○	○	B	○
9	Construction of a recycling plant	○	○	B	○

○: EIS, EEI and IEE are needed, ×: EIS, EEI and IEE are not needed.

Note: 1) The results of screening based on the Cuban guideline were confirmed by CITMA.

2) Based on the current Cuban criteria, EISs for construction of a composting yard and construction of a recycling plant are not required. However, CITMA judged them as EIS required projects because construction of a large scale composting yard and recycling plant has not yet been conducted in Cuba and these projects were identified as projects with potential negative impact on the environment. CITMA staffs are planning to add these projects to EIS criteria.

Table 5.11.3 Descriptions of Projects Requiring EIA

Project	Project descriptions
Extension of landfill (Campo Florido)	Campo Florido is located east of Havana City in an agricultural area about 26 km from the center of old town, having a population of approximately 11,000. Campo Florido landfill, having an area of 1.8 ha was planned as a special period landfill in 1992. A pilot project (PLP) was implemented at this site under this Study, and the site will be utilized as a temporary landfill after the completion of the PLP. DPSC and CITMA have already completed the necessary procedures for the changing of status of this landfill, including the preparation of an EIA. An extension of a maximum 4.5 ha is possible according to the information provided by CITMA. After the extension, the landfill will be utilized for one year and will receive the waste from Guanabacoa municipality.
Construction of environment-friendly landfill system (New Guanabacoa)	The existing Guanabacoa landfill and 3 special period landfills were closed in 2005 due to growing environmental concerns. The remaining 6 special period landfills will be closed before the end of 2006 according to the future plan prepared by DPSC. In anticipation of this closure, DPSC has already started the engineering work for the New Guanabacoa landfill, which has an area of 18 ha. Construction work is envisioned to be completed by the end of 2006, after which, the waste having been transported to the existing Guanabacoa site will be hauled to the New Guanabacoa site (108,000 ton/year).
Construction of environment-friendly landfill system (New site 1 in southwest region of Havana City)	To address the critical problems facing the landfills, DPSC have been exerting great effort in finding a new landfill having an area of 60 ha in the southwest region of Havana City according to the development plan for solid waste. In this plan, the collection area in Havana City will be divided into two areas, the West and East Areas. The new landfill will be utilized for collected waste from the West area of Havana City, while the East area will utilize the New Guanabacoa landfill after the closure of Calle 100. However, the local municipality's agreement to this plan is kept pending at present. As a result of the planned closures of the landfills at Calle 100 and 6 special period landfills, a total quantity of about 1,475 tons/day in year 2011 will be delivered to this new landfill. Therefore, the construction work of this landfill must be completed by 2010.
Closing of special period landfills	The existing 6 special period landfills are located in the urban area and soil covering is not provided in the operation, which caused numerous environmental problems. To prevent environmental problems such as littering of waste, bad odors from the dumping site, harmful vectors from pests breeding, natural fires in the dumped waste, etc., it is recommended that the landfills be closed according to the master plan.
Closing of the Existing Calle 100 and Guanabacoa landfills	In 2005, the existing Guanabacoa landfill (28ha) was closed while Calle 100 landfills (80 ha and 24 ha) should be closed in the near future according to the master plan. Currently, housing construction is ongoing adjacent to the Guanabacoa landfill, which may induce arising of another environmental problem. In addition, Calle 100 landfill is expected to reach its end capacity within the near future. Prior to implementing the post closure land use plan, it is important to ensure that all the factors that have impact on the environment are dealt with and active countermeasures put in place, i.e. all leachate and gasses discharged are to be monitored and vegetation covering provided.
Construction of composting yards	In the composting program, organics are collected separately from other waste, such as recyclable and non-compostable materials. The source separated waste is collected from residences and restaurants. Composting yards will be constructed in New Guanabacoa and Calle 100 landfills.
Construction of recycling plants	Recycling plants will be constructed in Calle 100 and New Guanabacoa landfills. The existing recycle center in Calle 100 will be closed by the beginning of 2010. New recycling plants in Calle 100 will be located in the unused area of the closed landfill.

5.11.3 The Results of IEE (Scoping)

Based on the project characteristics and site characteristics, IEE was conducted through the JICA Study in 2005. The results of IEE are summarized in Tables 5.11.4 to 5.11.9.

The IEE study revealed no items of serious potential impact in all six projects, but suggested that careful study would be needed for the construction and expansion of landfills.

5.11.4 Necessity of EIA

EIA (EIS) should be conducted for selected items whose impact is A (serious impact) or B (relatively serious impact).

EIS should be conducted by the Cuban side for the projects that are identified as EIS-required projects. Based on the EIS, the projects will be approved by CITMA for an Environmental License.

Table 5.11.4 The Result of IEE for Extension of Landfill

Environmental Items		Campo Florido		Remarks	EIA necessity
		CP	OP		
Social Environment	Resettlement	D	D	No resettlement will occur during construction and operation.	-
	Economic Activities	D	D	No economic activity is conducted in or around the project area.	-
	Traffic and Public Facilities	B	B	Traffic increase is expected. In addition, there exists a residential area near Campo Florido. Therefore, environmental considerations should be investigated.	+
	Separation of Communities	D	D	Separation of communities by extension of the landfill is not expected.	-
	Cultural Property	D	D	There is no cultural property in or around project areas.	-
	Water Rights and Access Rights	D	D	No obstruction of water rights or access rights is expected to be caused by the construction and operation of the landfills.	-
	Public Health Condition	B	B	Some outbreaks of noxious insects, odors, air pollution, noise, and vibration caused by construction and operation of the landfill is expected.	+
	Waste	D	D	Waste generated during construction is to be disposed of on site.	-
	Hazards (Risks)	B	B	Traffic accidents are expected.	+
Natural Environment	Topography and Geology	D	D	Because the project site is flat land, the excavation of soil caused by the extension does not affect the topography or geology in the landfill area.	-
	Soil Erosion	D	D	No soil erosion is expected to be caused by construction or operation of the landfill.	-
	Groundwater	D	D	No change in the quality or level of groundwater is expected because percolation of the leachate will be prevented by installation of a liner sheet.	-
	Hydrological Situation	D	D	No change of river flow or riverbed condition is expected to be caused by extension and operation of the landfill.	-
	Coastal Zone	D	D	The project site is so far (about 10km) from the coastal zone that the impact will be little or none.	-
	Fauna and Flora (Greenery Area)	D	D	Campo Florido is already used for special period landfills. There are no species of flora and fauna for conservation in the project area.	-
	Climate	D	D	No construction of facilities or activities that will change climatic conditions is expected.	-
	Landscape	B	D	A change of landscape caused by construction of landfill is expected.	+
Pollution	Air Pollution	B	B	Air pollution caused by construction activity, traffic increase and gas from waste is expected.	+
	Water Pollution	D	B	The leachate will be discharged after treatment, but the environmental considerations should be investigated in terms of water pollution to estimate the impact on surface water.	+
	Soil Contamination	D	D	Soil contamination is not expected because the infiltration of leachate into the soil will be prevented by installation of a liner sheet.	-
	Noise and Vibration	B	B	Noise and vibration caused by traffic increase and the construction and operation of the landfill are expected.	+
	Land Subsidence	D	D	No extraction of a large volume of groundwater will be conducted.	-
	Offensive Odor	D	B	Offensive odors caused by waste dumping will be prevented by daily cover soil, but the environmental considerations should be investigated in terms of offensive odors to estimate the impact on the surrounding environment.	+

CP: Construction phase, OP: Operation phase

A: serious impact, B: relatively serious impact, C: extent of impact is unknown, D: no or little impact

- : EIA not required, + : EIA required.

Table 5.11.5 The Result of IEE for Construction of Environment-Friendly Landfills

Environmental Items		New Guanabacoa		New Site 1		Remarks	EIA necessity
		CP	OP	CP	OP		
Social Environment	Resettlement	D	D	D	D	No resettlement will occur during construction and operation in New Guanabacoa and New Site 1.	-
	Economic Activities	D	D	D	D	No economic activity is conducted in or around the project area of New Guanabacoa and New Site 1.	-
	Traffic and Public Facilities	B	B	B	B	Traffic increase is expected to affect the existing transportation system.	+
	Separation of Communities	D	D	D	D	Separation of communities by construction of the landfill is not expected in New Guanabacoa and New Site 1.	-
	Cultural Property	D	D	D	D	There is no cultural property in or around the project areas of New Guanabacoa and New Site 1.	-
	Water Rights and Access Rights	D	D	D	D	The obstruction of water rights and access rights caused by the construction and operation of the landfills is not expected in New Guanabacoa and New Site 1.	-
	Public Health Condition	B	B	B	B	Some outbreak of air pollution, noise, and vibration caused by construction and operation of the landfill is expected.	+
	Waste	D	D	D	D	Waste generated during construction is to be disposed of on site.	-
	Hazards (Risks)	B	B	B	B	Traffic accidents are expected.	+
Natural Environment	Topography and Geology	C	C	C	C	The impact is unknown because the extent of soil excavation is unknown.	-
	Soil Erosion	D	D	D	D	Heavy rain, such as from hurricanes, could cause erosion of exposed soil in the New Guanabacoa site but soil erosion can be prevented by installation of drains.	-
	Groundwater	D	D	D	D	Change in the quality or level of groundwater due to leachate percolation is not considered to be a potential problem because seeping of leachate into the soil and ground water will be prevented by liner sheets and leachate collecting pipes.	-
	Hydrological Situation	C	C	C	C	A change in river flow and/or riverbed conditions is expected to be caused by an increase of the area bare of vegetation at the project site.	+
	Coastal Zone	D	D	D	D	The project sites of New Guanabacoa and New Site 1 are so far (about 10km) from the coastal zone that the impact will be little or none.	-
	Fauna and Flora (Greenery Area)	B	B	B	B	The environment in the project area for New Guanabacoa and New Site 1 is currently in a natural state. Therefore, a detailed study is needed.	+
	Climate	D	D	D	D	No activity that changes climatic conditions is expected.	-
	Landscape	B	D	B	D	A change of landscape caused by the construction of landfill is expected.	+
Pollution	Air Pollution	B	B	B	B	Air pollution caused by construction activity, traffic increase and gas from waste is expected.	+
	Water Pollution	D	B	D	B	The leachate will be discharged after treatment. Therefore, environmental considerations should be investigated in terms of water pollution to estimate the impact on surface water.	+
	Soil Contamination	D	D	D	D	No soil contamination is expected because the infiltration of leachate into the soil will be prevented.	-
	Noise and Vibration	B	B	B	B	Noise and vibration caused by construction activity, traffic increase and the construction and operation of the landfill are expected.	+
	Land Subsidence	D	D	D	D	No extraction of a large volume of groundwater will be conducted.	-
	Offensive Odors	D	B	D	B	Offensive odors caused by waste dumping will be prevented by daily cover soil, but the environmental considerations should be investigated in order to estimate the impact on the surrounding environment.	+

CP: Construction phase, OP: Operation phase

A: serious impact, B: relatively serious impact, C: extent of impact is unknown, D: no or little impact

- : EIA not required, + : EIA required

Table 5.11.6 The Result of IEE for Closing of Special Period Landfills

Environmental Items		9 sites*		Remarks	EIA necessity
		CP	OP		
Social Environ- ment	Resettlement	D	D	No resettlement caused by closure of special period landfills is expected.	-
	Economic Activities	D	D	No economic activity is conducted in or around the project area.	-
	Traffic and Public Facilities	B	D	Increase of traffic caused by closure of special period landfills is expected.	+
	Separation of Communities	D	D	The possibility of separation of communities is not expected.	-
	Cultural Property	D	D	The possibility of the existence of cultural property is not expected.	-
	Water Rights and Rights of Common	D	D	The obstruction of water rights and access rights caused by closure of special period landfills is not expected.	-
	Public Health Condition	B	D	Some air pollution and noise caused by closure of the landfills is expected.	+
	Waste	D	D	Waste generation is not expected.	-
	Hazards (Risks)	B	D	Traffic accidents are expected.	+
Natural Environ- ment	Topography and Geology	D	D	No change of topography and geology caused by closure of special period landfills is expected.	-
	Soil Erosion	D	D	Soil erosion is not expected.	-
	Groundwater	D	D	Change in quality of groundwater will be prevented by enclosing with impermeable clay.	-
	Hydrological Situation	D	D	No change of river flow or riverbed conditions is expected.	-
	Coastal Zone	D	D	No impact on the Coastal Zone from the new sites is expected because the project locations of all special period landfills are far from the coastal zone.	-
	Fauna and Flora (Greenery Area)	D	D	Reforestation of land will be conducted after closure of the landfills.	-
	Climate	D	D	No change of climatic condition caused by closure of special period landfills is expected.	-
	Landscape	D	D	The landscape will be improved by reforestation of the land.	-
Pollution	Air Pollution	B	B	Air pollution caused by the closing activity and traffic increase is expected. Gaseous products from closed special period landfills can pollute the surrounding environment.	+
	Water Pollution	D	D	Water pollution caused by leachate from closed special period landfills will be prevented by enclosing them with impermeable clay.	-
	Soil Contamination	D	D	Soil contamination caused by leachate from closed special period landfills will be prevented by enclosing them with impermeable clay.	-
	Noise and Vibration	B	D	Noise and vibration caused by closing of special period landfills are expected.	+
	Land Subsidence	D	D	Land subsidence caused by closing of landfills is not expected.	-
	Offensive Odors	D	D	Offensive odors will be prevented by closing the landfills.	-

CP: Construction phase, OP: Operation phase

*: Electrico D.S., Fraternal D.S., Managua D.S., Lugardita D.S., Prensa Lalina D.S., Rincon D.S., Las Canas D.S., Vidrio D.S., Los Perros D.S., Campo Florido D.S.

A: serious impact, B: relatively serious impact, C: extent of impact is unknown, D: no or little impact

-: EIA not required, + : EIA required

Table 5.11.7 The Result of IEE for Closing of Calle 100 and Guanabacoa Landfills

Environmental Items		Calle 100		Guanabacoa		Remarks	EIA necessity
		CP	OP	CP	OP		
Social Environ- -ment	Resettlement	D	D	D	D	No resettlement caused by closure of these landfills is expected.	-
	Economic Activities	D	D	D	D	No economic activity is to be conducted in or around the project areas.	-
	Traffic and Public Facilities	B	D	B	D	Increase of traffic caused by closure of the landfills is expected.	+
	Separation of Communities	D	D	D	D	The possibility of separation of communities is not expected.	-
	Cultural Property	D	D	D	D	The possibility of the existence of cultural property is not expected.	-
	Water Rights and Rights of Common	D	D	D	D	No obstruction of water rights or access rights caused by closure of these landfills is expected.	-
	Public Health Condition	B	D	B	D	Some air pollution and noise after closure of the landfills is expected.	+
	Waste	D	D	D	D	Waste generation is not expected.	-
	Hazards (Risks)	B	D	B	D	Traffic accidents are expected.	+
Natural Environ- -ment	Topography and Geology	D	D	D	D	No change of topography and geology caused by closure of these landfills is expected.	-
	Soil Erosion	D	D	D	D	Soil erosion is not expected.	-
	Groundwater	D	D	D	D	Change in the quality of ground water will be prevented by enclosing with impermeable clay.	-
	Hydrological Situation	D	D	D	D	No change in river flow or riverbed conditions is expected.	-
	Coastal Zone	D	D	D	D	No impact on the Coastal Zone from the new sites is expected because the project locations of the landfills are far from the coastal zone.	-
	Fauna and Flora (Greenery Area)	D	D	D	D	Reforestation of land will be conducted after closure of the landfills.	-
	Climate	D	D	D	D	No change of climatic condition caused by closure of landfills is expected.	-
Landscape	D	D	D	D	The landscape will be improved by reforestation of the land.	-	
Pollution	Air Pollution	B	B	B	B	Air pollution caused by closing activities and traffic increase is expected. Gaseous products from closed landfills can pollute the surrounding environment.	+
	Water Pollution	D	D	D	D	Water pollution caused by leachate from closed landfills will be prevented by enclosing them with impermeable clay.	-
	Soil Contamination	D	D	D	D	Soil contamination caused by leachate from the closed landfills will be prevented by enclosing them with impermeable clay.	-
	Noise and Vibration	B	D	B	D	Noise and vibration caused by closing of landfills are expected.	+
	Land Subsidence	D	D	D	D	Land subsidence caused by closing the landfills is not expected.	-
	Offensive Odors	D	D	D	D	Offensive odors will be prevented by closing the landfills.	-

CP: Construction phase, OP: Operation phase

A: serious impact, B: relatively serious impact, C: extent of impact is unknown, D: no or little impact

-: EIA not required, + : EIA required

Table 5.11.8 The Result of IEE for Construction of a Composting Yard

Environmental Items		Calle 100	New Guanabacoa	Remarks	EIA necessity
Social Environment	Resettlement	D	D	No resettlement will occur during construction and operation of composting yards at Calle 100 and New Guanabacoa.	-
	Economic Activities	D	D	No economic activity is to be conducted in and around the project areas.	-
	Traffic and Public Facilities	B	B	Increasing traffic is expected to affect the existing transportation system.	+
	Separation of Communities	D	D	No separation of communities caused by construction of composting yards at Calle 100 and New Guanabacoa is expected.	-
	Cultural Property	D	D	There is no cultural property in Calle 100 and New Guanabacoa.	-
	Water Rights and Rights of Common	D	D	Obstruction of water right and access right caused by the construction and operation of the composting yards is not expected at Calle 100 and New Guanabacoa.	-
	Public Health Condition	B	B	Some odor, air pollution, noise, and/or vibration is expected to be caused by operation of the yards.	+
	Waste	D	D	Waste generated during construction is to be transferred to a landfill.	-
	Hazard (Risk)	B	B	Some traffic accidents are expected.	+
Natural Environment	Topography and Geology	D	D	No change of topography and geology is expected to be caused by construction of the yards.	-
	Soil Erosion	D	D	No soil erosion is expected to be caused by construction of the yards.	-
	Groundwater	D	D	Change in quality and level of groundwater is not expected.	-
	Hydrological Situation	D	D	Change of river flow and riverbed condition is not expected.	-
	Coastal Zone	D	D	The project sites are so far from the coastal zone that there will be little or no impact.	-
	Fauna and Flora (Greenery Area)	D	B	No impact on fauna and flora caused by the construction is expected at Calle 100. The project area for New Guanabacoa remains a natural environment so a detailed study is needed.	+(New Guanabacoa)
	Climate	D	D	The construction of yards and associated activity is not expected to change climatic conditions.	-
	Landscape	B	B	A change of landscape caused by the construction of yards is expected.	+
Pollution	Air Pollution	B	B	Air pollution caused by traffic increasing is expected.	+
	Water Pollution	D	D	No water pollution caused by the construction and operation of the yards is expected.	-
	Soil Contamination	D	D	No soil contamination is expected.	-
	Noise and Vibration	B	B	Noise and vibration caused by the construction of the yards are expected.	+
	Land Subsidence	D	D	No large volumes of groundwater will be extracted.	-
	Offensive Odor	B	B	Offensive odor caused by waste transportation and storage during operation is expected.	+

A: serious impact, B: relatively serious impact, C: extent of impact is unknown, D: no or little impact
- : EIA not required, + : EIA required

Table 5.11.9 The Result of IEE for Construction of a Recycling Plant

Environmental Items		Calle 100	New Guanabacoa	Remarks	EIA necessity
Social Environment	Resettlement	D	D	No resettlement will occur during construction and operation of recycling plants at Calle 100 and New Guanabacoa.	-
	Economic Activities	D	D	No economic activity is to be conducted in and around the project areas.	-
	Traffic and Public Facilities	B	B	Increasing traffic is expected to affect the existing transportation system.	+
	Separation of Communities	D	D	No separation of communities by construction of recycling plant is expected at Calle 100 and New Guanabacoa.	-
	Cultural Property	D	D	There is no cultural property at Calle 100 and New Guanabacoa.	-
	Water Rights and Rights of Common	D	D	No obstruction of water right and access right caused by the construction and operation of the recycling plant is expected at Calle 100 and New Guanabacoa.	-
	Public Health Condition	B	B	Some odor, air pollution, noise, and vibration caused by operation of the plant is expected.	+
	Waste	D	D	Waste generated during construction is to be transferred to landfill.	-
	Hazard (Risk)	B	B	Some traffic accidents are expected.	+
Natural Environment	Topography and Geology	D	D	No change of topography and geology caused by construction of the plants is expected.	-
	Soil Erosion	D	D	No soil erosion caused by construction of plants is expected.	-
	Groundwater	D	D	No change in quality and level of groundwater is expected.	-
	Hydrological Situation	D	D	Change of river flow and riverbed condition is not expected.	-
	Coastal Zone	D	D	The project sites are so far from the coastal zone that there will be little or no impact.	-
	Fauna and Flora (Greenery Area)	D	B	No impact on fauna and flora caused by the construction is expected in Calle 100. The project area of New Guanabacoa remains a natural environment so a detailed study is needed.	+(New Guanabacoa)
	Climate	D	D	No change of climatic conditions is expected as a result of the construction of plant and associated activity.	-
Landscape	B	B	A change of landscape caused by the construction of plants is expected.	+	
Pollution	Air Pollution	B	B	Air pollution caused by traffic increasing is expected.	+
	Water Pollution	D	D	Water pollution caused by the construction and operation of the plant is not expected.	-
	Soil Contamination	D	D	No soil contamination is expected.	-
	Noise and Vibration	B	B	Noise and vibration caused by the construction of plant are expected.	+
	Land Subsidence	D	D	No large volumes of groundwater will be extracted.	-
	Offensive Odor	D	D	No offensive odor is expected to be caused.	-

A: serious impact, B: relatively serious impact, C: extent of impact is unknown, D: no or little impact

-: EIA not required, + : EIA required

5.11.5 Mitigation Measures

The magnitude or intensity of the impact affecting the environment can be reduced by implementation of mitigation measures. The planning and design of projects recommended in the M/P have duly taken into account mitigation measures to reduce environmental impact.

As stated above, the construction of new landfills and extension of landfills will involve varying types of potential environmental issues for which the following mitigation measures are proposed.

Table 5.11.10 Proposed Mitigation Measures for the Establishment of New Landfills and Extension of an Existing Landfill

Environmental Items	Proposed mitigation measure
Traffic and Public Facility	Control of vehicle flow
Public Health Condition	Control of vehicle flow
	Limitation of operating hours
	Daily soil covering
	Landfill gas control
Hazard (Risk)	Control of vehicle flow
	Installation of signboards
	Landfill gas control
	Daily soil covering
Groundwater	Covering with impermeable clay or liner sheet
Hydrological Situation	Discharge control from leachate treatment facility
Fauna and Flora	Reforestation
Landscape	Daily soil covering
	Reforestation
Air pollution	Control of vehicle flow
	Dust controlled by water spraying
	Landfill gas control
Water pollution	Discharge control from leachate treatment facility
Noise and Vibration	Installation of sound barrier walls
	Control of vehicle flow
	Limitation of operating hours
Offensive Odor	Daily soil covering

The existing Calle 100 and Guanabacoa landfills have serious negative impact on the surrounding environment caused by open dumping. Guanabacoa landfill was closed in March 2005. It has posed a serious danger to the health of the residents because Guanabacoa landfill is situated close to a residential area.

Calle 100 landfill will be closed after completion of New Site 1. However, some extent of impact will still remain even if the landfill is closed. Mitigation measures for closure of those landfills is proposed below:

Table 5.11.11 Proposed Mitigation Measures for Closure of Landfill

Environmental Items	Mitigation Method
Traffic and Public Facility	Control of vehicle flow
Public Health Condition	Limitation of operating hours
Hazard (Risk)	Limitation of operating hours
Soil Erosion	Covering with impermeable clay and vegetation
	Installation of drains
Groundwater	Covering with impermeable clay
Fauna and Flora (Greenery Area)	Reforestation of land after closing
Landscape	Reforestation of land after closing
Air Pollution	Effective disposition of gas extract pipes
	Limitation of operating hours
	Control of vehicle flow
	Installation of gas ventilation pipe
Water Pollution	Covering with impermeable clay
Soil Contamination	Covering with impermeable clay
Noise and Vibration	Installation of sound barrier walls
	Limitation of operating hours
	Control of vehicle flow
Land Subsidence	Restriction of land use after closure
Offensive Odor	Covering with impermeable clay
	Installation of gas extract pipes
	Effective disposition of gas extract pipes

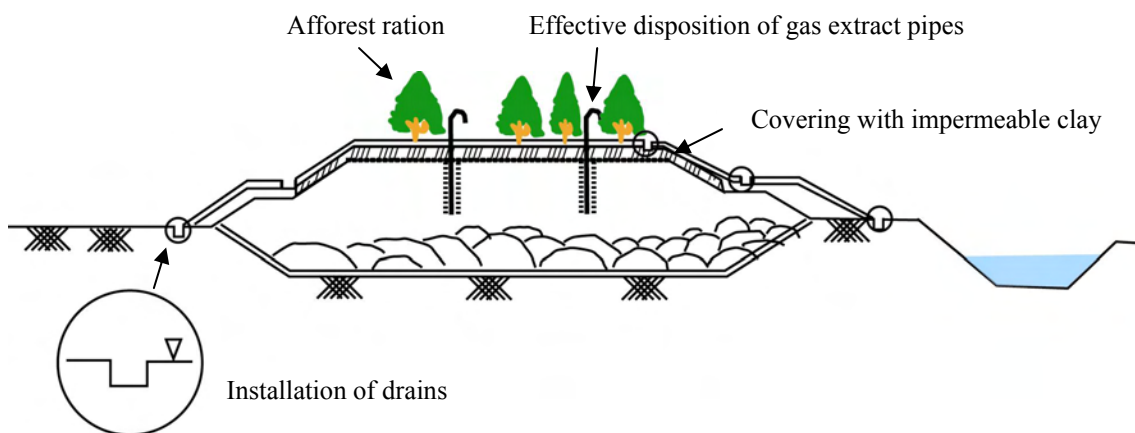


Figure 5.11.1 An Example of a Mitigation Plan for Landfill Closure

5.11.6 Environmental Monitoring Plan

(1) Objective

The objective of environmental monitoring is to collect data to determine:

1. Actual environmental impact of a project
2. Compliance of the project with regulatory standards, and
3. Performance of environmental mitigation measures and their successful application.

The information generated by monitoring programs provides the feedback necessary for effective application of the environmental mitigation measures.

(2) Institutional framework

Environmental monitoring for MSWM shall be carried out by specialized laboratories equipped with testing apparatus. Among them, the Waste Analysis Laboratory (WAL) of DPSC will be the leading agency to conduct the planning, implementation and evaluation of the monitoring. Currently, they have some equipment for environmental monitoring of water pollution and solid waste, but they have not yet conducted monitoring. They should start monitoring measurable environmental items within the range of their equipment as soon as possible. The analysis of parameters that they cannot measure shall be requested from other experienced laboratories.

(3) Relevant standards

In the case of implementation of environmental monitoring, the following relevant environmental standards shall be referred to.

- 1) Water pollution – NC 27/99: Discharge of sewage water to surface waters and sewerage.
- 2) Noise – NC 26/99: Noise in inhabited zones, hygienic-sanitary requirements.
- 3) Air pollution: A national standard for air quality is now being prepared and will be issued soon (the issued date is unknown).

(4) Environmental monitoring plan for each project

1) Extension and construction of landfill

The objective of environmental monitoring for landfills is not only to monitor the actual environmental impact of a project but also to evaluate the implementation performance of environmental mitigation measures such as leachate treatment facilities and gas treatment facilities and the success of their application. As considered in IEE, the potential environmental impact factors of landfills are water pollution by leachate, gas generation, odors, air pollution, and noise caused by traffic increase. In order to watch and evaluate the actual environmental impact, the following environmental monitoring shall be conducted.

Table 5.11.12 Environmental Monitoring Plan for Extension and Construction of Landfills

Monitoring Items	Sampling point	Analysis items	Frequency	
			Daily	Periodically
Water pollution	Leachate Discharge Ground water	Water Flow (Leachate: Entrance and Discharge), Water Temperature, pH, EC	○	
		DO, TDS, TOC, COD, BOD ₅ , Suspended Solids (SS), Coliform bacteria, Ammonia Nitrogen (NH ₄ ⁺), Nitrate Nitrogen (NO ₃ ⁻), Nitrite Nitrogen (NO ₂ ⁻), T-N, T-P Cadmium (Cd), Zinc (Zn), Copper (Cu), Lead (Pb), Chromium (Cr ⁶⁺), Arsenic (As), Total Mercury (T-Hg), Total Cyanide (T-CN), Cl, Oil and Grease, Fe, Mn, Sulfate		○
Gas generation	At the point of Gas Venting Facility	CH ₄ , CO, H ₂ S, O ₂	○	
Odors	Site boundary	Odor concentration		○
Traffic	Entrance of facility	Number of vehicles	○	
Air pollution	Site boundary	NO _x , SO _x		○
Noise	Site boundary	Noise level		○

In the above table, the frequency of monitoring is classified into “Daily” and “Periodically”. The periodical monitoring shall be conducted four times per year, at least twice each during the dry season and rainy season.

2) Closure of landfills

The closure of Calle 100 and Guanabacoa is to end the current environmental impact on the surrounding area. However, the impact on the environment will still remain after closure, and this shall be monitored. The proposed environmental monitoring plan is shown in the following table.

Table 5.11.13 Environmental Monitoring Plan for Closure of Landfills

Monitoring Items	Sampling point	Analysis items	Frequency	
			Daily	Periodically
Water pollution	Surrounding water Ground water	Water Temperature, pH, EC, DO, TDS, TOC, COD, BOD ₅ , Suspended Solids (SS), Coliform bacteria, Ammonia Nitrogen (NH ₄ ⁺), Nitrate Nitrogen (NO ₃ ⁻), Nitrite Nitrogen (NO ₂ ⁻), T-N, T-P Cadmium (Cd), Zinc (Zn), Copper (Cu), Lead (Pb), Chromium (Cr ⁶⁺), Arsenic (As), Total Mercury (T-Hg), Total Cyanide (T-CN), Cl, Oil and Grease, Fe, Mn, Sulfate		○
Gas generation	At the point of Gas Venting Facility	CH ₄ , CO, H ₂ S, O ₂		○

3) Construction of composting yard

As considered in IEE, the potential environmental impact of composting yards is from odor, air pollution and noise caused by traffic increasing. In order to watch and evaluate the actual environmental impact, the following environmental monitoring shall be conducted.

Table 5.11.14 Environmental Monitoring Plan for Construction of Composting Yards

Monitoring Items	Sampling point	Analysis items	Frequency	
			Daily	Periodically
Odor	Site boundary	Odor concentration		○
Traffic	Entrance of facility	Number of vehicles	○	
Air pollution	Site boundary	NO _x , SO _x		○
Noise	Site boundary	Noise level		○

4) Construction of recycling plant

As considered in IEE, the potential environmental impact of recycling plant is from air pollution and noise caused by traffic increasing. In order to watch and evaluate the actual environmental impact, the following environmental monitoring shall be conducted.

Table 5.11.15 Environmental Monitoring Plan for Recycling Plants

Monitoring Items	Sampling point	Analysis items	Frequency	
			Daily	Periodically
Traffic	Entrance of facility	Number of vehicles	○	
Air pollution	Site boundary	NO _x , SO _x		○
Noise	Site boundary	Noise level		○

(5) Cost estimate

A capital cost for implementing the environmental monitoring plan during the M/P period is estimated to be US\$265,000 and CUP55,000. For operation and maintenance cost for the plan is also estimated to be US\$276,000 and CUP40,000

5.12 Awareness-raising

5.12.1 General

The social aspects of MSWM projects need to be considered from two angles; one is the need to study potential social problems that may be arising, and the other is the need for awareness-raising of the people who would be involved in the MSWM. The two aspects are interrelated to each other and hence shall be integrated in the program. This Section describes the principal items of the social consideration and awareness-raising programs required for implementation of the MSWM master plan.

5.12.2 Improvement of the Organisational Structure for Awareness-Raising

There are several organizations that are responsible for MSWM. Nevertheless, these organizations act, in many cases, in an unrelated fashion, which negatively affects the outcomes of their actions and leads to an inefficient management.

To promote an integrated approach to awareness-raising activities for MSWM, it is proposed to establish an inter-institutional multi-stakeholder working group or task force (WG). This WG will be composed of representatives from all organizations and/or sectors related to MSWM. Within the WG, the actions of each member would be discussed and coordinated so that they could collaborate mutually, thus facilitating better effectiveness and efficiency and also avoiding useless double efforts.

The main topics relevant to the WG involve awareness-raising, training, and people's participation in MWSM activities such as segregated discharge of waste, recycling, composting, public health issues, and legislative needs. In order to cover all these aspects, the following composition is proposed for the WG:

- DPSC as the coordinator
- CITMA as the vice-coordinator
- Provincial government
- Municipal governments: 1 member representing the 15 municipalities
- ERMP
- NGOs: 1 member representing the whole sector of NGOs
- Police
- Invitees according to needs of the project

The municipal governments and NGO sector will be allowed to assign only one representative each to avoid creating an excessively large and unwieldy WG. A large WG would affect the efficiency of decision-making and create a

disproportionate weighting to respective groups. In the case of the representatives of the municipalities, the member will be appointed by the provincial government. An NGO representative will be appointed by the NGO federation.

The WG is to be established specifically to discuss issues pertaining to MSWM. However, there would be a possibility for the WG to eventually assume other functions, for example, more generally in the environmental field. There are examples in other countries where a WG with the same characteristics facilitated the identification, elaboration, and financing of other cooperation projects.

5.12.3 Provision of Information for the Public

Awareness-raising activity will be carried out with three goals in mind, i.e., (i) to provide relevant information, (ii) to raise awareness among the population, and (iii) to promote active participation by citizens. For attaining (ii) and (iii), proper conduct of (i) is essential.

The information to be provided will include: (i) potential problems and their impacts on society, (ii) responsibility for MSWM that is to be shared by the people of the City, and (iii) proposed solutions for proper undertaking of MSWM.

There are two types of information to be provided. One is information for raising the general interest of people as a whole, and the other is related to particular MSWM projects and activities. The appropriate tools for interest raising are mass media (radio, television and press), and for project specific information, the appropriate methods are printed materials (leaflets, stickers, posters, presentations, and meetings) coupled with person-to-person contact.

Mass media will be used to raise awareness of the population regarding the general aspects of MSWM. In order to explore the whole potential of mass media, it is suggested that the MSWM institution appoints a media specialist to its staff. This person would be the link between the institution and the mass media. He or she would promote the dissemination of all information of public interest. At the same time, this person would be the contact point for the media in case it requires information from the institution.

5.12.4 Promotion of Awareness-Raising and Participation of People

(1) Programs by type of groups

The target group for awareness-raising and participation will be the general population of the whole city or in the particular project area depending on the type of project.

Of the whole population, there are two specific groups that deserve special attention. The first group is housewives who are responsible for daily household waste management. A mechanism to reach this group will be via the Cuban Women's Federation. The second group is children and teenagers who represent the adults of the future. It is also known that in many situations, children and teenagers influence their parents. Access to this group will be through curricular and extra-curricular activities in the schools and organizations such as the "Pioneros" or "Pioneers".

The promotion programs are conceivable for each of the population groups as follows:

Regarding the public in general:

- Distribution of awareness-raising materials (leaflets, posters, bulletins, etc.) related to the different topics of the program
- Information dissemination by audio-visual products (spots on radio and television, videos), with promotion of the subject for inclusion in the contents of mass media where possible
- Workshops and presentations for communities
- Delivery of promotional materials to be distributed among the public (T-shirts, caps, pens, etc.)
- Set up a free telephone line for the public (ref. (2) below)
- Presentations and workshops for women groups

Regarding school system:

- Provision of necessary information for school boards
- Use schools as a model case for appropriate MSWM, including the systematic implementation of segregated collection, use of recycled materials, and production of compost for school gardens.
- Workshops for all school staff (teaching and non-teaching)
- Discussions at parent meetings
- Develop training and education aides (videos, printed material, etc)
- Establishment of discussion groups ("circuitos de interés") at schools
- Creation of student brigades, who will make visits to local families with the objective of awareness-raising
- Organisation of contests, festivals and technical-scientific events

(2) Establishment of a communication system for the population

To enable better communication between the public and the institutions for MSWM, it is proposed to install a free-of-charge phone line for public relations.

This line would be either to obtain information or make complaints and reports. The phone would be installed at a DPSC office with a permanent presence of competent officials. Standardized procedures would be established for handling the information gained through this phone communication system.

5.12.5 Training of Staff and Trainers

Proper operation of MSWM will require the upgrading of knowledge of personnel working at various levels. The staff training programs shall provide training on the following subjects:

- 3Rs programs for the executives and staff of public administration and enterprises
- Legislation related to MSWM for the staff of institutions in charge of implementation
- Methods of mobilizing people's participation and public relations for the staff of agencies in contact with the people
- Technologies regarding segregated waste collection, composting, recycling and landfill for the staff of MSWM operating agencies

Awareness-raising programs will require many instructors and facilitators. This means that there will firstly be a need for training of trainers who would train the instructors and facilitators. It is proposed to train the trainers in two steps. Firstly, the responsible government staff will be trained at a central level, and then they will train other trainers who would work at the community level.

The trainers at the community level will include the members of NGOs, staff of municipal governments, community leaders, etc. This group will be involved in the training and awareness-raising of the population 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, Committee for Defense of the Revolution (CDR), and Federation of Cuban Women (FMC).

5.12.6 Monitoring of Awareness Level of the People

To effectively raise awareness of the people and assure that activities proceed in line with actual needs, the awareness level of people shall be monitored with periodic surveys. The items to be monitored will include:

- Knowledge of the people about the City's current situation and problems with MSWM,

- People's consciousness of the relative responsibilities of the government and people for MSWM
- People's opinions on the strategies for MSWM projects and solutions to be adopted to achieve a sanitary and healthy environment in the City.

The monitoring will be conducted principally by questionnaire surveys, as conducted in the PLP, supplemented by listening to people's opinions at workshops and meetings.

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

Awareness-raising programs for the M/P implementation shall take into account the following considerations:

- Experience obtained through the PLP under the JICA Study in 2005 carried out in the Havana del Este municipality shall be fully utilized.
- Considering the involvement of a large population in the M/P project, mass media including radio and TV will be used in order to reach the population effectively.
- Getting the message through to residents should adopt a two-step approach; i.e., in addition to mass media programs, through existing community based organizations such as CPC, Army Veterans' Association, CDR, FMC and Delegates of Electro Districts.

Of the awareness-raising programs, the following three programs are directly relevant to environmentally friendly MSWM:

- (1) Awareness-raising program for the introduction of segregated collection
 - The target group will be the households of seven urban municipalities.
 - Awareness-raising activities will be carried out for three 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:
 - Target group will be the entire population of the municipalities where the landfill is constructed, but with special emphasis on the communities adjacent to the landfill.

- The program will be carried out for three years starting one-year ahead of the start of operations at the landfill. Overall awareness-raising for 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:
- Target group will be the households in eight sub-urban municipalities.
 - The program will be carried out continuously in parallel with the staged introduction of home composting, starting from 2007 and continuing until 2015.
 - Instruction pamphlets for home composting similar to the one prepared in the PLP under the JICA Study in 2005 will be distributed to every household. The paper shall be upgraded incorporating the experience gained from that PLP and additional advice from experts of MINAGRI as required.
 - DPSC/DMSC will establish a contact point for providing technical guidance and support to households in order to help produce better quality compost.

5.12.8 Cost Estimate

A cost estimate for the awareness-raising programs is given in Table 5.12.1.

The programs cover the three specific programs stated in Subsection 5.12.6 above and a general program covering overall MSWM.

Table 5.12.1 Cost Estimate for Awareness-raising Program
CUP/US\$ 1,000, Current Prices

	CUC	CUP
1. General	365	35
2. Segregated Collection	933	720
3. Environment-friendly Landfill	702	540
4. Home Composting	140	110
Total	2,140	1,405

5.13 Implementation Schedule and Cost Estimate

5.13.1 Implementation Schedule

An implementation schedule is shown in Figure 5.13.1.

The preparation of the schedule took into account the following aspects:

- (1) The most urgent projects are the construction of new landfills, i.e., New Guanabacoa and Calle 100 Extension (24 ha), in view of the impending need to provide additional landfill area. The work will be arranged by DPSC with financial support from the Government so that the landfills could be put in service in 2009.
- (2) Segregated collection of waste is planned to commence in 2010 in two municipalities, allowing sufficient lead-time for the preparation (planning, procurement of equipment, awareness-raising activities, etc.). It will be expanded to cover another five municipalities in 2013.
- (3) Simultaneously with the introduction of segregated collection, recycling and composting operations will be commenced at plants installed in Calle 100 and New Guanabacoa landfill sites.
- (4) Closure of existing landfills will be carried out basically according to the present DPSC schedule.
- (5) Equipment required for the projects will be procured according to the schedule of the respective projects.

The implementation of each project consists of a series of activities such as survey, planning, design, EIA, engineering services, procurement and construction work.

All the activities will principally be managed by DPSC, under which UPPH and/or DMSC will be assigned as the executing agency as appropriate.

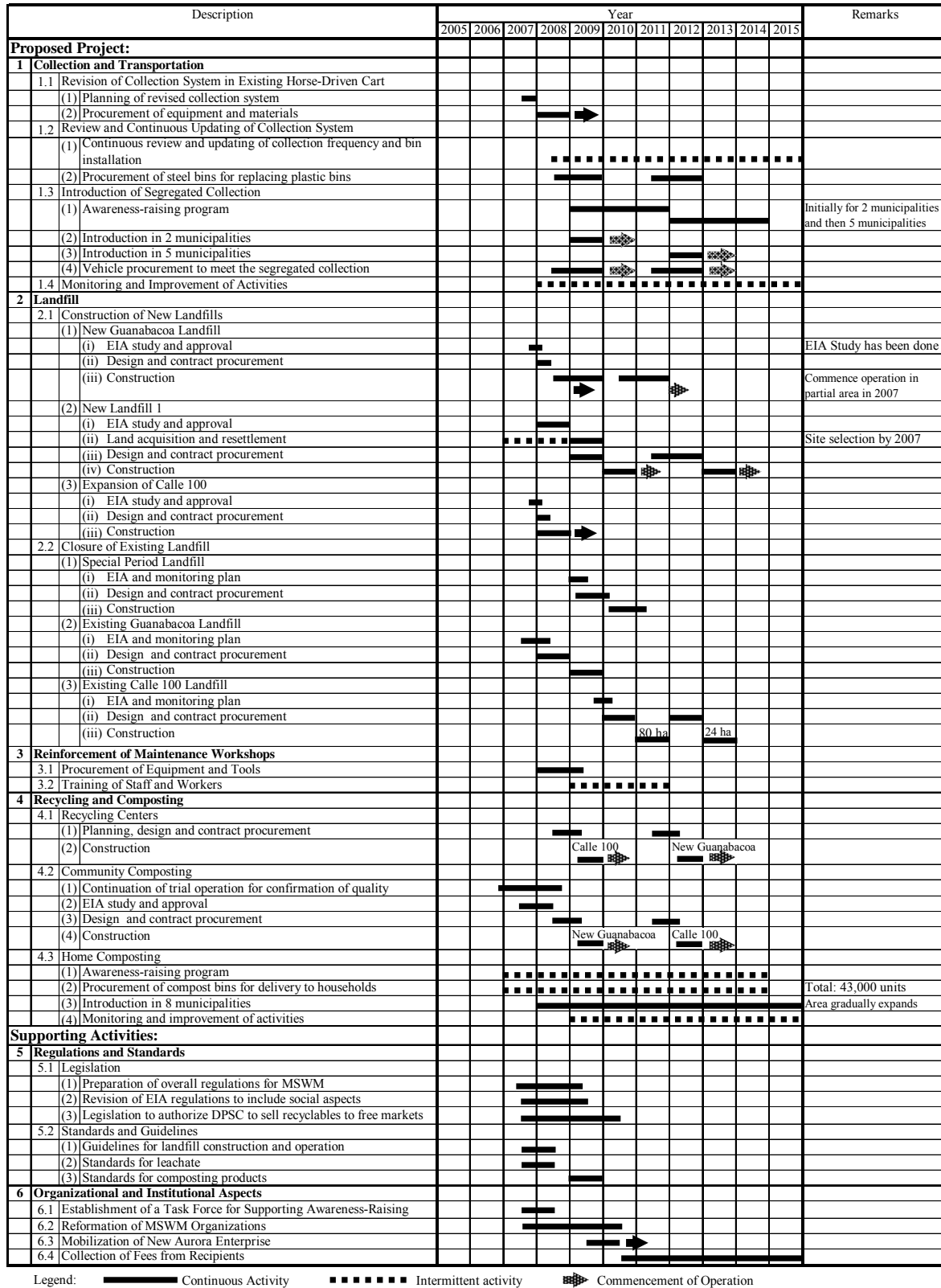


Figure 5.13.1 Implementation Schedule of the M/P

5.13.2 Cost Estimate

(1) Basic assumptions

Cost estimates covered both the capital cost (initial cost) and O/M cost (recurrent cost).

The capital cost consists of the following items:

- Direct construction and/or rehabilitation cost
- Equipment purchase and replacement cost
- Administrative expenses: estimated as 3% of the local currency portion of the capital cost to be defrayed as administrative expenses
- Engineering services cost: 2% of the foreign currency portion of capital cost and 5% of the local currency portion of capital cost to be defrayed as engineering costs
- Physical contingency: 10% of capital cost for construction works and 5% for equipment procurement work, respectively
- Land and resettlement cost: Land to be used for new landfills will be expropriated by the government. Thus, land and compensation costs for resettlement were excluded from the cost estimate above.

A large part of O/M costs is salary for staff and workers including increasing the number of employees in order to conduct the programs under the M/P. The salary rates are based on the current average of existing organizations in Havana City (DPSC, DMSCs, and Auroras).

The M/P costs estimated here are regarded as representing the prices that were prevailing in the first half of 2005, which are subsequently referred to as 2005 prices.

(2) Estimate of direct construction cost

The system used for preparing cost estimates in the Republic of Cuba for construction projects is called “PRECON” (in Spanish; *Instrucción del Sistema de Precios de la Construcción*, Ministry of Construction in Cuba), which is applied to all public works. The system provides cost information detailing labor cost, construction materials and products, equipment, and so on.

The cost estimates for the M/P and PLP were prepared using the database of “PRECON”, 24 October 2004. Examples of unit costs derived from the database are shown in Table 5.13.1⁷.

⁷ The same unit costs were used in the cost estimate for New Guanabacoa landfill, which was prepared by the Cuban side.

Table 5.13.1 Example of Unit Costs for Construction Work

Item of Work	Unit Cost* (CUP)	Unit	Remarks
Excavation Work	2	m ³	Using heavy equipment
Material Transportation from site	2	m ³	By 10m ³ truck, less than 1km
Macadam Road Work	330	m ³	Thickness: 18cm
Asphalt Pavement Work	5	m ²	Thickness: 5cm
Water Channel Installation Work	20	m ²	Depth and width: less than 1m ready-made concrete
Concrete Pipe Installation Work	90	m	Pipe dia.:450mm-600mm
Leachate Collection Pipe Installation Work	120	m	PVC dia: 100mm–250mm
Ventilation Pipe Installation	40	m	Using ductile cast-iron pipe
Materials Transportation	16	m ³	Earth, sand and Macadam

Source: *Memoria Descriptiva de Vertedero Nuevo Guanabacoa*, DCH, 26 Mar. 2004.

Note: The unit cost includes cost of materials, labor and equipment.

(3) Foreign and local currency portions

The cost includes a foreign currency (FC) portion and a local currency (LC) portion. The cost items available in the local market were estimated in LC and the items to be imported from foreign countries in FC.

When the composition of FC and LC portions was difficult to estimate, the ratio of FC and LC was estimated to be 60% FC and 40% LC, respectively. This ratio was also used in the cost estimate for the PLP prepared by a local design consultant under the JICA Study in 2005. FC and LC are expressed in US dollars and Cuban pesos (CUP), respectively.

(4) Estimated M/P cost

The total cost of projects proposed in the M/P was estimated as US\$96.7 million and CUP138.4 million, respectively. The breakdown by project is shown in Table 5.13.2 below.

Table 5.13.2 Estimated 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 5.13.4 hereinafter for total fund requirement including the estimated price escalation amount.

Further breakdown of respective projects is shown in Tables 5.13.3 below.

Table 5.13.3 Breakdown of the M/P Costs

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

Component	Capital cost						O/M Cost		Capital Cost + O/M Cost	
	Direct Cost		Indirect Cost		Direct+Indirect		FC	LC	FC	LC
	FC	LC	FC	LC	FC	LC				
Composting (total)	4.7	4.0	0.4	0.6	5.1	4.6	0.3	6.4	5.4	11.0
Composting at Calle 100	2.1	2.2	0.1	0.3	2.3	2.5	0.1	2.2	2.4	4.7
Composting at New Guanabacoa	1.6	1.8	0.2	0.3	1.8	2.2	0.2	4.2	2.0	6.3
Home composting	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0
Recycling (total)	4.0	3.9	0.3	0.5	4.3	4.4	0.3	14.2	4.5	18.6
Recycling at Calle 100	2.3	2.2	0.2	0.3	2.5	2.5	0.2	9.8	2.6	12.3
Recycling at New Guanabacoa	1.7	1.7	0.1	0.2	1.8	1.9	0.1	4.4	1.9	6.3
Collection and transportation (total)	22.7	0.0	1.6	0.0	24.2	0.0	7.5	65.5	31.8	65.5
Collection vehicle replacement	13.9	0.0	1.0	0.0	14.9	0.0	6.3	57.0	21.2	57.0
Improvement of waste bin	5.4	0.0	0.4	0.0	5.8	0.0	0.3	0.0	6.1	0.0
Maintenance workshop improvement	3.3	0.0	0.2	0.0	3.6	0.0	1.0	8.5	4.5	8.5
Landfill (total)	42.0	26.8	6.0	4.0	48.0	30.9	4.3	11.0	52.3	41.8
Construction of new site	7.5	6.5	1.3	1.1	8.7	7.6	2.2	4.6	11.0	12.2
Construction of New Guanabacoa	10.7	4.9	1.5	0.8	12.2	5.6	1.0	2.9	13.2	8.5
Extension of Calle 100	18.0	7.2	2.2	1.0	20.2	8.2	0.9	1.7	21.2	9.9
Closure of special period dumping sites	2.2	3.3	0.3	0.4	2.5	3.7	0.0	0.0	2.5	3.7
Closure of Calle 100	1.9	2.9	0.4	0.5	2.4	3.3	0.0	0.0	2.4	3.3
Closure of Extended Area of Calle 100	0.2	0.3	0.1	0.1	0.3	0.4	0.0	0.0	0.3	0.4
Closure of Guanabacoa landfill	1.2	1.7	0.2	0.2	1.4	2.0	0.0	0.0	1.4	2.0
Central workshop improvement	0.3	0.0	0.0	0.0	0.3	0.0	0.1	1.8	0.4	1.8
Awareness raising	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.4	2.1	1.4
Environmental monitoring	0.3	0.1	0.0	0.0	0.3	0.1	0.3	0.0	0.6	0.1
Total	73.6	34.8	8.3	5.2	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.

5.13.3 Disbursement Schedule (at 2005 prices)

Table 5.13.4 shows the disbursement schedule of capital cost and O/M cost at 2005 prices. This disbursement schedule has been used for subsequent economic and financial evaluation.

Table 5.13.4 Disbursement Schedule of the M/P Cost

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

5.13.4 Total Fund Requirement

(1) Price escalation rates

Actual financing for the implementation of the projects shall take into account price escalation likely to 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 as previously shown in Table 5.13.4.

The price escalation rate for the foreign cost portion was set at 1.0% per year. The manufacturing unit value (MUV) index⁸ was referred to as the proxy. The average increase rate during the period 2005 to 2015 was computed at 0.95% based on the MUV index, which was rounded up to 1%.

As stated before, the main component of O/M cost is the personnel salary cost. The average increase rate of the salary cost from 2001 to 2002 was computed at 4.2%. According to the cost data for year 2003, the personnel expenses account for 42% of the total peso expenditure for MSWM in Havana City.

Prices of other items in the O/M cost, such as materials and fuel, were assumed to be mostly foreign cost items. Thus, the weighted average price escalation rate for the local cost portion was computed at 2.3% per year ($= 4.2 \times 0.42 + 1 \times 0.58$).

(2) Total fund requirement including price escalation

Applying the price escalation rates to the base disbursement schedule in Table 5.13.4 above, a disbursement schedule with price escalation has been constructed as shown in Table 5.13.5

Table 5.13.5 Total Fund Requirement including Price Escalation

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

Description		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Capital Cost	FC	0.0	0.4	37.0	10.3	9.7	12.0	4.5	11.5	0.1	0.3	85.8
	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 Cost	FC	0.0	0.8	38.1	12.1	11.6	14.0	6.6	13.8	2.2	2.4	101.6
	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

The total fund requirement for the capital cost of the M/P was calculated to be US\$85.8 million and CUP44.4 million, and that for O/M cost US\$15.8 million and CUP115.7 million, respectively.

The breakdown of funds required by project is shown in Table 5.13.6 below.

⁸ The unit value index in US dollar terms of manufactured goods exported from the G-5 countries (France, Germany, Japan, UK, and US) weighted proportionally to the countries' exports to the developing countries. The MUV index was used in "Global Commodity Price Prospects", World Bank, 2004.

Table 5.13.6 Fund Requirement by Project (including Price Escalation)

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

Items	Capital Cost		O/M Cost		Total	
	FC	LC	FC	LC	FC	LC
1. Landfill including Closure Work*	49,964	34,121	4,631	12,861	54,595	46,983
2. Collection and Transportation**	25,586	0	8,074	76,556	33,660	76,556
3. Composting and Recycling	9,951	10,259	614	24,665	10,565	34,924
4. Awareness-Raising	0	0	2,191	1,542	2,191	1,542
5. Environmental Monitoring	288	62	293	46	581	108
Total	85,789	44,442	15,803	115,670	101,592	160,113

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

2. Price escalation rate: 1.0 %/year for FC and 2.3 %/year for LC

* Cost for central workshop improvement is included.

** Cost for waste bins and maintenance workshop improvement is included.

5.14 Institution and Organization Plan

5.14.1 Organizational Framework Alternatives

This M/P proposes the setting up of a new institutional and organizational framework for MSWM in Havana City, aiming to improve the current level of service.

In studying the institutional framework, several types of institutional model currently being adopted in Latin American countries were taken into account, namely:

- Direct administration by Municipality
- Municipal administration through outsourcing of the services
- Autonomous government authority (state enterprise)
- Concession by the government to the private sector
- Free market (private company providers)
- Combined models of the above.

Reviewing the advantages and disadvantages of the above, the following alternatives were listed for consideration as possible institutional models meeting the specific situation of Havana City:

- a) Remain as it is today, solid waste managed by DPSC and DMSC and two municipalities using the Aurora system.
- b) Extend the concept of one Aurora for each municipality: Replace the DMSCs by an Aurora until the 15 municipalities of the whole city are covered, and abolish UPPH.
- c) The same as above but with grouping of Municipalities: Set up Auroras for adjoining municipalities, each Aurora covering all the collection, street sweeping and disposal services in its area.
- d) Set up Auroras, based on their activity, one for solid waste collection and street sweeping, one for final disposal and another for vehicle and equipment operation and maintenance.
- e) Set up only one Aurora (Holding Company) for all the services and for the whole territory of Havana City.
- f) Create a joint venture with a foreign company, using the same model being used for the water and sewerage service provision.

5.14.2 Proposed Organizational Framework

(1) Aurora model

Comparing the above alternatives, the institutional model suitable for MSWM in Havana City would be to adopt the Aurora concept for the following reasons:

- a) The Aurora model is in line with a policy of providing public services through enterprise-like institutions that can pursue self-financing.
- b) In this type of institution, the staff is more motivated because the salaries may be set according to the productivity of each worker or group of workers, which is different from the government-budgeted institutions where salaries are fixed by category of staff regardless of their achievement.
- c) This type of institution has more autonomy in the management of its financial resources. For example revenue from tariff collection can be utilized to strengthen their financing conditions. This is a very important feature in enterprises that are operated on activity-based costing.
- d) The Aurora model will reduce the budgetary burden on the Government. Financing of the institution, or at least part of it, comes from revenue, so it is not fully dependent on a fixed budget as is the case with budgeted institutions.
- e) The Aurora model is an institutional framework already utilized in Cuba, which is fully compatible with the existing government administrative system.
- f) Higher work efficiency is expected in the case of the Aurora model. The table below shows that the performance of the existing Aurora institutions is around 20% higher than the Havana City average.

Table 5.14.1 Performance of Aurora Institutions

Municipality	Waste Quantity Collected	Productivity
Aurora Plaza	4.06 l/capita/day	0.61 tons/employee/day
Aurora Habana Vieja	3.54 l/capita/day	0.62 tons/employee/day
Average of Havana City	3.20 l/capita/day	0.52 tons/employee/day

Source: Waste quantity survey conducted during the Study.

The Aurora model has already been introduced by the Government in the two urban municipalities that require efficient solid waste management services. First, this concept was applied in Plaza de la Revolucion Municipality as a trial case, and four years later in the Habana Vieja Municipality after confirmation of improved performance from Aurora in Plaza de la Revolución.

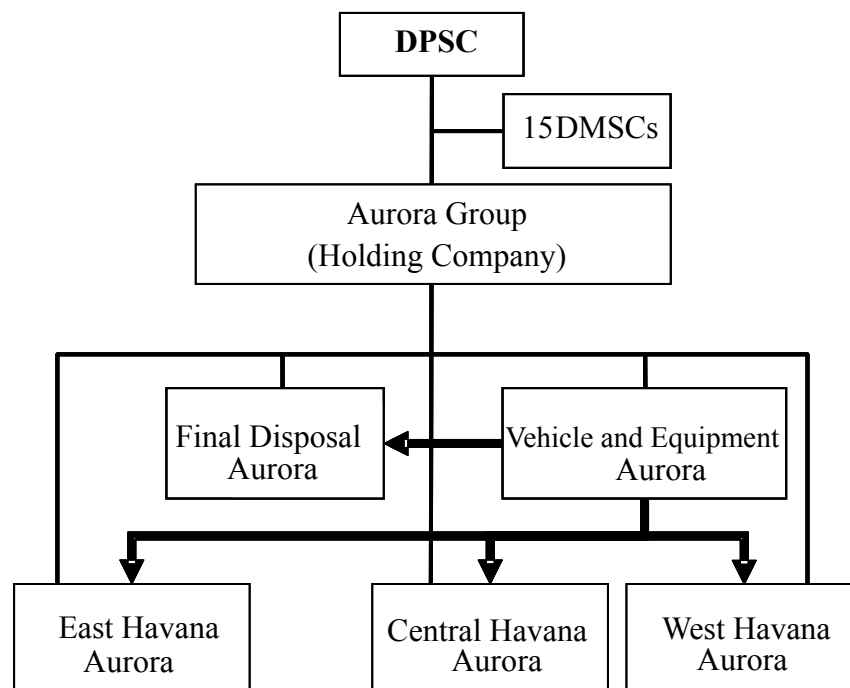
(2) Structure of proposed Auroras

Taking into consideration that the Aurora concept would be the basis of a new institutional model, the following organizational structure is proposed:

- Three regional Auroras will be in charge of collection of all kinds of MSW and street sweeping activities, one each for eastern, central and western parts of the City.
- One Aurora is to be in charge of operation of the disposal facilities (landfills). The regional Auroras will pay fees for safe disposal of waste to this Aurora responsible for final disposal.
- One Aurora is to be in charge of providing vehicles and heavy equipment to the regional Aurora and the final disposal Aurora. This Aurora will receive rental fees from the other four Auroras.
- The above five Auroras will be headed by one holding company, the Aurora Group, as shown in the following chart.

DPSC will carry out inspections of Aurora MSWM operations centrally through staff specially assigned for this task. The 15 DMSCs will be in charge of controlling the collection and street sweeping services in the respective territories. DPSC will also be responsible for litter control.

Figure 5.14.1 shows the proposed organizational structure of the proposed Auroras.



Legend: ← : Lease for vehicle & equipment

Figure 5.14.1 Proposed Organization Structure for MSWM

(3) Advantage of establishing Aurora

The proposed new institutional model has advantages in the following respects:

(a) Separation of operation and control functions

At present, there are two types of operational system. One is the direct operation by DPSC and DMSCs in 13 municipalities, where DPSC and DMSCs conduct both the operation and control of the services. The other is the system introduced in the two municipalities (Habana Vieja and Plaza de la Revolución), where Auroras are providing operational service, and DPSC and DMSCs are acting as supervisory bodies to control and evaluate the work done by the Auroras.

In the new institutional arrangement, the latter system will be introduced to cover all the municipalities of Havana City. In this system, DPSC and DMSCs can concentrate on functioning as the planners and regulators of MSWM, and Auroras on functioning as efficient service providers.

(b) Enhancing incentive and motivation

In practical terms, provision of more autonomy will enhance the incentive of the organization and the motivation of staff and workers. The organization will seek ways for providing better quality of services for customers, better salaries for staff and workers, and incentives for the administrative activities. Being a semi-autonomous institution placed administratively outside the usual government structure, the Auroras will have the possibility of having their own salary structures based on actually attained performance. Of course the salary system in the DPSC and DMSCs in the present structure is subject to approval by the Ministry of Labor, as is mandatory for all salaries of the public sector in Cuba.

(c) Potential of improving financial viability and sustainability

Being more independent from the government budget and being able to charge different types of tariff to its customers will provide the new Auroras with a certain degree of financial sustainability. Auroras have the potential of attaining financially self-reliant operation when they are allowed, in the future, to charge tariffs reflecting all the costs of operation and investment.

(d) Specialization of work

The proposed new Auroras will be devoted to specific tasks, such as solid waste collection and street sweeping, final disposal, and vehicle and equipment maintenance. The Aurora holding company will concentrate on

the tasks of management of the Aurora Group. The specialization of work will enhance the expertise of staff and allow the workers to focus on their specific subjects.

(e) Encourage competition

One of the reasons to split the collection and street sweeping Auroras into three different territories is to encourage competition among them. It is expected that the competition will help to improve the quality of services of the respective regional Auroras.

5.14.3 Proposed Organizational Structure of Aurora

(1) Responsibility of each Aurora

(a) Aurora Group (holding company)

This holding company will be in charge of:

- Overall administration of manpower, finance, operation monitoring and budget control of the Auroras in the group
- Collection of tariffs charged to solid waste generators. The holding company will invoice the generators directly and receive payments. After collection of monies, the resources will be distributed to the five operation companies according to their revenue sharing.
- Operational and strategic planning for medium and long-term activities, covering all of the Auroras, while each Aurora will make its own short term plans.

(b) Three regional Auroras

These three companies will be responsible for:

- Collection of MSW from the respective jurisdiction areas:
 - East territory enterprise: San Miguel de Padrón, Cotorro, Guanabacoa, Habana del Este and Regla
 - Central territory enterprise: Plaza de la Revolución, Centro Habana, Habana Vieja, Cerro and Diez de Octubre
 - West territory enterprise: Playa, La Lisa, Marianao, Arroyo Naranjo and Boyeros
- Supply of recyclable and composting materials to the Final Disposal Aurora, that are collected from the segregated collection areas within its jurisdiction.

(c) Vehicles and Equipment Aurora

This company will be in charge of:

- Providing vehicles and equipment through rental contracts, which include collection trucks, mechanical street sweepers, water tank trucks, and loaders, for the work undertaken by the three regional Auroras.
- Providing bulldozers, loaders and open dump trucks to the Final Disposal Auroras, on a rental basis.

The vehicles and equipment will be supplied with drivers/operators and fuel on a rental basis. The corresponding fees will be paid by the lessee Auroras to the Vehicle and Equipment Aurora.

(d) Final disposal enterprise

This company will be in charge of:

- Solid waste disposal at the designated landfills
- Handling and trading recyclable materials that are collected in the landfills and brought in to the recycling plant
- Operation of community composting yards, which are to be developed in or near the New Guanabacoa and Calle 100 landfills.

(2) Overall administration of Aurora Group

A president selected by Havana City Provincial Government will chair the holding company. The Ministry of Economic Planning, through the Director of Territorial Planning and Communal Services, shall approve this selection. The administration of the holding company will be headed by an administration board, composed of a President, a Finance and Administration Director, a Planning and Technical Director, and a Legal Matters Advisor.

The administrative structure of the overall administration of the Aurora Group is presented in Figure 5.14.2.

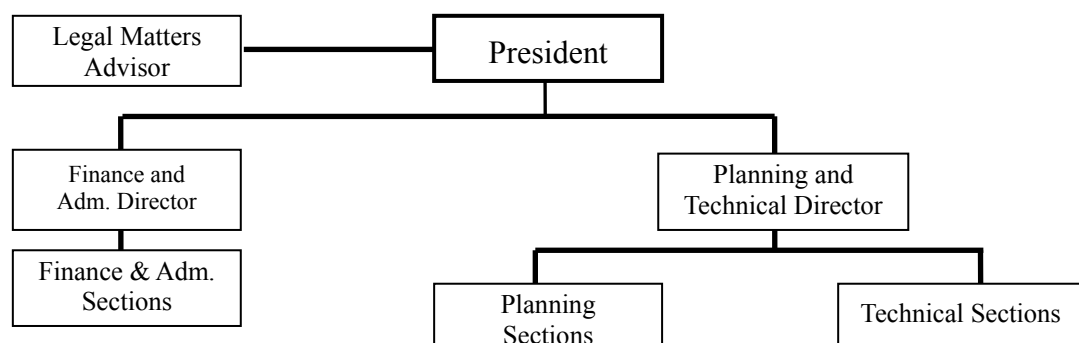


Figure 5.14.2 Administrative Structure of Aurora Group

(3) Financial revenue sources

In the initial period of the Aurora operation, the main source of financial income will be the subsidy from the Government. In the long run, Aurora will have the following four potential revenue sources:

(a) Revenue from the services of solid waste collection:

Provided that the Aurora is legally authorized to collect tariffs, the Aurora Group (holding company) will commence charging tariffs to all the recipients that receive service from the regional Auroras except households. These tariffs will be charged monthly, in CUP and CUC, according to the approved rates.

Tariffs will be grouped broadly into two, tariffs for households and non-residential generators. It is proposed that the Government will provide a subsidy for households at an amount equivalent to 100% of the tariff (ref. Subsection 5.15). Non-residential generators include commercial, institutional and industrial waste generators as well as foreign individuals. In the latter case, charges will be fixed, either in CUP or CUC, according to the classification of the waste generators.

(b) Revenues from street sweeping:

Charges for street sweeping will be paid by the municipalities according to the work done, that is, based on the length of streets swept. These charges will be collected by the Aurora Group and transferred to the regional Auroras according to the amount of service provided by each one.

(c) Tipping charge:

The Final Disposal Aurora will derive its income basically from tipping charges. These will be applied to the regional Auroras as well as to the independent haulers that carry solid waste to the landfills.

(d) Sale of recyclables and compost products:

Additionally, it is expected that income will be obtained from the sale of recyclable materials and compost processed in the disposal Aurora's unit. Both the collection of tipping charges and the sale of recyclables will be done by the Aurora Group.

Most of the above revenues are gained in CUP currency. However, part of the revenue from non-residential waste generators will be in CUC currency.

Figure 5.14.3 below shows the flow of financial revenues including internal transfer within Auroras.

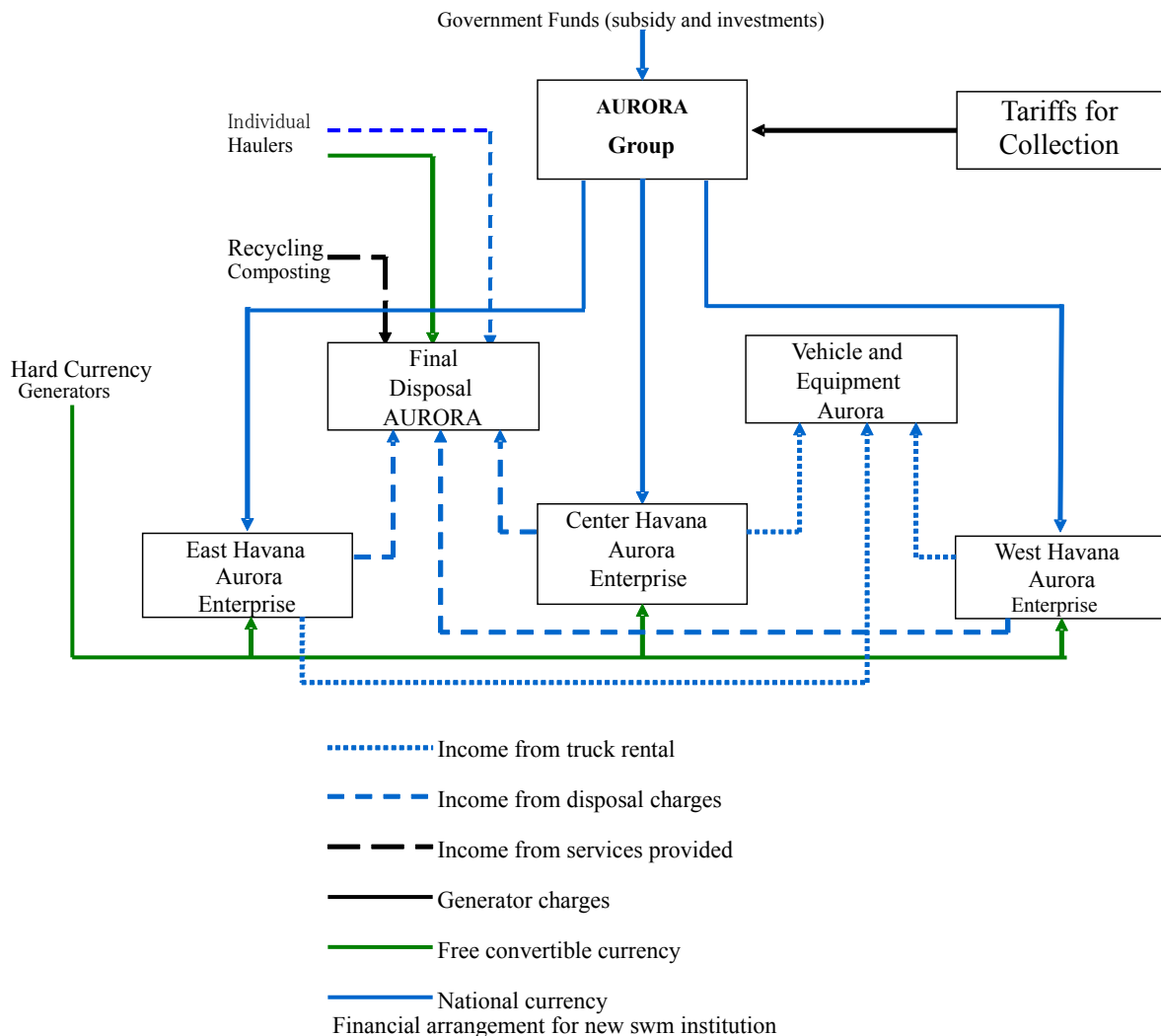


Figure 5.14.3 Financial Arrangements for Auroras

(4) Time schedule for establishment of the proposed new institution

Taking into consideration the need for time to prepare the new institutional structure and the relevant legislation, it is proposed that the new organization, including the restructuring of Auroras, will be processed toward 2010 when segregated collection of MSW would start.

In 2010, all the five new Auroras will be set up, absorbing the two existing Auroras of Habana Vieja and Plaza de la Revolución, and the operation staff, vehicles and equipment currently owned by UPPH and the 15 DMSCs.

5.14.4 Organizational Management and Staff Training

Associated with the establishment of a new administrative and institutional structure, the existing organizations in charge of MSWM in Havana City will be reformed as proposed below.

(1) CITMA Delegation

The CITMA Delegation to the province of Havana City already works closely with UPPH through DPSC. Nevertheless, some actions could be initiated in order to enhance its role in helping and providing support to MSWM activities in Havana City, especially in terms of control and monitoring. Some of these initiatives are proposed below:

(a) Technical capacity development

Notwithstanding that CITMA has a qualified group of professional staff, most of them seem not to have specialized knowledge regarding MSWM. As the officials of the central administration agency, they shall have training to gain knowledge of solid waste disposal techniques, including leachate and biogas control. Based on the knowledge, they will be involved in the preparation of norms and legislation that would be required for proper control of MSWM. In this regard, CITMA Delegation officials shall be given the opportunity to attend meetings, seminars, conferences, etc., in the country and elsewhere, concerning MSWM topics.

(b) Logistics support

One of the most pressing problems today for CITMA Delegation staff is the lack of transportation vehicles that would allow their inspectors to visit and to check possible environmental offenses. In this regard, transportation devices, vehicles and/or motorcycles, shall be provided to the CITMA Delegation officials.

(c) Integration of inspection activities with DPSC

It is recommended that the current inspection and control activities of CITMA be integrated with those being conducted by DPSC and several DMSCs, especially those related to demolition debris, old furniture and tree branches illegally disposed of in public spaces, such as parks and gardens, vacant lots, river banks and in the water drainage system.

(2) DPSC

(a) Gathering data

DPSC, as the main institution involved with MSWM in Havana City, shall have an improved capacity to gather data related to the activities of UPPH, the hygiene sector of several DMSCs and the Auroras, and further process them in order to provide information for operational and technical planning. This capacity will be embodied in a planning section of DPSC with qualified officials trained on MSWM subjects.

As a first step this requires preparation of the format of work record sheets to be used by the operation sections dealing with waste collection, treatment and disposal and street sweeping so that the staff/workers can record the data and have it input into the corresponding databases.

Among other measures, it is important to record the quantity of waste, for which an essential facility is a set of weighing scales to be installed in the final disposal sites in order to measure the weight transported by each type of vehicle. There are at the moment no weighing scales installed, except for a set at Calle 100 landfill, which is, however, currently out of order.

(b) Training of staff and technicians

DPSC has a number of staff and technicians, but many of them seem not to have been fully trained to have knowledge on MSW operational matters. Training of DPSC staff and technicians will be required on the following subjects:

- Integrated MSWM planning and operation
- Efficient methods of household waste collection and street sweeping control
- Solid waste disposal techniques and equipment operation
- Resource management within the institution.

(3) UPPH, DMSC, Aurora

In order to achieve smooth operation in the maintenance work of SWM, UPPH, DMSC and Aurora, they shall be carry out the following items of work in consideration of capacity development of operation staff.

1) Operation records for MSW

In order to control and monitor collection operations for MSW, it is required to establish a recording system for the quantity of MSW transported and

disposed of. This system will be based on the weighing of all truckloads of MSW.

2) Operation manuals for MSWM

Presently, there are no operation manuals for collection systems and landfill operations in MSWM. Operation manuals are indispensable for smooth operation of MSWM. Therefore, each concerned organization shall prepare manuals according to their requirements as soon as possible.

3) Performance standards

Performance standards for collection systems and landfill operation are not presently available. For achieving high performance MSWM, standards will be utilized as targets and guidelines in the maintenance work by each concerned organization

4) Training for SWM operation staff

Presently, there is no training plan for MSWM. Reinforcement of operation capacity of organizations through skilled personnel is necessary for the smooth operations of MSWM. In this regard, training of operation staff shall be carried out by each MSWM organization.

5.14.5 Reinforcement of Legal Framework

Reviewing the present configuration of regulations and standards relevant to MSWM, further elaboration will be needed on the following items:

(1) Revision of regulations regarding the location of landfills

The current Cuban Standard 135:2002 “Requirements for Final Disposal of Urban Solid Wastes” states in paragraph 5.6 that: “the solid waste final disposal sites shall be, in terms of limits from urbanized areas, located according to the minimum distance specified in Cuban Standard 3:1999, i.e., a minimum distance of 1,000 meters from urbanized areas.

The current regulations were prepared for the case of solid waste disposal in open dumps where there would be many environmental impacts deteriorating the natural environment and human health. In the case of environment-friendly landfills, which would involve only minimum impact on the environment, the location regulation can be mitigated.

Taking the above into consideration, the current air pollution norm may be revised such that, “for approved types of environment-friendly landfill, the distance from

urbanized areas can be reduced to 500 meters to cover the case where the urbanized area is located on the lee side of the prevailing wind (wind blowing more than 50% of the time in the same direction) and 300 meters in the other wind directions”.

(2) Guideline for use of mineralized solid waste as cover soil at landfills

Use of mineralized waste at the existing landfill can be allowed since there is no formal prohibition to this practice.

After years of natural aerobic or anaerobic decomposition, municipal solid waste turns into mineralized earth-type material that is biologically inert and therefore can be used as cover material for environment-friendly landfills. A concern for the use of this material is the possibility of spreading in the environment chemically non-inert substances dumped previously with the municipal solid waste. For example, there was a case in Havana City that, when the old landfill of Cayo Cruz, on the shore of Havana Bay, was dug out, toxic substances were released into the environment.

In order to ascertain that the mineralized solid waste is safe for the purposes of covering the fresh municipal solid waste, samples need to be taken and analyzed in order to make sure that no hazardous or toxic materials are present in the mineralized waste. Another recommendation is to routinely analyze the leachate coming out of the old solid waste pile, in order to ascertain that there is no toxic or harmful substance in the leachate, and therefore in the mineralized solid waste.

The use of mineralized waste shall be put into practice in accordance with guidelines and standards to be prepared in advance.

(3) Standards for quality of compost made from MSW

There is no formal prohibition on the use of compost produced from solid waste for agriculture, but, on the other hand, there is also no standard for ensuring compost quality. The quality of compost is currently not subjected to any standardized analysis.

The main concern for the use of compost from municipal solid waste is the possibility of it containing heavy metals and other toxic substances. As long as there is no separate collection of kitchen and green wastes for making compost, there is a risk that unwanted substances may be present in the compost. The interim recommendation, therefore, is to use compost from solid waste only for vegetation and greening in parks and gardens, flower production, reforestation, etc.

When segregated collection of kitchen and green wastes reaches a high standard and the quality of compost is assured, it can be used for agriculture.

Preparation of compost quality standards is an essential requirement before the introduction of compost production.

(4) Marketing recyclables

An important source of financing for the MSW operating agencies (UPPH, Hygiene Departments of DMSCs and Aurora) will be the selling of recyclables.

According to Law 1288 of 1975, it is mandatory that all government institutions shall collect the scraps that are produced and can be recycled, and convey them to the UERMP in order to send them to industries for reuse. This system has been used to place the UERMP as the sole buyer of recyclables from MWSM systems in Havana. However, the current rate of UERMP's purchase from the institutions remains at a relatively low price, which gives the institutions no incentive to improving the recycling activity.

In order to promote more efficiency in the recycling business, it is proposed that DPSC, and in the future the Aurora Group, be allowed to sell directly to the market (including foreign markets) the recyclable materials collected through the segregated collection system. This requires the revision of Law No. 1288 of 1975.

(5) Regulations concerning public cleanliness

Concerning public cleanliness, there are two existing codes:

- Decree No. 272 and Decree Law No. 99: Offenses for City Cleanliness
- Resolution No. 16/94: Regulation for Hygiene and Beautification of Havana City

In both the above legislation codes, the aspects of public cleanliness, particularly the aspect of MSWM, represents only a small part with most of the descriptions being concerned with other issues such as parks and gardens maintenance, cemeteries, use of public spaces, etc.

A conceptual framework of revised regulations was drafted and is presented in Supporting Report E.3 of the Final Report of the JICA Study. The proposed draft regulation covers the aspects of roles, duties, responsibilities and obligations of the government agencies and of the citizens and other MSW generators as a whole.

It also covers the responsibility for keeping the streets and other public spaces clean, including the disposal of demolition debris and litter generated in the public areas and the procedures for recovery and recycling of solid waste.

(6) Regulations for environment-friendly landfill

The existing regulations for construction and operation of landfills are embodied in several acts of legislation, mostly regarding environmental protection. The regulations, however, deal with the requirements for old types of landfill, but do not reflect the recent advancements in environment-friendly landfill technology.

In order to provide a conceptual framework of regulations for environment-friendly landfill, the draft version of regulations was prepared covering the aspects of planning, construction, operation, and monitoring during and after construction. The proposed draft is included in Supporting Report E.10 of the Final Report of the JICA Study.

5.15 Financing Sources

5.15.1 Financing Alternative

Nearly 90% of the MSWM expenditure in Havana City was financed by government funds in 2003. The remaining 10% was financed by tariff revenues (ref. Table 5.2.1). This dependence level on the government is very high and should be moderated as much as possible, although drastic reduction may be difficult. Financing alternatives are summarized in Table 5.15.1. Several financing alternatives can be combined to raise sufficient funds to sustain the MSWM services.

Table 5.15.1 Financing Alternatives of SWM Cost

	General Situation in Developing Countries					Practicability and Consideration in Cuban Context
	Adequate Revenues?	Easily Collected?	Polluter Pays?	Politically Acceptable?	Enforceable?	
User charge:						
Fixed Charge	Yes, if set at higher level than cost	Yes	No	Yes	Yes	Current tariff is mostly constant usage charges, thus there is familiarity.
Volume or Weight Based Charge	As long as rates are set based on costs and updated as needed	No, requires sophisticated collection system	Yes	No	Leads to dumping behavior without local inspection and enforcement capacity	Weight based charge is difficult to introduce because solid waste from each household and company has to be weighed.
Tipping Fee	Yes, if based on full costs of investment and operation	Yes, if weigh-bridges (truck scale) are utilized	Yes, if fees are passed on by hauler to waste generator	Municipalities are often reluctant to pay fair share	Yes, but must verify that trucks go to disposal site	Although no weigh-bridge is available, tariffs based on truck type can be applied.
Other revenues:						
Recyclables and compost sales	Market demands and prices affect the sales.	Yes	No	Yes	No, collaboration with habitants is key	Segregated collection has not been institutionalized.
Garbage tax	Can generate adequate revenues if rates are set based on costs, and are updated as needed	Often collected with property tax; Direct collection is expensive (about 10-13% of total costs)	Only to extent that rate depends on surrogate for waste generation, such as lot size and property value	Requires political will to set and update rates	Difficult to withhold service for non-payment; Inefficient when collected with property tax	Salaried workers are not accustomed to pay such tax. Companies are already paying various taxes including corporate tax, work force utilization tax, and social security contribution.
Property Tax	Suffers from typical weakness in property tax collection	Yes	No, except to extent that property tax is surrogate for waste generation	Requires political will to collect property tax and update rates	Evasion commonly observed	Property tax for real estates does not exist. However property taxes for vehicles and boats have been introduced.
Business License	Yes	Yes	No	Yes	Yes	Surcharging on commercial license is possible. Auroras already charge directly to business entities.
Utility Surcharge	Yes	Yes	No, except to extent that energy use is surrogate for waste generation	Not easy to get utility cooperation; often legally challenged	Yes	Aguas de La Habana and Empresa Electrica Ciudad Habana charge directly to domestic users, thus surcharging of SW fee is possible.
Government subsidy (including transfers)	Yes, but at expense of other needs	Yes	No	Low political priority for disposal services	No guarantee that funds will be allocated	Currently 90% of SWM cost is financed in this way.

Source: Prepared by the Study Team based on the data "urban development" in the World Bank website

(1) Analysis of SWM Tariffs

Havana City started charging solid waste fees in 1997 when Aurora companies (Aurora Plaza and Aurora Habana Vieja) were created as independent profit organizations. The task of tariff setting is the responsibility of Aurora Plaza. Aurora Habana Vieja is not involved as it is less adept at cost accounting than Aurora Plaza. The tariff proposal prepared by Aurora Plaza was confirmed by the DPSC, DPEP (Provincial Direction of Economy and Planning), and DFPF (Provincial Direction of Finance and Prices). It was the MEP and the MFP (Ministry of Economy and Planning) that finally approved the tariffs and promulgated the joint resolution. The latest tariff review was carried out in late 2004 and the new tariffs were approved in February 2005. The solid waste collection tariffs are summarized in Table 5.15.2.

Table 5.15.2 Present Solid Waste Collection Tariffs

Collection type Customer type	Curbside collection	Collection by exclusive bin *2
Households	CUP0.4/person/month *1	Not applicable
Cuban institutions without CUC earnings	CUP2.1/account/day	CUP3.8/bin/day
Cuban institutions with CUC earnings	(CUP1.1 + CUC1)/account/day	(CUP2.3 + CUC1.5)/bin/day
Foreigners and tourism	CUC1/account/day	CUC4/bin/day

*1: Although the tariff is set, actual payments are made by the municipal governments.

*2: Non-domestic users (commercial, industrial, service, etc.) dispose solid wastes either to communal containers or to exclusive containers.

The current tariffs are principally applied to all inhabitants and entities in the business territories of “Aurora” companies, which are the municipalities of Habana Vieja and Plaza de la Revolución. The two Aurora companies (Aurora Habana Vieja and Aurora Plaza) are self supporting entities and have been established to cover the municipalities where there are non-residential clientele bases of considerable sizes. Small scale “Aurora” budget units were created in three municipalities (Miramar, Guanabao, and Cayo Hueso) where the number of foreign currency earning customers was not as high as in Habana Vieja and Plaza de Revolución. Aurora budget units collect charges from non-domestic users and are located within the municipal offices and collect SWM fees from non-domestic users. In the other municipalities where no Aurora companies or Aurora budget units exist, the municipality’s UPPH is substituted for the Aurora. The actual tariff collections are relatively thorough in the business territories of Aurora Habana Vieja and Aurora Plaza, but nowhere else.

The MSW collection tariffs can be divided into the CUP part and the CUC part. This bi-currency tariff structure is a result of the tariff setting in 2005. The MSW management service costs are composed of the CUP cost and the CUC cost. These bi-currency costs are reflected in the current tariff to the maximum extent, thus the tariffs maintain the bi-currency structure.

The tariff for households is set at CUP0.4 per person per month and is applied to most Cuban households. Although the tariff for households is set, the inhabitants are not actually charged. Instead, the payments are made by the municipal governments. This approach is compromise between the Auroras' need to ensure self sustainability by collecting MSW fees from service recipients and Havana City's policy of not requiring households to pay MSW fees. Tariffs for services other than solid waste collection are summarized in Table 5.15.3.

Table 5.15.3 Tariffs for Other SWM Services

Type of service	Non- CUC earner	CUC earner
Manual cleansing (solid waste collection and site cleansing)	8.45 CUP/ m ³	8.45 CUC/ m ³
Manual and machine cleansing (solid waste collection and site cleansing)	7.6 CUP/ m ³	7.6 CUC/ m ³
Manual cleaning, solid waste collection, and cleansing by water truck (weekly)	300 CUP/ account/ month	300 CUC/ account/ month
Daily sweeping and twice-a-week cleansing by water truck	350 CUP/ account/ month	350 CUC/ account/ month
Cleansing by water truck (weekly)	150 CUP/ account/ month	150 CUC/ account/ month
Cleansing by water truck (twice-a-week)	300 CUP/ account/ month	300 CUC/ account/ month
Cleansing by water truck	30 CUP/ trip	30 CUC/ trip
Manual street cleansing	6 CUC/ 000 m ²	6 CUC/ 000 m ²
Road sprinkling	3.6 CUP/ hectare	3.6 CUC/ hectare
Cleansing of bus stop	3.6 CUP/ bus stop	3.6 CUC/ bus stop
Cleansing of fountain and monument	118.35 CUP/ site	118.4 CUC/ site
Tipping fee at dumping site	0.5 CUP/ tonne	0.5 CUC/ tonne
Cleansing and maintenance of park and avenue	3 CUP/ 000 m ²	3 CUC/ 000 m ²
Machine sanitizing of event site	0.058 CUP/ m ²	0.058 CUC/ m ²
Manual sanitizing of event site	0.048 CUP/ m ²	0.048 CUC/ m ²

Source: DPSC

It should be noted that the tipping fee is set at CUP0.5/ton. However, this tariff is not actually enforceable. Vehicles carrying solid wastes, whether belonging to UPPH or not, are free to enter the landfill sites and dump wastes without paying any fees. This is because the current tariffs have been set in accordance with the

activities of the Aurora. Thus the tipping fee at the landfill is just a nominal fee because the Auroras are not involved in landfilling.

The Aurora's tariff setting process follows the revenue requirement method. Generally there are two methods of pricing SWM services, which are the marginal cost method and the revenue requirement method. Under both methods, the tariff level should be set adequately and the tariff structure should be rational, so that the SWM service operator can operate and expand the system in a technically efficient and financially sound manner.

The marginal cost method is to price at marginal cost, where the SWM service operator would regularly calculate the cost of supplying the next unit of service, and price the product accordingly. The marginal cost can be calculated for long-term as well as short-term time frames. The revenue requirement method is to calculate the revenue required by the operators to meet their financial obligations, and then to reasonably apportion the revenue requirement between the different customer groups.

The appropriateness of the tariffs can be determined by three factors: (i) cost coverage requirements; (ii) objective price level; and (iii) ability of the service users to pay for the SWM services.

The most understandable example of the cost coverage requirement would be the "full cost recovery" where service users and/or polluters are required to contribute all of the operation costs for the SWM. The operation costs may or may not include depreciation costs which can be interpreted as capital costs. Whether or not the capital costs should be included in the operation costs depends on the SWM policy of the service provider or its superior organization.

In the case of Aurora's tariff setting, the cost accounting includes the costs of the required materials, labor inputs, depreciation, indirect costs, and a margin of 15%. However this cost calculation is based on full capacity utilization, which is not necessarily the case for the Aurora. As a result, unit costs and computed tariffs tend to be inflated. Therefore the estimated input costs have to be checked to determine if they are consistent with the actual costs incurred.

The Study Team presented a tariff setting simulation model to the Cuban side at the capacity building workshop. The results of simulations under three scenarios are shown below:

The first scenario is the case where the present SWM tariffs are applied to the entire Havana City area. The results showed that the cost recovery rate was 38% for the CUC cost portion and 14% for the CUP cost portion. The second scenario

is the case where the full cost recovery is achieved with cross-subsidies only from non-household users to household users. To realize this situation, the tariffs would have to be raised exorbitantly. The inhabitants would be charged CUP2 per person. A company using an exclusive bin would have to pay as much as CUC40 + CUP1700 per bin. The third scenario is the situation where 50% cost recovery is achieved with a certain cross-subsidy. The tariffs would be CUP2 per person for household users. A company which earns no foreign currency and uses exclusive bins would have to pay about CUC10 + CUP100 per bin. A company earning foreign currency and using exclusive bins would pay about CUC70 + CUP600 per bin. All these results are based on the cost data for the year 2003. However, this data contains various estimations due to the lack of information. Therefore more precise data should be applied and the tariff model should be refined when employed as a reference in actual tariff setting.

The second factor in determining the appropriateness of a tariff is the objective price level. The objective price level can be gauged through a comparison with other tariffs. Other tariffs include the prices of other utility services such as water supply, sewerage, electricity, gas and fixed-line telephone. The other utility tariffs are summarized in Table 5.15.4.

The inhabitants in Aurora's business territory are charged CUP0.4/person/month for solid waste collection services, which can be converted into CUP2/household/month for an average sized household of four family members. This level can be regarded as appropriate if compared with the water charge of CUP4 or sewerage charge of CUP1.2 per household. The solid waste tariff could appear quite low if compared with the electricity tariff which is CUP40/household as an estimated average monthly bill. It should be reiterated that the solid waste charge is not actually collected from inhabitants. Municipal governments pay Aurora on behalf of the inhabitants.

Table 5.15.4 Utility Tariff Comparison

Service type (Provider)	Tariff for local currency earners *a	Tariff for foreign currency earners *a	monthly pay *b
Solid waste collection (Aurora)	<u>Domestic</u> CUP0.40 person/ month <u>Industry (discharge to collective use container)</u> CUP1.00 account/ day <u>Industry (discharge to private container)</u> CUP2.00 account/ day	<u>Domestic and industry (discharge to collective use container)</u> 30.00 CUC account/ month <u>Industry (discharge to private container)</u> 4.00 CUC account/ day	CUP1.6 *c
Water (Aguas de La Habana)	<u>Domestic (unmetered)</u> CUP1.00 person/ month <u>Domestic (metered)</u> CUP0.25/ m ³ up to 3 m ³ CUP0.50/ m ³ between 3-4.5 m ³ CUP0.75/ m ³ between 4.5-6 m ³ CUP1.00/ m ³ between 6-7.5 m ³ CUP1.50/ m ³ for > 7.5m ³ <u>Commercial</u> CUP1.20/ m ³ <u>Industry</u> CUP0.35-0.60/ m ³	<u>Domestic</u> 1.00 CUC/ m ³ <u>Commercial</u> 1.20 CUC/ m ³ <u>Industry</u> 0.35-0.60 CUC/ m ³	CUP4
Sewerage (ditto)	30% of water bill	30% of water bill	CUP1.2
Electricity (Eléctrica Ciudad Habana)	<u>Domestic</u> CUP0.09/ kWh up to 100 kWh/ month CUP0.20/ kWh between 101-300 kWh/ month CUP0.30/ kWh for > 300 kWh/ month <u>Non domestic users</u> CUP3 to 5/ kW/ month for each contracted kW + CUP0.02 to 0.083/ kWh used	<u>Domestic</u> 0.1215 CUC/ kWh <u>Tourism, commerce and telephone companies</u> 3 CUC/ kWh/ month for each contracted kW + 0.095 to 0.17 CUC/ kWh used	CUP40
Gas (Compañía de Gas Licuado, Compañía de Gas Manufacturado)	<u>City gas user (domestic, metered)</u> CUP0.11/ m ³ <u>City gas user (domestic, unmetered)</u> CUP1.05/ person/ month CUP1.95/ 2 persons/ month CUP2.90/ 3 persons/ month CUP3.85/ 4 persons/ month <u>LP gas user (domestic)</u> CUP7/ 10kg bottle CUP31.50/ 45kg bottle <u>City gas user (state company)</u> CUP0.1224/ m ³ <u>LP gas user (state company)</u> CUP8.404/ 10kg bottle CUP37.818/ 45kg bottle	<u>Diplomats and foreign firms</u> 0.24 CUC/ m ³ <u>JV companies</u> 0.1370 CUC/ m ³	CUP7
Telephone (ETECSA)	<u>Domestic</u> CUP6.25/ line up to 300 minutes/ month <u>State company</u> CUP9.95/ line up to 300 minutes/ month	<u>Domestic and JV companies</u> 10 CUC/ line up to 300 minutes/ month	CUP20

*a: Effective in October 2004

*b: Estimated average monthly bill per household

*c: Aurora receives payment from municipalities based on the number of inhabitants. Households do not actually pay.

The third factor, namely the ability of the service users to pay for the SWM services, can be examined in comparison with the prices of basic daily necessities (Table 5.15.5). The solid waste fee of CUP0.4/person/month or CUP1.6/household/month should not be expensive when compared with prices of those basic necessities.

Table 5.15.5 Prices of Basic Daily Necessities

Item	Price
Public telephone	CUP0.05 / 3 minutes
Bus	CUP0.4 / ride
Taxi (share-ride type)	CUP1.0 / ride
Newspaper	CUP0.2 / copy
Rice	CUP10.0 / kg
Eggs	CUP3.0 / medium size egg
Bread	CUP10.0 / pound
Cola	CUP9.0 / can
Local tobacco (mild)	CUP9.0 / box

Note: prevailing market prices in October 2004

Source: Survey by the Study Team

The ability of the service users to pay for the benefits of SWM services can also be measured by the proportion of the service charge of the total available income of the potential users. Table 5.15.6 shows the estimated average household income and expenditure.

Table 5.15.6 Household Income and Expenditure

(CUP/month)			
Income		Spending	
From husband		Purchase of food and other necessities by ration book	50
Monthly salary	300	Rent	30
Bonus	50	Electricity	40
From wife		Telephone	20
Monthly salary	300	Gas	7
Bonus	50	Water & sewerage	5
From retired person		Transportation	30
Pension	60	Food	300
(120 pesos/oldster)		Toiletries	70
Total	760	Cloths	60
		Recreation	60
		Medicine	60
		Others	28
		Total	760

Note: An average household is estimated to comprise 4 members (husband, wife, 1.5 children and 0.5 oldster).

Source: Estimate by the Study Team

The solid waste bill does not appear in the list of expenditure items because households are not actually paying this. Instead, the municipal governments pay on behalf of the households. The solid waste bill of CUP2, if it was paid by

households, would account for 0.3% of total household spending. This level is considered low enough that households should not need to feel burdened.

The willingness to pay is not necessarily consistent with the ability to pay because it depends mainly on the individual's awareness and evaluation of the benefits stemming from the SWM services. Furthermore, individuals have a common tendency to underestimate their capability to pay the charges. Usually, water and electricity provide more visual and evident benefits, while the benefits of SWM services are more intangible as represented by general sanitation and aesthetic improvements. Especially in Cuba, where most inhabitants are not actually paying the SWM charge, the willingness of individuals to pay for the SWM services could not be as explicit as their willingness to pay for water and electricity. Conducting a willingness to pay survey was not possible in this study due to Cuba's institutional difficulties. However the Study Team confirmed at the sensitization meetings for the pilot project that the inhabitants showed a clear willingness to pay for better SWM services.

5.15.2 Financing Sources

Possible financing sources include, (i) tariff revenue, (ii) revenues from recyclables and compost, (iii) foreign loans, (iv) foreign grants, and (v) state subsidy.

(1) Tariff revenue

The Government set forth tariff rates for several types of recipients. Of those, households are actually not charged⁹.

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 pay the equivalent amount to the operating agencies (UPPH/DMSCs and/or Auroras) as a subsidy.

(2) Revenues from Recyclables and Compost

The revenues from recycling and composting will be one of the sources of finance. Revenues from the sale of recyclables and compost were estimated to be CUP51.4 million and US\$2.6 million in total¹⁰.

⁹ Municipal governments subsidize the Auroras by the equivalent amount.

¹⁰ Cost savings in landfill use due to reduced dumped volume of recyclable or composting materials (life prolongation effect of landfills) are estimated at US\$1.6 million and CUP2.7 million, which are not included in the revenues from recyclables and compost.

(3) Foreign Loans

Cuba's hard-currency debts were around US\$11 billion during the 1997-2001 period. In 2005, Cuba has no access to multi-lateral financial institutions such as the World Bank, the International Monetary Fund or the Inter-American Development Bank. Considering that the US has a stake in each of those banks and that the relationship between Cuba and the US is likely to remain as at present, the chance of Cuba obtaining multi-lateral loans from those banks is quite slim.

The EU and Canada as sources of bilateral loans cannot be promising either, taking account the current relations between Cuba and those countries. It also appears that the Cuba-Japan relationship has not yet reached the point where a considerable amount of loan will be extended to Cuba.

(4) Foreign Grants

Cuba received ODA of less than US\$100 million/year between 1998 and 2001. Cuba's main sources of ODA were the EU and UN. The ODA situation in 2005 was not favorable. The EU nations have not provided bilateral ODA to Cuba since 2003 for political reasons. Unlike the EU, Canada's ODA has not stopped but the amount is rather meager, reflecting the politically difficult relations between Cuba and the EU and US. Japan's ODA to Cuba is also modest. Major areas for assistance are cultural cooperation and grass-roots cooperation.

Taking account of such donor situations, it will be hard to expect that an ODA fund from a particular country or financial institution will be provided for a large-scaled project single-handedly.

However, the opportunity of obtaining a grant for an environmental project like the proposed MSW project is more than nil if a large-scaled project is split into several components or if its implementation is phased so that the annual disbursement of the ODA fund would be smaller. It can be presumed that the government could seek the possibility of acquiring grant aid as much as possible from several sources to finance the foreign currency portion of the M/P costs.

(5) State Subsidy

The financing capability of the state or appropriateness of the amount of state financing for the M/P can be evaluated by analyzing the ratio of the M/P cost to other government expenditures. The referential financing indicators are shown in Table 5.15.7.

The M/P cost is estimated as US\$96.7 million in foreign currency and CUP138.4 million in local currency. The total cost converted into a CUP equivalent amount can be estimated using the exchange rate determined by the Government of Cuba. This total cost can be annualized or converted into a stream of annual payments of equal amounts by applying the discount rate of 8.0%/year¹¹ so that the annualized yearly payment can be compared with the current Havana City expenditure on community services.

Another analysis can also be made to compare the M/P cost with the Havana City expenditure on community services in terms of the capital investment and O/M, respectively.

The exchange rate shall be determined from the policy of the Cuban government despite the fact that there might be a market rate for small individual transactions. In any case, however, it can be said that a State Government subsidy is essential for implementation of the M/P.

Table 5.15.7 The M/P Cost in Relation to Financing Indicators

Unit: US\$ million, CUP million

Description	Indicator	M/P Cost	
		US\$	CUP
a) Cuban GDP (2003)	32,337	-	-
b) Havana City GRP (2003 estimate) *1	12,935	-	-
c) Havana City spending (2003 budget)	1,352	-	-
d) Havana City spending on O&M cost of community services*2 (2003 budget)	230	-	-
e) Havana City spending on capital investment for community services (2003 budget)	110	-	-
f) Havana City spending for community services (d + e)	340	-	-
g) Master plan cost (total cost)	-	96.7	138.4
h) Master plan cost (annuity base) *3	-	16.7	23.9
h-ci) Master plan cost on capital investment	-	14.1	6.9
h-om) Master plan cost on O&M	-	2.6	17.0

*1. Havana City Gross Regional Product (GRP) was estimated as 40% of Cuban GDP, which is a rule-of-thumb estimate commonly used in Cuba.

*2. Community Services is categorized I Budget for "housing and community" including housing development and solid waste management

*3. A discount rate of 8% is applied, which is a three-year deposit rate of Cuban peso.

Another guideline was the relationship between per capita MSWM costs and per capita GDP. As shown in Table 5.15.8, under-developed countries generally do not spend more than 2.6% of their per capita GDP on MSWM. Thus, the 2.6% of GDP value can be considered as a general limit for the MSWM budgets of developing countries. In the case of Havana City, this ratio shall be assessed and compared

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

with these global indicators and then the Government needs to determine the level of priority for the MSWM sector and allocate finance accordingly.

Table 5.15.8 Global Perspective on MSWM Costs versus Income

Description	Unit	Low-income country	Middle-income country	High-income country
Average waste generation	tons/cap/yr	0.2	0.3	0.6
Average income from GNP	US\$/cap/yr	370	2,400	22,000
Collection cost	US\$/ton	10 - 30	30 - 70	70 - 120
Transfer cost	US\$/ton	3 - 8	5 - 15	15 - 20
Environment-friendly landfill cost	US\$/ton	3 - 10	8 - 15	20 - 50
Total cost without transfer	US\$/ton	13 - 40	38 - 85	90 - 170
Total cost with transfer	US\$/ton	16 - 48	43 - 100	105 - 190
Cost as % of income	percent	0.7 - 2.6	0.5 - 1.3	0.2 - 0.5

Source: World Bank, "Guidance pack - private sector participation in municipal solid waste management", SKAT, 2000.

CHAPTER 6 EVALUATION OF THE MASTER PLAN AND RECOMMENDATIONS

6.1 Evaluation of the Master Plan

6.1.1 Comparison of “With” and “Without” the Master Plan Cases

The future conditions “with” and “without” the M/P were predicted and compared to analyze the economic development effects of the M/P. The “with-and-without” comparison is different from a “before-and-after” comparison because even under the condition of “without the M/P”, economic development in Havana City would take place.

In the M/P evaluation, the relevant comparison is made in terms of the net benefit accrued under the “with the M/P” case versus the “without the M/P case”. In formulating the scenario for both cases, projects for which the constructions have already started were included in the scenario. Projects still at the planning stage were not incorporated in the “without” scenario.

Comparison between the “with” and “without” the M/P cases are summarized in subsequent sections, with information separated into the following components: (i) recycling, (ii) composting, (iii) collection and transportation, (iv) final disposal, (v) awareness-raising, and (vi) environmental monitoring.

(1) Recycling

In the “with the M/P” case, the collection of recyclable materials can be carried out in a more efficient manner through the introduction of segregated collection. The reuse and recycling will reduce the pollution load and solid waste volume for final disposal.

In the “without the M/P” case, the recovery of recyclable materials from mixed waste is to be continued at the final disposal sites as is done at present, which involves low efficiency of recyclables recovery and unhygienic working condition for the workers.

In the “with the M/P” case, recyclable materials collected by DPSC could be sold to UERMP at a higher price than the existing price level since the supply quantity of recyclable materials becomes larger and more stable than the current situation. In the “without the M/P” case, the current situation is unlikely to change, which cannot be a strong incentive for DPSC to further the recycling activity.

(2) Composting

In the “with the M/P” case, organic materials will be collected more efficiently facilitated by the introduction of segregated collection. The reuse of waste for compost production will reduce pollution load and volume of solid waste for final disposal. In addition, a great merit of the reuse of organic materials in the form of compost is that it supports a natural circulation system.

The construction of a compost plant requires an EIA in the “with the M/P” case. By carrying out the EIA, various foreseeable impacts are pre-examined and impact mitigation measures are formulated. As a result, adverse environmental impacts will be reduced. The EIA will require the Cuban side to monitor the environmental impacts during the project period, by which actual impacts will be correctly analyzed and fed back to the stakeholders strengthened. The socio-environmental considerations will be also examined in the EIA. Hence, community participation will be facilitated and the project implementation smoothed.

In the “without the M/P” case, the classification of solid waste and obtaining of organic materials for composting will take place only at the final disposal sites. As a result, the compost will be adulterated with non-organic materials and the quality will be lower. Hygienic conditions of the workplace for sorting staff will remain poor.

The compost production will continue to be insignificant, maintaining the existing level of three tons/day. The compost quality is unlikely to improve as well. As a result, the marketability of compost will remain slim.

(3) Collection and transportation

In the “with the M/P” case, the solid waste collection service will cover almost the entire Havana City area. The collection efficiency level will also improve because collection vehicles will be properly replaced. As a result, the solid waste collection service will become less interruptive and more punctual. Scattering of waste will decrease as well.

In the “without the M/P” case, the solid waste collection service will be less frequent. As a result, offensive odors in the street will increase and aesthetic qualities of the town will not be improved. The public health and the living condition in general will deteriorate. Horse-driven carts will be used as at present, but they will have to transport the waste much longer distances at low transportation efficiency after the SPLs are closed.

(4) Final disposal

In the “with the M/P” case, the existing non-sanitary disposal sites will be closed with final soil covering and vegetation/tree plantings, which will improve the landscape. The land will be able to be used as parks or other facilities, which will augment public amenities. There will be no generation of harmful insects or outbreak of fires at the closed disposal sites. However, there still exists the possibility of some environmental contamination being left. Hence, continuous environmental monitoring to check the impact on the surrounding water bodies (rivers and groundwater) will be necessary.

As a result of the extension and opening of new environment-friendly type disposal sites, all solid waste will be disposed of in environment-friendly landfills by 2015.

In the “without the M/P” case, it is likely that solid waste collected will continue to be dumped without soil covering and leachate collection and treatment facility. Naturally, the aforementioned benefits expected in the “with the M/P” case will not materialize due to the absence of environment-friendly landfill. Environmental condition around the landfills will remain as is present.

(5) Environmental monitoring

In the “with the M/P” case, the environmental impacts on the areas surrounding the final disposal sites will be measured and quantified on a scientific basis during the project period. As a result, the environmental supremacy of the newly built environmental-friendly landfills over the existing non-sanitary open-dumping sites will become more apparent. This could be the basis of proceeding with the construction of new environment-friendly type landfills that are sufficiently explained to and acceptance by the inhabitants.

In the “without the M/P” case, the situation might go in the reverse direction, and the construction of new landfills might be hampered due to a lack of explanation on the scientific basis.

(6) Awareness-raising

MSWM services to be improved by the M/P involves the need for various awareness-raising activities to sensitize the inhabitants to issues such as segregated discharge of waste, composting at home, and more attention to recyclables. The construction and closing of disposal sites will provide the inhabitants with opportunities for environmental education because the functions of the disposal sites will be geared directly to environmental protection. In

addition to those intrinsic sensitization functions that the M/P components have, awareness-raising activities focusing on the advantages of the M/P will be carried out in the “with the M/P” case. As a result, the inhabitants will be further sensitized to the M/P and have a better understanding of MSWM of the City.

In the “without the M/P” case, the inhabitants will not be convinced of the benefits of MSWM due to absence of awareness-raising activities. For example, the inhabitants in the vicinity of the new landfills might object to the construction. The inhabitants will not be interested in following the correct procedures for waste discharge. The compost and recyclable materials discharged from households contain inappropriate ingredients due to a lack of knowledge of reuse of resource materials. Without sufficient awareness-raising activities, the public consciousness on proper MSWM will decline, and as a result clandestine and unauthorized dumping of waste might increase.

6.1.2 Summary of Evaluation of the Master Plan Soundness

The M/P soundness was evaluated from multiple angles; i.e., (i) technical adaptability, (ii) economic/financial viability, (iii) institutional adaptability, (iv) community acceptance, and (v) environmental impact. The results are summarized briefly in Table 6.1.1.

Table 6.1.1 Summary of the M/P Evaluation

Component Evaluation Item	Recycling	Composting	Collection and transportation	Final disposal	Awareness-raising
Technical adaptability	Adoptable	Adoptable with training	Adoptable	Adoptable if trained	No relevance
Economic/financial viability	Both the government and households are affordable to bear MSWM costs within their means, while the economic analysis shows a heavy burden of costs compared with the expected monetary benefit				
Institutional adaptability	Adoptable	Adoptable	Adoptable	Adoptable	Adoptable
Community acceptance	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Environmental impact	Minimum	EIA is needed	Minimum	EIA is needed	No relevance

Details of evaluations conducted in the Study are described in subsequent sections.

6.1.3 Technical Adoptability

(1) Recycling

A recycling plant is already in operation by DPSC. Skills for processing recyclable materials have already been accumulated to a certain extent. Although staff training will be needed, the recycling work introduced by the M/P is within the technical capability of DPSC, since the method of work and type of equipment are similar to the present ones.

(2) Composting

Regarding community composting, the composting yard facilities and equipment are technically simple and the basic skills required have already been accumulated in the existing agencies. With a little additional training, smooth operation of composting will be ensured. Implementation of composting projects should need to receive technical advice from MINAGRI for both production and marketing. Close tie-up with MINAGRI is recommended.

An aspect to be noted is that the PLP was not able to fully develop the production method and compost quality on account of limited time afforded for the PLP. This requires further confirmation of the method and quality of compost production in an additional pilot project coupled with segregated collection, which should be mobilized prior to the implementation of the M/P project.

Similarly, the PLP could not fully quantify the quality of home composting products, though the compost was observed to be of acceptable quality judging from the smell, moisture and color of compost actually produced at households. 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 if intensive guidance on production methods is given to the households.

(3) Collection and transportation

The PLP spearheaded the segregated collection proposed in the M/P. The result of the PLP suggested that the segregated collection system was technically manageable, both for the operator and the inhabitants. The vehicles to be provided by the M/P are of the same type as the currently used

vehicles (compactor trucks and tractor driven carts). Hence they can be operated with the existing experience and skills of workers.

The PLP showed that people were willing to cooperate on the segregated discharge of waste. But, the quality of segregation varied depending on people's awareness of the need for waste segregation. The PLP suggested that the people's performance for segregated discharge could be greatly improved by providing intensive awareness-raising programs for the people, provided that the program is on a continuous basis until the consequences are fully affirmed.

(4) Final disposal

The proposed environment-friendly landfill technology is new in Cuba. However, the PLP proved that the Cuban side was capable of applying soil covering if provided with proper equipment and training. Introductory training and technology transfer will be needed with respect to planning, design, construction, O/M, and environmental monitoring. The training for selected staff within or outside Cuba by foreign experts, particularly on leachate treatment practices, in which the Cuban agencies have no practical experience, will be carried out as a part of the M/P implementation.

(5) Awareness-raising

This component has no direct relevance to the technical (engineering) aspects of the M/P. Thus the technical adoptability is irrelevant.

6.1.4 Economic Viability

(1) Approach to the analysis

According to JICA's reference materials¹², MSWM is an indispensable public service that should be provided by municipal administrations. Hence, there should be no such option for a municipality to not provide MSWM services. The objective of economic evaluation herein is not to decide whether the MSWM should be implemented but to judge (i) the affordability of the executing agency to implement the proposed MSWM plan, and (ii) the ability of service users, especially households, to contribute to part of the project cost.

¹² "MSWM improvement measures in developing countries", 1993, and "Study of economic evaluation methodology in development studies – No. 12, solid waste", 2002

In addition to the affordability analyses, attempts were made to quantify economic benefits that were identified in the Study. Unquantifiable benefits were also identified and described qualitatively.

(2) Analysis of affordability to implement the M/P projects

1) Affordability of the MSWM cost for City Government

The analysis of financing capability of the government is presented in Section 5.15.2. As stated there, the affordability of financing for the City Government depends on the exchange rate applied for the calculation of the total M/P costs adding both the foreign and local currency portions.

This exchange rate shall be determined by the Government of Cuba.

In case the annualized total M/P cost is beyond the practical limit of the City's financial capacity when compared to the City's total expenditure on community services, the implementation of the M/P will require financial support from the State Government. The amount will not be excessive for the State Government if the proposed M/P project is recognized as a national project essential for the public welfare of the State capital city.

2) Affordability of MSWM fees to households

In June 2005, a tariff for a household was set at CUP0.4/person/month. Therefore the affordability analysis of households to pay solid waste charges can be also considered. However this tariff was applied only for households living in the Aurora's business territories. The payments were actually made by the municipal governments, meaning that no household in Havana City is really charged. This means that above mentioned affordability of the M/P costs for City Government should include the MSWM fees to residents.

(3) Economic viability

1) General conditions

The economic analysis is made based on the following conditions.

- i) The period for the evaluation is set from 2007 to 2015 considering the planning period of the M/P.
- ii) The cost and benefit are expressed in US\$ for foreign currency portion and CUP for local currency portion.
- iii) The conversion factors are set as 0.90 for the foreign currency portion, and 1.04 for the capital cost and 0.94 for the recurrent costs in local currency portion

- iv) Transfer payments such as tax, subsidy, and interest are excluded from the calculation of economic costs and benefits.
- v) The exchange rate of US\$1.0 = J¥110 is applied for the calculation.
- vi) The economic value was calculated by applying the conversion factors to the financial value after excluding the relevant transfer payments.

2) Economic Costs

i) The M/P implementation cost

The economic cost of the M/P is summarized in Table 6.1.2 below together with the financial cost. The details of the financial cost estimate are shown in Section 5.13.

Table 6.1.2 Economic Cost of the M/P Projects

(FC: US\$1,000, LC: CUP1,000)

Description		Financial Cost* ¹	Economic Cost* ²
Composting	FC	5,448	4,903
	LC	10,993	10,797
Recycling	FC	4,535	4,082
	LC	18,623	17,947
Collection & Transportation	FC	31,772	28,595
	LC	65,470	61,542
Final Disposal	FC	52,291	47,062
	LC	41,837	42,416
Awareness-raising	FC	2,090	1,881
	LC	1,391	1,308
Environmental monitoring	FC	555	499
	LC	97	97
Total	FC	96,691	87,022
	LC	138,412	134,107

Note: FC: Foreign Currency, LC: Local Currency

*1: Cost as estimated in Section 5.13, covering both initial cost and O/M cost, Expressed at 2005 price

*2: Economic cost after incorporating conversion factors shown in Para.1) above

ii) Salvage value of implementation cost

The implementation cost will be disbursed over the 9-year M/P period from 2007 to 2015, while the evaluation period of this economic analysis is up to 2015. This implies that most of the invested facilities and equipment will have salvage value at the end of evaluation period, i.e., 2015. This salvage value is regarded in this economic evaluation as a reduction in the investment cost.

The salvage value is computable on the basis of the annual depreciation rate. Taking account of the component items of the cost, a depreciation rate of 10% per year was applied in computing the salvage value of capital assets at the end of 2015. The salvage values are shown in the table below.

Table 6.1.3 Salvage Value*¹ at End of the M/P Period

(FC: US\$1,000, LC: CUP1,000)

	FC	LC
Composting at Calle 100	1,156	1,367
Composting at New Guanabacoa	435	572
Home composting	594	0
Recycling at Calle 100	625	700
Recycling at New Guanabacoa	913	1,041
Collection vehicle replacement	4,819	0
Maintenance workshop improvement	1,303	0
Construction of new site	3,711	3,404
Construction of New Guanabacoa	4,184	1,458
Extension of Calle 100	3,281	1,505
Total	21,021	10,047

Note: FC: Foreign Currency, LC: Local Currency

*1: Economic cost after incorporating conversion factors shown in Para. (3)-1)-iii) above

3) Economic Benefits

The following items are considered as the economic benefits accrued from the implementation of the M/P:

i) Production of compost and recyclables

The production of compost and recyclables that are collected through the segregated collection system are considered as the benefit. It was assumed that production of saleable compost would gradually increase from 30% of the total production in 2010 to 60% in 2015. Production of recyclables depends on the plant capacity installed in 2010 and 2013.

There is uncertainty about whether sustainable markets for compost and collected recyclable materials exist. Considering that the government policy of Cuba promotes organic agriculture to reduce the dependence on imported fertilizer, the market for compost can be developed if the quality of compost meets the requirements. Regarding recyclables, experience shows that some items collected at the existing recycling center can be sold, but at the same time, some types have accumulated because of a depressed market.

However, the recent world wide outlook for the recycling market could be regarded as positive due to the soaring price of crude oil and the rise in environmental awareness. For example, China is a huge market for collected recyclables. In fact, much of the plastic waste collected through segregated collection in Japan under the Japanese Packages and Containers Recycling Law enter the Chinese market, not recycling facilities in Japan. In Latin American countries, it can be observed that most recyclable materials have value to be collected for recycling. In addition, considering Cuba is a rare country in its thorough efforts to achieve a sustainable society under difficult

economic conditions, recyclable materials should provide valuable resources.

Therefore, it is considered that a market for recyclables will exist in future, and a sensitivity analysis is presented later in this section to show how changes in market prices for recyclables or compost would affect the financial plan.

The production, sale ratio, and sale amount are summarized in the table below.

Table 6.1.4 Economic Benefit from Sale of Compost and Recyclables

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

Recyclables								
Description	Unit	2010	2011	2012	2013	2014	2015	
Production								
1) Plastic	tons/year	246	374	496	1,011	1,280	1,527	
2) Paper	tons/year	828	966	1,110	2,842	3,133	3,421	
3) Aluminum	tons/year	276	325	377	954	1,058	1,161	
4) Glass	tons/year	3,380	4,010	4,688	11,739	13,069	14,387	
5) Steel	tons/year	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 sale 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, respectively, all at 2005 price, actually obtained during the Study, 2005.

ii) Saving of landfill cost

Due to the production of compost and recycling, the quantity of waste disposal to landfill will be reduced and, hence, the cost of landfill activity will be saved. The saved cost can be considered as the benefit and the amount of saving is estimated as shown in Table 6.1.5.

Table 6.1.5 Economic Benefit Accrued from Saving of Landfill Cost

Description	Unit	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: FC: Foreign Currency, LC: Local Currency

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

iii) Willingness to Pay (Ability to Pay)

The improvement of solid waste management provides various intangible benefits represented by improvement of the hygienic condition of people's living conditions and the scenic values of the City. However, these benefits are quite difficult to quantify or place a value on. Willingness to pay (WTP) is often applied as a proxy for these benefits in economic evaluation. Although the WTP among inhabitants was recognized during the workshops of the PLP, its valuation through interviews could not be conducted because of procedural constraints in Cuba. Therefore the ability to pay was used as a proxy for WTP and it is assumed to be 1% of household income as assumed for the affordability analysis stated above. The household ability to pay for MSWM is calculated as below.

Table 6.1.6 Estimated Amount of Household Ability to Pay

Description	Unit	Value
a. Monthly household income (estimation for 2006)*	CUP/household	760
b. Average number of household members	Persons/HH	4
c. Estimated monthly income per head	CUP/person	190
d. Amount of ability to pay (1% of c)	CUP/person	1.9
e. Estimated number of beneficiaries	1,000 persons	2,176
f. Total WTP (ability to pay) per year	CUP1,000	49,613
g. Total WTP per year in economic value	CUP1,000	46,636

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

4) Results of economic analysis

Based on the economic cost and benefit explained above, the flow of economic benefit and cost is summarized below.

Table 6.1.7 Economic Cost and Benefit Stream

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

Note: FC: Foreign Currency, LC: Local Currency

As shown in the result, the projects proposed in the M/P do not seem to be economically viable in the foreign currency portion. However, 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.

As noted before, MSWM is an indispensable public service that should be provided by the Government under any circumstances. The project shall be implemented regardless of the economic viability.

5) Sensitivity Analysis

One of uncertain factors involved in the above economic evaluation is the price of compost and recyclables sold to markets. There may be a case of recyclables not being sellable at the expected price and, in other instances, being sellable at a higher price. In this context, a sensitivity analysis was conducted by varying the prices of recyclables and compost as follows:

Sensitivity analysis for compost price:

- Base Case: Compost price is CUP500/ton as assumed in Table 6.1.4 above
- 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 per assumed in Table 6.1.4 above
- Case R-1: Recyclable prices are 20% lower than the Base Case
- Case R-2: Recyclable prices are 20% higher than the Base Case

Economic cost stream is the same for all cases. Economic benefit stream varies by compost and recyclables prices assumed in the respective cases as shown in Table 6.1.8 together with the resultant benefit-cost balance.

Table 6.1.8 Cost and Benefit Streams for Sensitivity Analysis

FC: US\$ million, LC: CUP million

Description		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Economic Cost:	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:											
Case C-1	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	47.5	47.7	47.8	49.4	49.8	50.2
Case C-2	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	53.9	56.2	57.4	74.8	78.0	80.9
Case R-1	FC	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.8	0.9	0.9
	LC	0.0	46.6	46.6	46.6	49.9	50.9	51.5	59.2	60.6	61.9
Case R-2	FC	0.0	0.0	0.0	0.0	0.3	0.4	0.4	1.0	1.1	1.2
	LC	0.0	46.6	46.6	46.6	50.2	51.2	51.9	60.0	61.6	63.1
Balance (B-C):											
Case C-1	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	31.9	31.9	31.4	31.9	35.2	45.6
Case C-2	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	38.3	40.5	41.0	57.3	63.4	76.4
Case R-1	FC	0.0	-0.7	-33.2	-10.4	-9.7	-11.6	-5.2	-10.7	-1.0	20.0
	LC	0.0	46.1	27.5	26.7	34.3	35.2	35.0	41.6	46.0	57.3
Case R-2	FC	0.0	-0.7	-33.2	-10.4	-9.6	-11.5	-5.1	-10.5	-0.7	20.2
	LC	0.0	46.1	27.5	26.7	34.5	35.5	35.4	42.5	47.0	58.5

Note: FC: Foreign Currency, LC: Local Currency

The results of the sensitivity analysis are summarized in Table 6.1.9 below.

Table 6.1.9 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 for Para. 4) above
EIRR was not calculated.

As shown above, the sensitivity to compost price is relatively large. This indicates the importance of producing high quality compost that can be sold for a higher price. Sensitivity to recyclables price is not so large because of the relatively small share of recyclables sales of the total benefit.

6.1.5 Financial Viability of Operating Agency

Financial viability of the operating agency, either UPPH/DMSC or new Aurora Group (a holding company) after its establishment, was evaluated based on the anticipated cost and revenue streams relevant to the M/P projects. Importance in the analysis is to confirm whether the operating agency would be able to finance the recurrent O/M costs from the revenues or whether it would still need to receive a Government subsidy 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 agency (UPPH/DMSC or Aurora holding company)
- Evaluation horizon: 2007 – 2015, corresponding to the M/P period
- Cost stream: O/M costs disbursed as the expenditure of the operating agency, for both the case 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 agency; consisting of (i) waste collection fee¹³, (ii) tipping fee at landfills¹⁴, and (iii) revenue from selling recyclables and compost, see Para.(3) below for detail
- Currency exchange rate: US\$1 = J¥110
- Price level: At 2005 constant price, where no price escalation was considered for both the cost and revenue

(2) Cost stream

Cost stream estimated in Table 5.13.4 (ref. Subsection 5.13.3) was used for the financial evaluation.

Judging from foreseeable financial condition of the operating agency, the Study Team considers it appropriate to propose that the Government would retain the 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 agency is basically limited to the O/M expenditures. This case was examined as ‘Case-A; without depreciation cost’ in the financial analysis.

Nevertheless, the Study Team also examined an alternative case of including the depreciation cost in the account of the operating agency. In this case, the salvage value of the project facilities and equipment remaining at the end of the evaluation period would be taken into account in the cost stream. This case was examined as ‘ Case-B; with depreciation cost ‘ in the financial analysis.

Table 6.1.10 below shows the cost stream of the above two cases used for financial evaluation. A breakdown of the details is presented in Data book.

Table 6.1.10 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: FC: Foreign Currency, LC: Local Currency

Case-A: Depreciation is excluded from the cash account. Case-B: Depreciation cost is included.

Salvage value of equipment at year 2015 was estimated to be US\$21.9 million and CUP9.7 million. Cost expressed at 2005 price

¹³ This fee is actually not collected from households but subsidized by the City Government at present. See Para, (3) 1) below for detail.

¹⁴ This fee is also not charged to users at present. See Para, (3) 2) below.

(3) Revenue stream

The Study Team assumed that the operating agency would have the following revenues:

1) Waste collection fees:

This would be main source of revenue for the operating agency. However, the collection of fees from households is actually not possible at present, due to the policy of the Government, although the fee rate is legally set out. The Study Team assumes that the operating agency will be entitled to receive funds corresponding to the amount of the fee as subsidy from the Government, as is presently received by two existing Auroras. For a conservative estimate, the Study Team assumes that the Government could finance the subsidy to the amount equivalent to the fees from 50% of the serviced population in 2007 and gradually increase this to 80% by 2015.

The operating agency will directly collect the fees from institutions as is being collected by the existing Auroras. The ratio of actual fee collection would be gradually improved from 50% initially in 2007 to 80% ultimately in 2015.

The fee rates were assumed to be the currently approved rates shown in Table 4.2.2 in Subsection 4.2.2.

2) Tipping fee at landfills

Tipping fees are not presently collected at landfills even though it is legally permitted. The Study assumes that this situation would be rectified by DPSC within three to four years and that collection would be possible from 2010 onward. The ratio of actual fee collection would be 50% initially in 2010 with gradual improvement to 80% in 2015. The fee rates are as per the currently approved rates shown in Table 4.2.2. The fees will be collected from institutions that dispose of solid waste at landfills, but MSWM agencies (including Auroras) would not be charged deeming it to be included in the waste collection fees.

3) Revenue from selling recyclable materials and compost

The M/P allows for segregated collection of wastes to commence in 2010, together with the introduction of recycling and composting. The operation of recycling and composting is expected to generate revenues to the operating agency. The revenue amount was assumed as per financial values estimated in Table 6.1.4 in Subsection 6.1.4.

The revenue stream so derived is shown in Table 6.1.11.

Table 6.1.11 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 as long as the Government does not allow for the fee collection.

** Charge to commercial and public institutions that dispose waste of at the landfill, but no charge to MSWM agencies.

(4) Financial Balance during the evaluation period

Table 6.1.12 shows the financial balance over the evaluation period up to 2015 for both the 'Case -A' and 'Case -B'.

Table 6.1.12 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: Without depreciation cost												
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: With depreciation cost												
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 by 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 expanding the capacity for recycling and community composting together with the segregated collection, especially for the foreign currency portion. However, the accumulated total deficit for the foreign currency for 9 years till 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 deficit must be subsidized by the State Government in view of the nature of the expenditure, i.e., that it is required for public services related to basic human needs.

In case ‘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. In the present case for Auroras too, the depreciation of capital cost is not charged to the Auroras’ account. On the other hand, the operating agency shall 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. On one hand, it is recommended that the Government would consider to establish the policy and system of fee collection allowing the operating agency to collect the fees directly from households in the future. The fees will be collected by being added to existing fees that are collected, such as water supply tariff.

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

(5) Sensitivity Analysis

A sensitivity analysis was performed in a similar manner to the one in the economic evaluation (ref. Subsection 6.1.4 (3) 5)). The cases examined were the

same as those in the economic evaluation. The results are shown as revenue-cost balance in Table 6.1.13 for the cases of ‘Case-A) and in Table 6.1.14 for the case of ‘Case-B’, respectively.

Table 6.1.13 Sensitivity Analysis for Financial Evaluation (Revenue-Cost Balance) (1/2)
(For the ‘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 6.1.12)	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 6.1.4 (3) 5) for details of ‘Case C-1, C-2, R-1 and R-2’ assumed in this sensitivity analysis
‘CUP0’: compost price is zero, CUC1,250 : compost price is CUP1,250/ton.
3. The figures are expressed in revenue-cost balance

Table 6.1.14 Sensitivity Analysis for Financial Evaluation (Revenue-Cost Balance) (2/2)
(For the ‘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 6.1.12)	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	-63.6
	LC	0.0	8.3	-9.6	-9.9	-2.2	-0.8	-0.2	6.3	11.3	22.9	26.1
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	-63.6
	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 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 6.1.4 (3) 5) for details of ‘Case C-1, C-2, R-1 and R-2’ assumed in this sensitivity analysis
‘CUP0’: compost price is zero, CUC1,250 : compost price is CUP1,250/ton.
3. The figures are expressed in revenue-cost balance

The compost price is added to the local currency and it may have a slight 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 the price of either compost or recyclables in total. In ‘Case-B’, however, the accumulated loss at the end of 2015 is quite large, particularly for the foreign currency portion.

6.1.6 Institutional Adaptability

(1) Recycling

The PLP verified that the existing UPPH would be capable of collecting recyclable materials through segregated collection, subject however to further improvement of segregation at source, which is a vital requirement for success of recycling operation. The UPPH is already processing collected recyclables at a small scale. The Aurora to be newly established will take over this UPPH recycling operation accompanied by the transfer of current staff and equipment. This transfer of responsibility will involve no institutional problem.

Under the current national law, UERMP has a monopolistic power as a trader of recycled materials. If the present system continues, the new Aurora will function as only a supplier of raw materials or intermediate materials with relatively low income. To give incentives to the new Aurora, it is proposed to alter the current legal framework so that the new Aurora could sell the recyclable materials directly to the market.

(2) Composting

The experience from the PLP was not able to demonstrate that a successful composting operation would be possible under the current system of UPPH. However, results suggested that composting could be conducted under the current system if expertise from MINAGRI is provided. As with recycling, the composting operation will be taken over by a new Aurora enterprise with the transfer of current UPPH staff and facilities. The M/P proposes to provide improved facilities and equipment, which will help improve production efficiency and the necessary training for operators for proper segregation of kitchen waste at source.

(3) Collection and transportation

The present operating structures of the existing organizations (UPPH, DMSCs, and Auroras) are formed well enough to handle the collection and transportation of solid waste. The staff structure is assumed to be carried over to the new Auroras with reasonable modifications as necessary. There would be no institutional constraint in conducting this transfer of staff.

The M/P proposed the introduction of segregated collection system (increase of C/T and change of H/C to C/T). These changes will require the reformation of collection operation method and further the staff assignment. The new Aurora shall take into account these aspects.

The reorganization from the current MSWM structure to the new Aurora structure will not involve the significant reduction of personnel. The staff and workers reducible in the collection and transportation sections will be either re-employed in other sections or subject to natural attrition. This arrangement will minimize the problem that may be arising from the transfer of collection and transportation function to Aurora.

(4) Final disposal

The PLP evidenced that the existing organizations could manage the environment-friendly landfill operation if appropriate equipment were provided. The operation of environment-friendly landfill will require more workers than are deployed at the existing landfills. The required personnel could be recruited from other working sections with necessary training on landfill operation and environmental monitoring.

(5) Awareness-raising

Cuban society has a certain extent of experience in awareness-raising and community mobilization activities. Those experiences can be applied to sensitizing the inhabitants to have a better understanding and support for the MSWM system recommended in the M/P.

Under the current political system, the Consejos Populares (the People's Councils) would be the leading organization that could coordinate various awareness-raising and mobilization activities at the grass-roots level. Other organizations that are rooted in the local community and can support the awareness-raising activities will be, among others, the Comité de Defensa de la Revolución (CDR, the Defense Committee of the Revolution), and the Federación de Mujeres Cubanas (FMC, the Cuban Women's Federation).

6.1.7 Community Acceptance

(1) Recycling

In the PLP, communities expressed their acceptance to the idea of segregated waste collection and were convinced of the merits derived from the recovery of recyclable materials. The fact that material recovery by UERMP is already active is one of the reasons for the community acceptance for recycling.

Notwithstanding this community's acceptance, it is noted that much effort and time period, both for communities and operating agencies, would be needed until

the communities become accustomed to the proper performance of waste segregation.

(2) Composting

Construction of compost plant facilities at the landfills appears to be socially accepted as long as the communities understand the objectives and benefits of composting. The PLP verified active participation of communities in home composting. The community's acceptance of composting activities could be formulated through continuous awareness-raising and educational activities.

(3) Collection and transportation

The people's acceptance of segregated waste collection was observed during the conduct of the PLP. With the implementation of the M/P, people will perceive the reliable waste collection service and less scatter of waste in their livelihood areas. In conjunction with the awareness-raising activities, the inhabitants are expected to use waste bins more carefully so that bins will be serviceable for a longer period.

(4) Final disposal

Closure of the existing landfills will alleviate the current environmental pollution, which will be understood and accepted by the inhabitants. The number of inhabitants living within a 1 km radius of the landfills to be closed by 2015 is estimated at about 80,000.

In addition, adopting the environment-friendly landfill for final disposal, combined with intensive awareness-raising efforts, will enhance the community acceptance of construction of new landfills. The number of inhabitants living within a 1 km radius of the landfills to be operated until 2015 is estimated at about 28,000.

As regards the resettlement issue, the closure of existing landfills will not cause any new resettlement. The New Guanabacoa site will not necessitate resettlement either. Regarding the New Site 1, the need for resettlement is unknown since the exact location has not been determined yet. However, past experience suggests that if resettlement is required at the New Site 1, it will be amicably resolved¹⁵.

¹⁵ Resettlement was obliged previously at the Calle 100 landfill. The families who lived there gladly accepted the resettlement because they were transferred to the vicinity with new houses provided by the Government.

There are some objections raised from the inhabitants in the vicinity for the construction of the New Site 1. UPPH shall deal with this issue through provision of sufficient information and adequate compensation.

(5) Awareness-raising

As described in the section on institutional adoptability (ref. Subsection 6.1.6), awareness-raising and environmental education are carried out in Havana City in various forms. The communities are closely tied up with political/social organizations such as CDR and FMC. The experience in the PLP indicated that the communities mobilized by such organizations functioned well. The communities were not simply submissive to the given orders but were also capable of discussing the issues, digesting the resolutions and putting them into practice.

In a similar way, it is assumed the community will accept the awareness-raising activities because the M/P provides for the establishment of a more environment-friendly MSWM system. The executing agency is required to elaborate the plan based on the precedents of environmental and health campaigns deployed in the City in the past.

6.1.8 Environmental Impacts

(1) Recycling

Recycling itself will lead to the mitigation of environmental loads by reducing materials which otherwise would have been disposed of at landfills. Solid waste of 132,495 tons will be incrementally recycled by the recycling project, which will reduce the volume of solid waste to be disposed at landfills. No adverse environmental impact is expected in both the construction and operation of new recycling plants.

(2) Composting

Composting is also expected to reduce the environmental load in the form of reusing organic materials that otherwise would have to be disposed of at the landfills. Solid waste of 285,795 tons will be converted into compost instead of being sent to landfill during the 2006-2015 periods.

The construction of a compost plant may potentially cause adverse environmental impacts because the composting deals with organic materials. Therefore, an EIA will be required with the DPSC responsible for formulating the mitigation measures.

(3) Collection and transportation

Replacement of old vehicles with new equipment together with streamlining the collection and transportation will provide favorable environmental impacts by reducing harmful exhaust emissions and interference with traffic. On the other hand, the increased number of vehicles required for the introduction of segregated collection and the replacement of horse carts with vehicles will bring some adverse environmental impacts, but not to a significant extent. Overall, the resultant environmental impact will be immaterial.

(4) Final disposal

Sanitary landfilling by environment-friendly landfill planned in the M/P is expected to reduce BOD₅ in leachate from 1,000 mg/L to 60 mg/L. Taking account of the landfill area, precipitation, evaporation and infiltration data, hypothetical unused oxygen demands are computable. This BOD reduction of 940mg/L can be converted to 1,549 tons of unused oxygen demand during the 2007-2015 period, or 172 ton/year on average. According to Havana City Territorial Office of Statistics, Havana City generated a pollutant load of 28,501 tons of BOD in 2003. Hence, it can be said that the leachate treatment by the environment-friendly landfill operation will reduce Havana City's pollutant load by 0.6% on the year 2003 basis. There still remains, however, some possibility of leachate inflow into the adjacent surface waters at the New Guanabacoa site. Therefore, an EIA will be required for the formulation of necessary mitigation measures and the associated monitoring system.

(5) Awareness-raising

The awareness-raising component itself is not relevant to environmental impact, although in the long run it will contribute to improvement of people's behavior on MSWM, thus reducing the people's generation of environmental load.

6.1.9 Overall Evaluation of the Master Plan

In general it is not easy for MSWM projects to operate on a financially self-reliant basis since the financial revenue resources are quite limited. The M/P project for Havana City is no exception. However, the results of affordability analyses showed that both the government and inhabitants would at least be capable of financing the O/M costs.

The overall soundness of the M/P is assured by various benefits. The most obvious benefit of the M/P is the improvement of public health and the living environment,

although they are not able to be quantified. Other intangible benefits include a general increase in amenities, such as the reduction of odor, harmful insects and other health hazards, and an increase in the scenic values of the City.

Composting and recycling of waste materials contribute to the City's economy by producing goods of economic value, and also reduce the quantity of waste for disposal at landfills; thus reducing the cost of landfills.

Environmental benefits are also expected in the form of reduced pollutant loads through leachate treatment at landfill sites.

Educational benefits were significant because the Awareness-raising activities will greatly sensitize the inhabitants to environmental issues, which is an intangible benefit for the City's administration in the long term.

All these benefits will positively raise the overall reputation of Havana City as an environmentally clean city. A clean-town image will help Havana City to promote further development of tourism.

6.2 Recommendations for the Implementation of the Master Plan

6.2.1 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 previously mentioned in Subsection 6.1.5, a model financing plan based on state subsidy was preliminarily prepared as shown in Table 6.2.1.

The CUP portion of user charge revenues (CUP103.5 million) plus the CUP portion of recyclables and compost revenues (CUP51.4 million) would exceed the local currency portion of the M/P cost by about CUP26.1 million.

However, out of the user charge revenue, fees from households represent CUP60.3 million, which is more than half the total. Under current Government policy, this amount will be subsidized by the City Government.

In addition, separate financing of US\$63.7 million equivalent will be required for the foreign currency portion.

These points mean that realization of the M/P depends on an increase in state subsidy. The possibility for an increase in state subsidy should be clarified with MEP and other decision-makers to decide how to implement the M/P.

Table 6.2.1 Financing Plan for the M/P
(LC: CUP million, FC: US\$ million)

Description	FC	LC
The Master plan cost *1	74.8	128.8
User charge revenues *2	8.5	103.5
- Collection fee from household	0	60.3
- Collection fee from institutions	8.5	41.8
- Tipping fee at landfill	0	1.3
Recyclables and compost revenue *2	2.6	51.4
Financing surplus (deficit)	-63.7	26.1
Financing by State Government	63.7	0

Source: *1: Table 6.1.10, *2: Table 6.1.11, in Section 6.1

It is noted that the above table shows just a simple balance of cost-revenue amount accumulated for the M/P period, where no time frame of cost-revenue streams is taken into account. Hence, the table should be read for reference only. The detailed stream of financing requirement is described in Section 6.1

(2) Prioritized activities

In view of the financial constraints foreseen, it may not be possible for the Cuban counterparts to implement all of the M/P proposals. 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.

6.2.2 Recommendations for Implementation of the Master Plan Components

(1) Operation for recovery of recyclables

Promoting the recovery of recyclables by segregated collection will require preparatory works and other considerations on implementation. These include:

- The proposed system for recovery of recyclable materials from MSW will coexist with the existing recovery operation conducted by ERMP. DPSC shall coordinate closely to discuss 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 undertaken by UNIDO is crucial because similar segregated collection with two categories will be examined by the Cuban side.
- Presently, significant amounts of recovered materials are stockpiled in existing recycling centers. DPSC shall clarify why these materials have not sold and seek to market them in cooperation with ERMP.
- The collection capacity of the implementation bodies should satisfy the performance of residents for segregated discharge. Therefore, a prerequisite for improved recycling 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.

(2) Community composting plan

The results of the PLP did not demonstrate the feasibility of the community composting method and its quality control. As previously mentioned, the skills

needed to manage a community composting plant and associated equipment have not been acquired within the existing organizations concerned. For this reason, the community composting plan will be introduced only after reliable experience can verify the feasibility of community composting through pilot scale trials or examinations such as the UNIDO project.

In addition, since community composting is being attempted in many places in the world recently, successful accomplishments are accumulating. It is therefore suggested that available information be collected from the experience of other countries. One successful example is the compost projects being undertaken in Dhaka City, the capital of Bangladesh, which are described in Data Book A4.

(3) Home composting

The plan envisages that an awareness-raising program be commenced before the introduction of home composting in the respective areas to attain efficient composting activity. 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. This guidance and support system shall be initiated by DPSC.

Another important point for sustainable measures for home composting is to provide appropriate home compost bins. The plastic molded bins used in the PLP under the Study were imported and expensive. Once the fundamental mechanism of home composting is experienced by using such plastic bins, simpler and cheaper bins can be manufactured domestically in Cuba. Examples of compost bins commonly used in other countries are shown in the Data Book A5

(4) Selection of waste collection and transportation vehicles

It is proposed in the M/P that C/T be adopted as the appropriate collection and transportation vehicle after objectively evaluating the transportation efficiency of each of the several types of vehicles presently used.

However, if the conditions of the waste collection system change from those existing at the time of the JICA Study, the implications and corresponding actions will be addressed accordingly. Possible changes include things such as the location of waste discharge points and stations and the quality and quantity of waste at the collection points.

(5) Steel bins for waste collection

It should be understood that unlike plastic bins, steel bins tend to corrode by acid and rainwater. Using corrosion-proof galvanized steel or anticorrosive painting are possible, but such bins require frequent cleaning. 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 the trial manufacturing of bins in the domestic market, with attempts to reduce their weight, and use them in a pilot area. If the advantage of steel bins is confirmed, their use will be expanded to wider areas by gradually replacing the HDPE bins.

(6) Segregated Collection System

It is proposed in the M/P that segregated collection will be introduced by classifying waste into three categories¹⁶: kitchen waste, recyclable materials and other wastes, as described in Figure 5.7.1.

The alternative of a mixed collection system, on the basis that recycling and community composting activities are not undertaken, was also examined in the Study. Details are shown in the Supporting Report B2. The total cost for a mixed collection system of the M/P period (2007-2015) including the cost for UPPH and DMSC 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. Segregated collection costs more because it requires more collection vehicles and waste bins. The segregated system requires an additional 26 vehicles and 20,802 bins compared with the mixed collection system to the year 2015.

Table 6.2.2 Cost Comparison of Waste Collection Systems

Collection system	Total cost (2006-2015)				Remarks
	US\$		CUP		
	Initial	O/M	Initial	O/M	
Mixed collection	18.1million		64.1million		—
	11.2million	6.9million	0	64.1million	
Segregated collection	22.4million		67.9million		Compared to mixed collection, 26 more collection vehicles and 20,802 more waste bins are necessary

¹⁶ A UNIDO project currently underway in Playa Municipality envisages two 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 two categories and later change to three categories.

Although the cost of a segregated collection system is higher than that of a mixed collection system, segregated waste collection is regarded as a primary requirement for attaining environment-friendly operation of MSWM as represented by the benefits of reducing the quantity of waste disposal and enhancing the recovery of valuable resource materials. Reducing the quantity of waste for disposal will reduce the environmental burden to landfill sites, and the recovery of resource materials contributes to the economy of the City.

Placing more importance on the establishment of environment-friendly MSWM, the Study team proposes adopting segregated collection in the urban areas where the majority of MSW is being generated. In economic terms, the cost for segregated collection will be partly offset by benefits that will accrue from revenue from selling compost products and recyclable materials and also by reducing landfill cost as preliminarily evaluated in Supporting Report C4.

It was considered that a certain lead time is required to prepare for introducing segregated collection, e.g. selection and procurement of proper vehicles and bins, planning of work operations, and awareness-raising of residents for segregated collection. The introduction of a segregated collection system should be attempted carefully because Havana City so far has no experience with this system. Especially there are three issues to consider when implementing a segregated collection system, which are 1) how to optimize the incremental cost, 2) how to attain public cooperation, and 3) how to coexist with the existing recycling system by group collection.

In addition, to further reduce expenditure, a more appropriate collection system should be re-studied through practical trials using the existing trucks other than C/T, referring to similar experiences in other countries. Japan has exercised a long-term effort for establishing segregated collection systems, especially for the collection of recyclable wastes, since the 1970s. The work faced a variety of difficulties midway toward establishing the present system. Japanese historical background in implementing segregated collection is attached in Data Book B3 for reference.

(7) Schedule for replacement of H/C system

The H/C system was established in connection with the development of the SPLs under the critical economic conditions prevailing in Havana City, though 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 by a mechanical collection system as proposed in the M/P, provided the SPLs are closed.

On the other hand, for short-distance transportation of small amounts of collected waste, the H/C system can be an important alternative system. Therefore, in the M/P, the H/C system will be retained for the Campo Florido area for the purpose of handing this system down to posterity.

For the estimation of overall fund requirements in the M/P, it was tentatively assumed that the replacement of the H/C system would start in 2007. However, considering the difficulty of procuring new vehicles, the H/C system can remain in the area close to the designated landfill and be gradually phased out.

(8) Type of landfill

It is proposed in the M/P that the level of landfill to be newly constructed or expanded should be Level 3 and/or Level 4. However, if the DPSC faces difficulty in financing the Level 3 and/or Level 4 types, despite the possibility of using low cost technologies such as using locally available used goods or bio-materials, the alternative solution will be to adopt Level 1 or Level 2 types. The Level 1 and 2 types will also be effective in reducing most complaints from nearby residents, such as waste littering, odor, generation of insects and fire outbreaks, provided that soil covering is conducted properly. In addition, careful monitoring of groundwater and other environmental parameters should be carried out.

(9) Leachate Treatment

It is recommended that the effectiveness of the proposed leachate treatment system in the M/P be verified through laboratory-scale and pilot-scale trials in cooperation with the agencies concerned prior to construction.

Calculation of leachate generation volume, estimation of leachate treatment volume and a plan of the leachate regulating reservoir should be carefully conducted at the feasibility study and basic design stages with detailed conditions such as a wider range of climate data, geological conditions, and site restrictions.

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

(10) Tariffs as a financing source

Generally, regarding the future of charging tariffs to households, there are two options:

- (a) Tariffs will not be charged to households for the foreseeable future. Instead, the City and/or Municipal Governments will subsidize the operating agencies to an equivalent amount (UPPH/DMSCs and/or Aurora Enterprise).
- (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. water supply tariff, as is the case for the sewerage tariff.

Selection of the above option is dependent on Government policy, and the financial evaluation in the M/P was based on Option (a).

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

6.2.3 Monitoring of Implementation of the Master Plan

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

- Checking the progress of implementation of the projects,
- Identifying the difficulties and obstacles preventing realization of the project, and
- Promoting and coordinating 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 DPSC (General Director)
- Secretariat: DPSC
- Member Agencies: MEP, CITMA, MINSAP, MINAGRI, DPSC, DMSCs, UERMP, Aurora Enterprise, representatives of selected communities
- Frequency of the meetings: Annual
- Duties: Preparation of action plans for the realization of the M/P, leadership for the financing, and monitoring and coordination of the activities

An option is for the present Steering Committee (SC) to 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 this Study are expected to play leading roles in the technical committee.

6.3 Recommendations on Industrial and Medical SWM

6.3.1 Recommendations on the Improvement of Industrial SWM

(1) Responsibility for industrial SWM

When improving industrial SWM, it is extremely important to clarify who has the responsibility for dealing with the industrial SWM.

Concerning hazardous industrial waste, the national regulation clearly states that the generators of hazardous waste themselves shall be responsible for their waste management. The industrial waste generators should not only be responsible for the treatment of their generated hazardous industrial waste, but also for the management of non-hazardous industrial solid waste. The reason why the waste generators need to be totally responsible for the management of all their industrial solid waste, irrespective of whether or not it is hazardous, is that it is not easy in reality to distinguish hazardous waste from non-hazardous waste.

It is also noted that, according to the existing national regulations, CITMA is responsible for the monitoring of industrial waste.

(2) Establishment of management system for the treatment of industrial SWM

It would be ideal for DPSC to establish a management system responsible for the management and coordination of industrial SWM under DPSC or separately. The responsibility of the proposed management system would cover not only industrial waste management services, especially hazardous waste, but also include management services for transportation, treatment, and disposal.

It is the responsibility of CITMA to ensure the city environment remains hygienic and sanitary, according to the laws and related national regulations. Accordingly, CITMA needs to enforce the regulations so that respective industries shall fulfill their responsibilities in accordance with those regulations.

(3) Treatment and disposal of industrial waste

Incineration is the most widely used method of treating hazardous industrial waste. Environment-friendly landfill is the most economical and recommended method for disposal of non-hazardous industrial waste. The Study Team foresees that these treatment and disposal methods will be practiced in the immediate future as well.

CITMA, or the new entity to be created, shall monitor the treatment of hazardous waste generated in industries, including inspection of the treatment facilities. Periodic emission monitoring and factory inspection shall be conducted with

attendance of environmental specialists. The monitored data and inspection results will be used for the evaluation of impact on the environment.

(4) Management of industrial waste

It is proposed that CITMA and DPSC shall specify the policy and priorities on how industrial solid waste can be best managed, covering both non-hazardous and hazardous waste. Industries will be encouraged to take the following positive measures:

- Reduction of generation of industrial waste
- Reuse or recycling of industrial waste
- Treatment of waste to neutralize hazardous characteristics
- Treatment of waste to reduce hazardous characteristics
- Disposal of treated waste to landfills

Each of the above measures has equal importance in respect of reducing hazards to the natural environment and human health.

6.3.2 Recommendation on the Improvement of Medical Waste Management

(1) In-hospital management plan

In-hospital waste management in each hospital is the primary requirement of medical waste management. Each hospital shall be guided to prepare an in-hospital waste management plan with the technical support of MINSAP.

1) Objectives

- Complete separation of medical waste from other waste
- Isolation of medical waste by putting it into exclusive bags and boxes
- Separated and isolated storage of medical waste in an exclusive storeroom

2) Proposed activities

a) Installing plastic bags and cartons for medical waste

Necessary quantities and categories of bags or cartons/boxes should be installed in the treatment rooms, examination rooms and other rooms generating medical waste. They should also be installed in the patient wards if medical waste is generated there. A carton is recommended because it is cheap and flammable and can be closed or packed to maintain complete isolation of the waste from human contact. They are incinerated as enclosed

in the bags or boxes. Biohazard marks should be put on the bags and boxes for clinical waste.

b) Manual for proper handling of medical waste in hospitals

Though separation of medical waste according to its category is defined in the relevant regulation, a more practicable manual describing the standard operating procedures for medical waste handling should be prepared to facilitate the actual practice by hospital staff. This should be provided at all places where medical waste might possibly be generated and be available for all hospital staff to refer to whenever necessary. The manual should be prepared by each hospital with the participation of the doctors and nurses.

(2) Collection and transportation plan

UPPH/Aurora will be in charge of collection and transportation of medical waste. In view of the hazardous nature of the waste, the workers shall be trained in the knowledge required for proper handling and transportation of the waste. Due care shall be paid to the following:

a) Transportation by special vehicles

The vehicles to be used for medical waste collection shall be enclosed trucks with a completely enclosed deck to prevent the loaded medical waste from dropping off or being exposed to sunshine and wind while on the way to the disposal site.

b) Daily collection

Collection on a daily basis is required as the medical waste contains not only bacterial or viral contaminated matter, but also bloodied cotton/bandages and human tissue/organs that must be properly treated before degradation. In the case of bacterially contaminated matter, keeping the waste for a long time may cause the bacteria to multiply.

Medical waste contains many articles hazardous to health. Any improper handling of the waste directly threatens the health of workers 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) Specification of the incinerator

There are a total of 56 hospitals in Havana City, of which 29 have old type incinerators and the others have none. To eliminate concerns for pollutants that

might be generated by the existing old type incinerators, and to treat the waste from the other hospitals not having incinerators, it is recommended that a centralized incineration plant be constructed. All the collected medical waste from each hospital shall be treated at this modernized plant under hygienic conditions at a low cost.

Medical waste incinerators, if not properly functioning, tend to emit pollutants that are extremely dangerous even at the lowest level. There is a large risk of dioxin being present in emissions; dioxin is a carcinogen and one of the most toxic pollutants. Other harmful pollutants, including mercury, cadmium, lead and fine soot, are also released during the incineration of medical waste. Therefore, incinerators designed to yield a low level of toxic emissions shall be used for the proposed incineration plant.

(4) Disposal plan

Incinerator ash shall be disposed of in a designated section of the landfill for improved control. It will not be mixed with other waste even though appropriate incineration can reduce the toxicity of medical waste.

PART 3 PILOT PROJECT

CHAPTER 1 SELECTION CRITERIA

1.1 Objectives of Pilot Project Implementation

1.1.1 Objectives Contemplated in the Inception Report

As stated in the Inception Report (IC/R), the following were set as the primary objectives of the Pilot Project (PLP) implementation:

- To prove the effectiveness of the methods chosen for solving the impending problems, and
- To prove the effectiveness of the projects to be recommended in the M/P.

1.1.2 Additional Objectives and Consideration

During the course of the first study in Cuba, discussions were held between the Study Team and the Cuban side and it was agreed that the following additional objectives were to be included:

(1) Contribution to capacity development and awareness-raising

It would be very desirable if the PLP could contribute to the capacity development of the personnel who would be involved in both the implementation and the operation and maintenance (O/M) of the full-scale project that will cover a wider area and be implemented incorporating the experience gained in the PLP. In particular, the personnel would gain experience in the following fields:

- Segregated collection
- Composting of the segregated organic waste
- Systematic measuring and recording of the data relevant to the segregated solid waste landfill operation

It would also be desirable if the PLP could be used as an opportunity for raising the awareness of the residents and community based organizations concerned with regard to:

- Necessity and usefulness of segregated collection for recycling of resource materials and the reduction of waste quantity
- Benefits accrued from home composting

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

Actions taken in the PLP would possibly contribute to improvement of MSWM in

the PLP area, especially in drawing the residents' attention to MSWM. Though the scale of the PLP conducted this time was limited, it could be a model for extension to a full-scale project covering the whole City. These aspects have been taken into account in the process of formulating and implementing the PLP.

1.2 Selection Criteria and Process

The PLP had to meet the following two conditions:

(1) Objective Achievement:

The selected PLP needed to satisfy the objectives and considerations mentioned in Section 1.1 above.

(2) Practicality and Acceptability:

The PLP needed to be of a practical nature that could be implemented within the framework of the current Study and be accepted by the organizations/people in the area.

1) Time-frame

PLP should be implemented and operated within the time-frame set for the study. The schedule needed to have some time allowance for extension if possible.

2) Budget

Funding required for the implementation and operation of the PLP needed to be within the amount allocated by JICA and the Cuban Government.

3) Acceptance of the Government and community

Implementation of the PLP needed to be acceptable from social and environmental viewpoints and accepted by the Government and local communities concerned.

Based on the selection criteria above, a PLP was formulated and selected through the following selection process:

Step 1: Formulation of projects

Step 1-1: Determination of project components in consideration of the objectives of the PLP

Step 1-2: Formulation of project packages

Step 2: Selection of project site

Step 2-1: Availability of land

Step 2-2: Acceptability to the Government and local communities

Step 3: Conformity to additional objectives

- Capacity development
- Awareness-raising
- Contribution to the improvement of MSWM in the PLP area

1.3 Formulation of Projects

1.3.1 Determination of the Project Components: Step 1-1

The components of the PLP were determined in consideration of the objectives stated above and also background requirements as follows.

(1) Segregated collection

Disposal of a large volume of MSW is a heavy burden for DPSC. As concern for the environment grows among people, establishment of new landfills is becoming increasingly difficult. New landfills will require the installation and operation of sanitary facilities, which will impose heavier financial burden on DPSC. In view of the limited financial capacity of Havana City, the reduction of disposal volume of MSW is a key factor for the future MSWM in the City.

Segregated collection with composting and recovery of resource materials would certainly be an effective measure for reducing the physical volume of MSW disposal and accordingly the financial load on the DPSC. This component of the total solution is also proposed in the M/P. Aiming at proving its effectiveness, segregated collection was considered to be a candidate for the PLP.

In the PLP implementation, it was proposed that a three-category segregation system would be applied, i.e., kitchen waste (food waste), resource/recyclable materials and other waste. Segregated organic materials would be transported to a nearby existing landfill for composting, while the collected resource materials would be transported to the existing recycle center for recycling.

(2) Composting

Associated with segregated collection, PLP attempted to carry out community-level composting at the existing landfill utilizing kitchen waste collected from the urban part of the PLP area.

In addition to community-level composting, home composting was also introduced for selected households in a semi-urban area. This was intended to verify the capability and effectiveness of composting in each household.

(3) Awareness-raising and environmental education

Obtaining cooperation from the communities and residents was essential for the successful implementation and operation of the PLP, especially for segregated collection and home composting. With this in view, the PLP included programs of awareness-raising and environmental education aimed at getting the understanding and cooperation of the people and organizations concerned with the PLP.

1.3.2 Formulation of the Project Package: Step 1-2

All the above-mentioned project components were interrelated and interdependent. Hence, all the proposed project components were formulated in a single package.

Of the segregated waste, organic materials were to be processed for composting either at homes or at a community composting yard. Resource materials were to be separately transported to a recycling center¹. Materials other than organic materials and recyclable materials were to be disposed of at a landfill.

Awareness-raising of the residents was essential for successful implementation of segregated collection. The program attempted both education of residents and encouragement of their cooperation.

DPSC, the sole agency responsible for MSWM in the City, was responsible for all the project components with the cooperation of the ministries and organizations concerned, including CITMA. It was proposed that all the above components of the PLP package would be implemented in a selected area to concentrate the efforts for the PLP therein.

1.3.3 Selection of the Project Site

(1) Availability of land: Step 2-1

The PLP project site needed to have an existing landfill located nearby to receive waste collected in the PLP and to establish a composting yard. This aspect was therefore taken into account as a primary factor for the selection of the project site.

¹ Resource materials collected under the PLP were supplied to an existing recycling center near Calle 100, but further processing of recyclable materials was not dealt with in the PLP.

The candidates were 14 existing landfills. Of the 14 landfills, 9 special period landfills (SPLs) are planned for closure within a few years. Ocho Vias landfill was ruled out since it is the site for disposal of industrial waste. Barreras landfill does not have unused land for establishing a composting yard. Guanabacoa is planned for closure due to an environmental pollution problem. Hence, only two existing landfills, Campo Florido and Calle 100, remained for consideration in the planning. Consequently, the project site needed to be the communities located in the vicinity of these two landfills.

(2) Acceptability by Government and local communities: Step 2-2

The two candidate project areas, the areas in the vicinity of Campo Florido and Calle 100 landfill sites, were compared from the viewpoint of acceptability to the Government and surrounding communities. As a result, it was thought that both these areas would have no particular difficulty with respect to acceptability by the communities or the Government.

(3) Selection of the Project Site: Step 2-3

As stated above, no significant difference was observed between the two candidate project sites. From the viewpoint of acceptability by the communities, however, a preliminary interview survey showed that the area located in the vicinity of the Campo Florido landfill, i.e., Campo Florido and Peñas Altas communities, was a more favorable environment since the people there appeared to be more willing to accept the implementation of a PLP than the people in the Calle 100 area. The area comprising the Campo Florido and Peñas Altas communities was therefore selected as the PLP site.

1.3.4 Conformity to Additional Objectives: Step 3

The two candidate areas were further compared from the viewpoint of additional objectives; i.e. (i) beneficial effects for the improvement of MSWM in the PLP area and Havana City, and also (ii) effects expected for community awareness-raising, and (iii) effects for capacity development of C/Ps. It was thought that there would be no notable difference in these aspects between the two areas.

During the discussions with the Cuban side, the need for practicing environment-friendly landfill operation was pointed out. Accepting this request, a trial operation of environment-friendly landfill, consisting of operations of waste disposal in cells and soil covering, was conducted during the PLP period for

purposing the capacity development of UPPH and DMSC staffs. This was also regarded as an associated program of the PLP.

1.3.5 Waste Weight Measurement

In addition to the main PLP package stated above, the need for waste quantity control in the future was highlighted during the discussions with the C/Ps.

At present, waste disposal quantity is measured only by counting the number of trucks hauling and is based on nominal loading capacity of the trucks regardless of actually loaded waste quantity. It was thought that this situation should be rectified in the future and the practicability of measuring waste quantity by weight be investigated. The weighing of waste hauled to Campo Florido landfill was attempted during the PLP implementation.

1.3.6 PLP Components Formulated

In summary, the following five work components were formulated as the programs to be conducted during the PLP period:

- (1) Segregated collection of waste (ref. Subsection 1.3.1)
- (2) Composting, consisting of community-level composting and home composting (do. above)
- (3) Awareness-raising and environmental education (do. above)
- (4) Waste weight measurement (ref. Subsection 1.3.5)
- (5) Environmentally-friendly landfill operation (ref. Subsection 1.3.4)

Of the above, (5) was initiated, as stated above, purposing mainly the capacity development of UPPH and DMSCs staff.

1.4 Brief Summary of PLP Implementation by Work Component

1.4.1 Segregated Collection

Segregated collection in the PLP was not always properly conducted, especially during the initial period, due to the people's inexperience in waste segregation, coupled with occasional trouble with the collection vehicles. Nevertheless, after intensified awareness-raising for the people in a selected area, the performance of segregated waste discharge was much improved in that particular area. This has suggested the potential for improving the people's performance in segregated collection if sufficient awareness-raising is given. The M/P was prepared with the assumption that intensive and continuous awareness raising programs are in place in order to achieve a high performance in segregated collection.

Table 1.4.1 below summarizes the outline of segregated collection in the PLP.

Table 1.4.1 Outline of Segregated Collection Performed in PLP

Item	Description
Purpose:	To investigate the practicability of segregated collection, inviting the people's cooperation for segregated discharge of waste. Segregated collection was regarded as a primary requirement for attaining the 3Rs envisaged in the M/P,
Waste Collection Area:	Peñas Altas community (in Habana del Este Municipality), which represents a typical urban area
Collection Stations:	The number of collection stations increased gradually to 64 stations*, which covered some 2,045 households (about 8,000 inhabitants).
Collection Period:	Originally planned to be from March 4 to May 31, 2005, but subsequently DPSC extended the work period until the middle of July 2005.
Waste Segregation:	A three-segregation system was introduced: 1) Kitchen waste: Transported to a community compost yard provided at Campo Florido landfill site 2) Recyclable waste: Initially transported to Campo Florido landfill and after sorting there further transported to an existing recycling center near Calle 100 landfill 3) Other waste: Hauled to Campo Florido landfill for disposal
Equipment used:	1- 18m ³ compactor truck for waste collection, and 196 bins in total for waste discharge, basically 3 bins for each station
People's Performance Achieved:	People's performance for segregated collection was far below the expected level in the initial period. To rectify the situation, an intensified awareness-raising program was conducted for an area consisting of 4 selected priority stations. While the ratio of properly segregated waste remained at 51 % for the area as a whole (result measured on June 16 th), that for the 4 priority stations was improved to 87 % during the intensive awareness-raising period (result measured during May 21-31). This indicated that people's performance can be improved by providing intensified awareness-raising programs.
Feedback to the M/P:	Implementation of segregated collection in the M/P shall be accompanied by intensive and continuous awareness-raising programs for provision of knowledge to the people and call for the people's cooperation.

Note: * Originally planned to be 8,000 stations covering 2,075 household (8,300 inhabitants), but later reduced to 64 stations

1.4.2 Composting

(1) Community-level Composting

Community-level composting was attempted at a composting yard provided in Campo Florido landfill. The result was not always satisfactory since the work could not fully confirm the progress of fermentation and maturing due to the limited time. Therefore, the quality of compost produced could not be confirmed. Implementation of community composting in the M/P will require an additional pilot project to affirm the quality of compost produced there.

Table 1.4.2 below summarizes the outline of the community-level composting conducted in the PLP.

Table 1.4.2 Outline of Community Composting Performed in PLP

Purpose:	To investigate the practicability of producing compost by using kitchen waste collected from urban areas, thus aiming at reduction of waste quantity to be disposed of in the landfills
Source of compost:	Kitchen waste collected from segregated collection in the Peñas Altas community of Habana del Este Municipality
Work Period:	Compost production was tried from March 4 to the end of June 2006, but mostly failed due to improperly segregated raw materials. A retrial was made during the May 24 – June 7 period by using well segregated raw materials collected from 4 priority stations. The work was much delayed due to improperly segregated raw materials and also delays of completion of compost yard roofing.
Composting Method:	Composting in the May 24 – June 7 period was conducted at a roofed compost yard (but unpaved due to delay of concrete base paving). The operation comprised 4 steps; (i) removal of impurities, (ii) fermentation, (iii) maturing, and (iv) sieving.
Quantity of Raw Materials Used:	In total, 560 kg of raw materials was processed for composting during the May 24-June 7 period.
Result of Composting:	Owing chiefly to the delay in the completion of the roofed compost yard, PLP could not confirm the final quality of compost produced. Nevertheless, the fermentation process seemed to be progressing (temperature 40 – 60 degrees Celsius) when the Study Team left Habana in June 2005.
Feedback to the M/P:	Implementation of community composting in the M/P shall be preceded by an additional pilot project for confirming the quality of compost to determine whether it would meet the quality required by the market.

(2) Home Composting

In general, home composting in the PLP was deemed to be successful on account of people's cooperative attitude to conducting the home composting activity. Visual inspection of the home compost produced showed an acceptable quality for use as soil conditioner for their domestic purposes (home farming and gardening). Nevertheless, the PLP did not fully confirm the quality in quantitative terms. The quality of home compost will be confirmed in more detail through implementation of the M/P to ensure the safety of home compost products.

Table 1.4.3 below summarizes the outline of home composting conducted in the PLP.

Table 1.4.3 Outline of Home Composting Performed in the PLP

Purpose:	To assure the practicability of introducing home composting to suburban households, expecting that it would be an effective measure for the 3Rs.
Objective Area:	Campo Florido community (in Habana del Este Municipality), which represents a typical suburban area
Number of Households:	Initially introduced to 40 households, but actually 29 households conducted home composting according to the prescribed program.
Source of Raw Materials:	Kitchen waste generated by each household
Composting Bins:	50 in total were supplied to 40 households (40 containers procured by import and another 10 plastic buckets procured in Cuba), 10 of the 40 households used both types of compost bins
Result of Home Composting:	The following items were identified: <ol style="list-style-type: none"> 1) Home composting is expected to reduce household waste by 43 %, which would otherwise be disposed of in the public collection system 2) Judging from the smell, moisture and color of the compost, the fermentation of kitchen waste was taking place relatively well. The quality appeared to be acceptable for use for the domestic use of each household, however no testing of physical quality was conducted during the PLP. 3) After the PLP period, home composting was not always done appropriately. This suggested the need for continuous awareness-raising and guidance programs.
Feedback to the M/P:	As represented by a fact that only 29 out of 40 households conducted home composting properly, it is anticipated that some households will not be willing to participate in home composting. The M/P shall assume this fact. Although the quality of compost produced in the PLP appeared to be of an acceptable level, further confirmation of the quality is required in the M/P.

1.4.3 Awareness-raising Programs

Awareness-raising activities covered the whole PLP area of Campo Florido and Peñas Altas communities. People were generally cooperative with the awareness-raising activities with their positive participation. Nevertheless, the results of the PLP identified the need for intensive and continuous awareness-raising activities to be planned for the implementation of the M/P; say, for a period of some three years.

Table 1.4.4 summarizes the outline of awareness-raising programs conducted in the PLP.

Table 1.4.4 Outline of Awareness-raising Activities Performed in the PLP

Purpose:	To convince people of the importance of MSWM, explain the purpose and components of the PLP, and obtain support for implementation of the PLP, especially segregated collection and home composting
Objective People:	People living in Peñas Altas and Campo Florido communities, particularly people directly involved in the PLP (some 2,000 households involved in segregated collection in Peñas Altas and 40 households participated in home composting in Campo Florido)
Activity Period:	Started ahead of the PLP in October 2004 and continued to the termination of the PLP in the end of June 2005. Some activities (post-PLP workshop and awareness level survey) were conducted after the PLP.
Activities Conducted:	Dissemination of information and education of people were conducted through 3 main workshops for community residents, one workshop for school children and teachers and 35 meetings/small workshops at community group level. Other than these, visits to households were made to provide guidance in the proper method for segregated discharge (in Peñas Altas area) and home composting (for 40 households in Campo Florido area) as required.
Result of Awareness Level Survey:	A questionnaire survey was conducted to determine the level of people's awareness of MSWM/PLP and willingness for cooperation. The survey was given twice; before and after the awareness-raising activities. The results of the survey based on 180 samples indicated that the people's understanding of MSWM improved from 53 % (before) to 95 % (after) and the willingness for cooperation from 75 % to 93 %. This suggested that awareness-raising activities conducted in the PLP were effective in terms of improving the people's knowledge regarding MSWM and their attitude for cooperation.
Feedback to the M/P:	The following items were noted: <ol style="list-style-type: none"> 1) People's knowledge and attitude have been much improved by the awareness-raising programs conducted in the PLP. Similar effort is required in the implementation of the M/P. 2) Nevertheless, people's performance for some PLP activities (e.g. segregated discharge and home composting) declined after the end of the awareness-raising activity. This suggested the need for continuous awareness-raising and education until the people's performance would be firmly fixed.

1.4.4 Waste Weight Measurement

To rectify the present deficiency of waste quantity control, the practice of waste weight measurement was introduced under the PLP. This attempt was generally successful in that the Cuban staffs became acquainted with the weight measurement work through the PLP.

Table 1.4.5 below summarizes the outline of waste weight measurement work conducted in the PLP.

Table 1.4.5 Outline of Waste Weight Measurement Performed in the PLP

Purpose:	To train UPPH and DMSCs staff regarding the method and practice of waste weight measurement and also measure the bulk density of hauled wastes
Measurement Site:	At a truck scale site newly installed at DPSC's office compound located 6 km from Campo Florido landfill
Waste Measured:	Waste hauled to Campo landfill including segregated waste collected from Peñas Altas community under the PLP and also transported from other areas (but excluding the waste transported by H/Cs due to the location of the truck scale site away from the H/C hauling route)
Truck Scale Used:	A set of portable type truck scales of 40-ton weighing capacity, which was of a type that measured front wheels and rear wheels separately
Measuring Period:	From May 5 th to the end of June 2006
Result of Work:	Measurement was sometimes interrupted due to power failure and heavy rain. The measurement work itself was conducted fairly well by UPPH/DMSCs staff during the PLP period. Afterward, however, the work was discontinued leaving the truck scale in disorder.
Feedback to the M/P:	The following items were suggested: <ol style="list-style-type: none"> 1) In view of the necessity of quantity control of waste, measurement of waste weight shall be introduced at all landfills, recycling centers and compost yards proposed in the M/P 2) The truck scales shall be of a stationary type that can weigh a truck with a single operation (instead of a portable type that requires two weighings) 3) The facility shall be provided with a reliable power supply source to avoid the interruption of measurement due to power supply failure

1.4.5 Cell Construction and Soil Covering at Landfills

This work was conducted with the main purpose of training Cuban staff regarding the practice of essential elements of environmentally-friendly or sanitary landfill operation. The work consisted of waste disposal by the cell method and soil covering. In general, the work was performed fairly well by the Cuban staff.

Table 1.4.6 below summarizes the outline of the cell construction and soil covering operation conducted in the PLP.

Table 1.4.6 Outline of Cell Construction and Soil Covering Performed in the PLP

Purpose:	To train UPPH and DMSCs staff regarding the practices of waste disposal by the cell method and operation of daily soil covering as basic elements of environmentally-friendly landfill
Work Site:	Campo Florido landfill
Waste Handled:	Waste hauled to Campo Florido landfill from everywhere in the vicinity of the landfill, 150 m ³ /day on average
Operation Period:	From May 5 th to the end of June 2006
Equipment Used:	1-bulldozer, 1-wheel loader, 1-shovel loader, and trucks
Work Performed:	Cuban staff practiced the disposal of waste in cells with soil covering on a daily basis.
Feedback to the M/P:	Compared with waste disposal by simple dumping, waste disposed by the adopted method clearly provided a sanitary landfill environment. This type of sanitary landfill will be adopted in the M/P with additional provisions such as leachate treatment facilities, gas vents, etc.

CHAPTER 2 SELECTED PILOT PROJECT

2.1 Priority Project Package

2.1.1 Segregated Discharge and Segregated Collection

(1) Segregated discharge

1) Classification of waste

For segregated collection in the PLP, waste was classified into three categories as proposed in the M/P, namely, (i) kitchen waste, (ii) recyclable waste, and (iii) other wastes.

2) Segregation in households

In segregated collection, all waste generated in each household must be segregated before being discharged to public waste bins. Residents were educated to do this through explanation at workshops and the distribution of instruction papers. It was thought that the segregation and storing of kitchen waste in the homes would be difficult because of its perishable character and high moisture content. Hence, plastic buckets were provided to each household in the PLP area, in which the residents were able to store wet kitchen waste separately.

3) Instruction to residents regarding segregated discharge

Workshops and meetings were held to give information about the PLP, including the method of segregated collection. Handouts for publicity were distributed and utilized to explain how to segregate waste at the generation source. Also, stickers were attached to every waste bin identifying the waste category and classification.

(2) Segregated collection

1) Concept of collection and transportation system

a) Concept

The concept for the segregated collection system adopted in the PLP is shown in Figure 2.1.1. In the collection area of Peñas Altas community, it was planned to collect 5.5 tons of domestic waste per day from 2,075

households (8,300 inhabitants) at 80 collection stations¹ (each station had three containers).

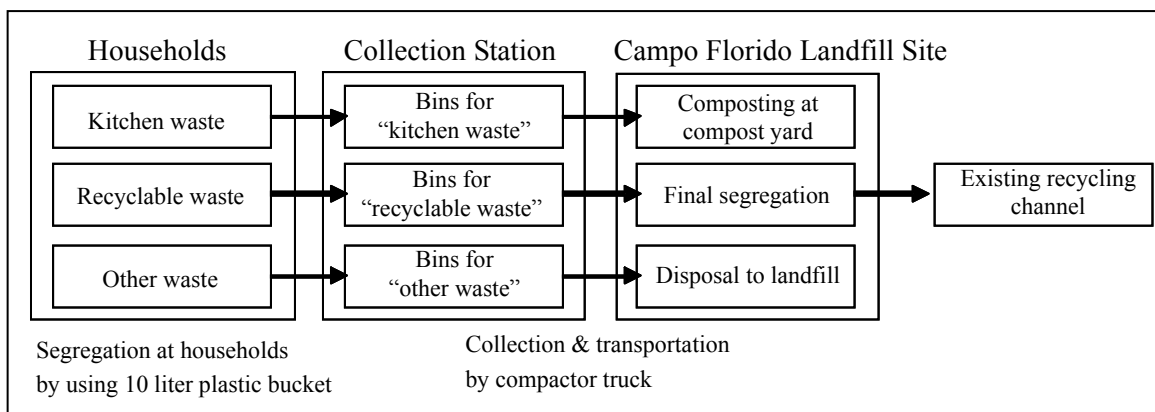


Figure 2.1.1 Concept of Segregated Collection in the PLP (Planned for the Peñas Altas Area)

b) Segregated waste to be conveyed

- Organic waste:

Each house owner was instructed to segregate kitchen waste as organic waste and deposit it into roadside waste bins every day. The collection staff collected the segregated organic waste from the bins and hauled it to a compost yard in Campo Florido landfill.

- Recyclable materials:

Each house owner was required to place the recyclable materials separately into 'recyclable' containers. The collection staff collected and transported the segregated recyclable materials to the Campo Florido landfill site. The operation staff in Campo Florido landfill sorted out the collected recyclable materials and separated them for further transportation to the Recycling Center near the Calle 100 landfill.

- Other wastes:

Other wastes were deposited into separate bins by residents and transported by the UPPH directly to Campo Florido landfill for disposal.

c) Collection equipment and collection frequency

One 18 m³ compactor truck (C/T) was used to collect all types of waste according to a predetermined collection schedule. The collection time and frequency were decided by C/P and UPPH staff after discussion with the Study Team.

¹ These figures represent the figures originally planned. The number of stations actually provided for the PLP was 64 stations covering 2,046 households (see Subsection 5.1.2(2) 1)).

d) Cleaning of containers

Each household was responsible for the periodic cleaning of small buckets provided for them. The UPPH had the responsibility for cleaning the C/T vehicles and roadside waste bins periodically.

2) Preparation for data collection

Before the implementation of the PLP, the C/P and the Study Team jointly undertook the following preparation work:

- Design of collection route
- Training of engineers and technical persons engaged in PLP operation.

The C/P agreed that, as much as possible, they would record the collection data listed below:

- Time and motion surveys before and after the replacement of bins (the number of bins was increased for segregated collection)
- Calculation of collected waste volume and its specific gravity
- Observation of the condition of collected waste at the landfill
- Observation of the condition of bins and the number of missing bins
- Review of collection schedules to meet the actual collection requirements.

2.1.2 Composting

(1) Community Composting

1) Raw material for compost

The raw material used for community composting was the kitchen waste collected through the segregated collection from the Peñas Altas area. Community composting in the PLP was regarded as a trial to gain experience for large-scale composting plans proposed in the M/P.

2) Facility for community composting

A temporary composting yard was established in the Campo Florido landfill site. Basically, the treatment of collected kitchen waste was carried out manually. Construction of the yard and provision of necessary materials, except for wheel loader, were conducted by the Cuban side.

3) Methodology

The method applied in the PLP was based on the simplest procedure of composting. This was roughly divided into the following four steps.

i) First step: Receiving kitchen waste to be used as raw material

Initially, any large items of material unsuitable for composting were removed from the raw material, since a not negligible quantity of impurities were contained in the waste collected from the residents (waste generators).

ii) Second step: Fermentation

Fermentation was controlled and progressed in three stages (sections) at the community composting yard. The kitchen waste generated in one week was piled in the first section of the yard. This pile was moved to the next section after seven days. This operation was repeated every week in the first to third sections. After the third section, the material was moved to the maturing section (see “Third step” below). Therefore, it took around three weeks in total for the fermentation procedure.

Leaf mold or dry soil was added to adjust the moisture content of the fermenting material during this step. Close attention was paid to the moisture content throughout this period. To maintain appropriate moisture content, water was added manually when necessary. A moisture content of 50% is considered appropriate for fermentation.

Oxygen supply was managed by turning the composting material once a day using a wheel loader.

iii) Third step: Maturing

Three sections were prepared for maturing. The necessary work for maturing is similar to that for fermentation. The processed materials were moved to the next section and turned using a wheel loader twice a week.

iv) Final step: Sieving

The matured compost was sieved to break down or separate lumps in the product. This work was performed manually using a sieve.

4) Activities conducted for community composting

Table 2.1.1 shows a summary of community composting work conducted in the PLP. In particular, C/P performed the leading role in carrying out the following work:

- Selection of the target area for the PLP
- Management for utilization of collected kitchen waste and promotion of community composting
- Preparation of dissemination workshops to explain the required segregation work to households.

Table 2.1.1 Outline of Community Composting Work in the PLP

No.	Items	Description
1.	Location of composting yard	Built in the compound of Campo Florido landfill
2.	Preparation of composting yard	Yard was composed of a base structure paved with concrete and a roof structure for fermentation and maturing of compost
3.	Raw material for composting	Kitchen waste collected by segregated collection in the Peñas Altas community
4.	Preparation for awareness-raising workshop	Conducted by C/P with support of the Study Team
5.	Preparation of instruction manual and handouts	Conducted by C/P with support of the Study Team
6.	Implementation organization	DPSC, UPPH, C/P, and the Study Team
7.	Supervision	Monitoring and inspection work for composting were conducted by the UPPH and C/P
8.	Awareness-raising	Activities included holding workshops, distribution of handouts, questionnaire surveys for local residents, etc.
9.	Analysis of survey results and preparation of report	Organized and implemented by C/P with support of the Study Team

(2) Home Composting

1) Raw materials for composting

Home composting was introduced to 40 households in the Campo Florido community. The kitchen waste generated in households such as vegetable and fruit leftovers was considered as appropriate raw material for compost. Achieving self-treatment of such domestic waste in the form of composting resulted in the reduction of the waste volume needing collection and disposal by the UPPH.

2) Equipment for home composting

Composting bins were supplied to the households selected for the PLP in the Campo Florido community. Manuals and instructions for composting were prepared giving due consideration to the care needed to avoid propagating rodents, insects, or other scavenging animals.

3) Methodology

The method of home composting is described below.

Preparatory work:

- Securing a place for the compost bin in each household
- Excavation of the bin locations down to a depth of around 15 cm
- Lining the ground with dry leaves before placing the bins
- Setting the bins on that place.

Daily work:

- Separation of kitchen waste, composed of food waste such as vegetables, fruit, and grains
- Drainage of surplus water from kitchen waste with a kitchen net
- Cutting of kitchen waste into small pieces to foster the fermentation process
- Putting kitchen waste into the compost bin
- Adding leaf mold or dry leaves to adjust moisture
- Mixing waste and leaves with a shovel.

Observation and recording:

The residents were asked to perform daily observation and recording tasks.

The points to be checked were as follows:

- Volume of kitchen waste used for composting
- Volume of leaf mold added to composting, if any
- Problems that residents faced in composting work
- Existence of grubs or insects
- Level of offensive odor.

The C/P monitored the residents' observation and recording work and also checked the condition of home composting.

4) Activities conducted for home composting

Table 2.1.2 shows the summary of work activities conducted for home composting. In proceeding with the work, the C/P took initiative role including the handling of the following work:

- Selection of the 40 households that participated in the PLP
- Promotion of home composting at the residential level
- Preparation of dissemination workshops to explain home composting procedures
- Delivery of home compost bins to the selected households
- Preparation and distribution of instruction manuals and handouts

- Monitoring of home composting to identify any problems during the implementation and provide feedback to improve the method of home composting.

Table 2.1.2 Outline of Home Composting Work in PLP

No.	Items	Description
1	Location of home composting	Conducted in Campo Florido area, at 40 households
2	Number of composting bins supplied	50 in total (40 containers were procured by import and another 10 plastic buckets procured in Cuba), where 10 of the 40 households utilized both types of waste bin.
3	Raw material for composting	Kitchen waste generated in the households
4	Preparation of a workshop for introducing home composting	Conducted by the C/P with support of the Study Team
5	Preparation of instruction manuals and handouts	Conducted by the C/P with support of the Study Team
6	Implementation organization	DPSC, UPPH, C/P, and the Study Team
7	Supervision	Monitoring and inspection of composting work were conducted by the UPPH and C/P
8	Awareness-raising	Conducted by holding workshops, events, distribution of handouts, and questionnaire surveys for local residents, etc.
9	Analysis of survey results and preparation of report	Conducted by the C/P with support of the Study Team

2.1.3 Awareness-raising

Awareness-raising activities were conducted for the entire PLP area covering the Peñas Altas community and Compo Florido community.

(1) Objectives and approach of the awareness-raising activities

The objectives of the awareness-raising were:

- To convince people of the importance of MSWM
- To convince people of the purpose and components of the PLP
- To obtain support/cooperation for the smooth implementation of the PLP.

In carrying out the awareness-raising activity, the maximum involvement of C/P and existing community organizations was required. The following approach was adopted:

- The C/P took the initiative role in all the activities with the Study Team's support
- A two-step approach was adopted, i.e. firstly from the C/P to the community organizations/leaders and secondly from community organizations/leaders to the residents.

At the workshops and meetings (see (2) blow), specific guidance was given to the people who would be involved in segregated collection and home composting. Topics emphasized were:

1) Segregated collection:

- Purpose and beneficial effects of segregated collection
- Segregation of wastes into three categories (kitchen waste, recyclable waste and other waste)
- Composition of three separate waste bins
- Manner of segregated discharge by people
- Schedule of waste collection by UPPH

2) Home composting:

- Purpose and beneficial effects of home composting
- Contents of kitchen waste to be separated from other wastes
- Method of installing and using compost bins / plastic buckets supplied under the PLP
- Method and manner of storing, fermenting and use of compost
- Method of recording of home composting

The guidance was based on pamphlets and handouts that had been prepared by the C/Ps.

(2) Components of the awareness-raising program

The following activities were carried out to raise the awareness of the residents:

1) Pre, mid-term and post implementation workshops for the PLP

Three workshops were held inviting the residents in the PLP area: before, during and after the implementation of the PLP.

- Pre implementation workshop before the PLP (also as Second Dissemination Workshop) in October, 2004
- Mid-term implementation workshop at the mid-way point of the PLP in March, 2005
- Post implementation workshop after implementation of the PLP in June, 2005.

2) Workshop for the primary school children

Aiming at raising the awareness of the young generation, one workshop was held inviting primary school children and teachers.

3) Materials for raising awareness

The following materials were used in the workshops:

- Education materials (pamphlets, handouts)
- Campaign materials (T-shirts, calendars).

4) Pre and post implementation awareness level surveys

Questionnaire surveys were conducted pre and post implementation to measure the effect of awareness-raising.

5) Other workshops/meetings for raising awareness

- Various meetings among the C/P, community leaders and residents were held to raise the awareness of the PLP and to obtain the support of the residents for PLP implementation. (ref. Section 1.4 for details)

2.1.4 Project Site of the Priority Project Package

The project site was located in the eastern area of Havana City and belongs to the Habana del Este municipality. It is located in an agricultural area about 26 km from the center of Habana Vieja. The communities involved in the PLP are Peñas Altas and Campo Florido with a population of approximately 19,000 inhabitants. Segregated collection was implemented for some 2,075 households of the Peñas Altas community and home composting for 40 households of the Campo Florido community, while improved landfill operation and community composting were implemented at Campo Florido Landfill.

2.2 Waste Weight Measurement

Although the measurement of the weight of waste hauled to the landfill site is one of the most fundamental and important tasks in MSWM, it is currently not performed adequately. At present, the waste quantity is recorded only by drivers' statements of limited items such as car number, driver's name, volume of waste measured based solely on truck load capacity, and the name of the place where the truck collected the waste.

It has been observed that the actual loading on trucks is not always full. Therefore, the recorded volume might be larger than the actual volume, resulting in an overestimation of the waste volume hauled and disposed of.

In the PLP, waste was weighed using portable truck scales starting from 5 May 2005 at a DMSC field office located approximately 6 km from the Campo Florido landfill.

2.3 Cell construction and Solid Covering at the Landfill

Initially, improved landfill operation was considered as a potential candidate work for the PLP. However, it was finally ruled out in view of budgetary and time

constraints. After discussion between the Cuban side and JICA, it was decided that a part of the landfill operation, i.e. cover soil embankment operation, would be conducted as a program of capacity development. The work was carried out simultaneously with the PLP.

The work consisted of (i) construction of a dyke and cells to accommodate disposed waste, (ii) spreading and compaction of hauled waste, and (iii) providing a cover soil embankment.

One of the most significant problems of MSWM in Havana City is the environmental/hygiene problem at existing landfills, such as outbreaks of fire, pollution of surface water and groundwater, breeding of flies and mosquitoes, littering of waste and bad odors.

A possible measure to mitigate these problems is the covering of disposed waste by soils on a daily basis so as not to expose the waste to an external environment. The waste was deposited in cells each having a volume corresponding to the daily waste volume.

In the PLP, cell construction and daily soil covering was executed using heavy equipment comprising a bulldozer, a shovel loader, a wheel loader and a dump truck at the Campo Florido landfill starting from 5 May 2005.

CHAPTER 3 IMPLEMENTATION ORGANIZATION AND COST SHARING

3.1 Implementation Organization

The PLP was carried out through the collaboration of the Cuban side and the Study Team. On the Cuban side, C/Ps worked together with DPSC and CITMA, and other organizations relevant to the PLP. A PLP Unit comprising of C/Ps and the Study Team members was set up as follows:

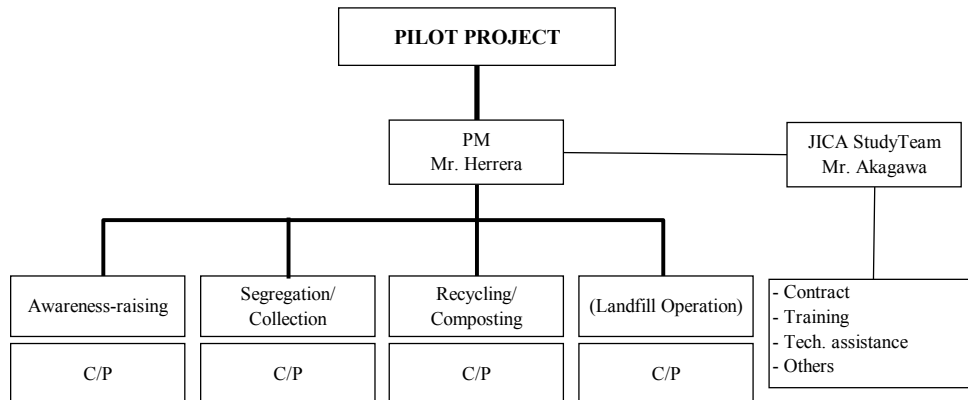


Figure 3.1.1 Implementation Organization of the Pilot Project

The PLP Unit was responsible for planning and overall supervision and evaluation of the implementation and operation of the PLP. In the PLP Unit, C/Ps took the initiative while the Study Team gave advice and provided full support and technology transfer. The actual operation of segregated collection and composting (home and community composting) was carried out by DPSC/UPPH and the local DMSC. DPSC/UPPH took the overall responsibility for operation and maintenance of the vehicles and equipment.

In addition to the above, a separate team was established for the landfill operation. This team supervised the work and undertook the collection of data to record the operational performance of daily soil covering and truck weighing. The operation was conducted by the UPPH's operation group at the Calle 100 landfill.

Awareness-raising was carried out as a joint effort between the PLP Unit and the local communities, including the local government and volunteers as well as the organizations concerned with raising environmental awareness.

3.2 Cost Sharing between the Japanese Side and the Cuban Side

The following principles were agreed for the implementation and operation of the PLP.

- (1) In principle, the foreign currency component would be borne by the Japanese side while the local currency component would be borne by the Cuban side. Manpower required for the implementation would be provided by the Cuban side.
- (2) More specifically, heavy equipment and vehicles for the landfill operation would be obtained by means of the “Imported Parts and Repairing/Assembly” method. The Japanese side would bear the cost for the imported parts while the Cuban side would take the responsibility and bear the cost for repairing and assembling the equipment. Arrangements for procurement of vehicles and equipment, custom clearance and carrying out other necessary procedures would be the responsibility of the Cuban side.

Table 3.2.1 below shows cost sharing between the Japanese and Cuban sides.

Table 3.2.1 Cost Sharing between Japanese Side and Cuban Side

Items	Burden		Cost US\$*	Note
	Study Team	Cuban Side		
1. Segregated Discharge and Collection				
Waste Bin	x		34,560	160sets
Waste Bin		x	0	20sets, Shortage of Bin (UPPH's Stock)
Plastic Bucket	x		6,225	2075sets
Compactor Truck		x	0	UPPH's Vehicle
Sticker for Waste Bin	x		1,200	
Fuel Cost for Vehicle		x	1,440	8L/day x 2round-trip x 90days
Manpower Cost for Collection		x	240	4persons x 3months
Subtotal			43,665	
2. Community Composting				
Shed of Operation Yard		x	6,300	90m2 x 70\$
Temporary Prefabricated House		x	0	Temporary
Manpower Cost for Composting		x	200	5persons x 2months (Including Works of Landfill)
Subtotal			6,500	
3. Home Composting				
Compost Bin (JICA Supply)	x		4,520	40sets
Compost Bin (C/P Supply)		x	500	10sets x 50 \$
Manpower Cost for Instructors		x	40	1person x 2months
Subtotal			5,060	
4. Awareness-Raising Activities				
Pamphlet and Calendar	x		8,600	
T-shirt and Ball-Point Pen	x		1,900	
Workshop	x		3,000	

Items	Burden		Cost	Note
	Study Team	Cuban Side	US\$*	
Questionnaire Survey	x		900	
Manpower Cost		x	60	3persons x 1month
Miscellaneous Cost of Workshop	x		500	
Subtotal			14,960	
5. Weighing of Waste Amount by Truck Scale				
Truck Scale	x		28,000	To be used for UPPH after PLP
Personal Computer	x		3,600	
Manpower Cost		x	40	1person x 2months
Subtotal			31,640	
6.Landfill Operation (Cell and Soil Cover) Site				
Design and Engineering Fee for PLP Facilities	x		3,800	The construction of facilities is cancelled.
Repair of Equipment: Bulldozer	x		45,000	To be used for UPPH after PLP
Repair of Equipment: Wheel Loader	x		28,000	To be used for UPPH after PLP
Repair of Equipment: Truck	x		11,000	To be used for UPPH after PLP
Fuel Cost for Operation		x	3,600	120L x 60days x 0.5\$
Manpower Cost		x	120	3persons x 2months
Subtotal			91,520	
Total			193,345	

Note: Manpower Cost is the average salary of officials in Cuba (US\$20/month)

* Cost borne by Cuban side was estimated based on 1 CUP = 1 CUC

CHAPTER 4 IMPLEMENTATION SCHEDULE

4.1 Overall Implementation Schedule

The implementation schedule for the PLP is shown in Figure 4.1.1 below. Physical implementation of the PLP, consisting of segregated collection, home composting, community composting and landfill operation, commenced on 4th March 2005 on completion of arrangements for equipment supply (dump truck, bulldozer, wheeled loader) and procurement of compost bins. The awareness-raising activities had started in October 2004, five months ahead of the commencement of physical work.

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

Note: The Cuban side decided to continue the follow-up activities of PLP after July 2005.

Preparation of PLP operation started from September 2004

Figure 4.1.1 Implementation Schedule of the PLP

After July 2005, the work was taken over by the Cuban side to continue as a regular operation within the MSWM system.

4.2 Procurement of Equipment and Materials

Observation of the condition of existing equipment indicated that some of the equipment to be used for the landfill operation (dump truck, bulldozer, wheeled loader) would need engine replacement. Further, new items for the segregated collection needed to be procured. The equipment parts and other items purchased for the PLP are shown in Table 4.2.1 below.

Table 4.2.1 Equipment and Other Items Procured for the PLP

No.	Items	Parts	Quantity	Remarks
1	Dump truck	Engine	1 set	Russia (KAMAS 55111)
2	Bulldozer	Engine	1 set	Italy (Fiat BD-20)
3	Wheeled loader	Engine	1 set	Italy (Fiat FR-12B)
4	Waste bins	-	160 sets	700L, plastic
5	Compost bins	-	40 sets	220 L, plastic
6	Buckets	-	2,075 sets	Plastic

4.3 Actual Work Period

(1) Segregated Collection

For the segregated collection in the Peñas Altas area, three sets of waste bins were placed at each station. The work was commenced on 4th March 2005 and completed at the end of May 2005. The monitoring and survey activities related to segregated collection were conducted by C/P.

After May 2005, DPSC desired to continue the segregated collection for an extended period for further observation of the performance. The activity was continued until the middle of July 2005.

(2) Composting

The work started on 4th March 2005 and ended at the end of May 2005 according to the predetermined schedule.

As for the segregated collection, DPSC extended the composting operation until the middle of July 2005.

(3) Awareness-raising

Three main dissemination workshops were conducted during the period from October 2004 to June 2005 in the Peñas Altas area.

After completion of segregated collection at the end of May, a questionnaire survey was conducted and an analysis was made to evaluate the achievement of the awareness-raising program based on opinions/comments collected from local residents.

(4) Landfill Operation

The work under the PLP program started on 4th of March and was completed at the end of May 2005.

Similar to the case of segregated collection and composting, the actual operation was continued until the middle of July 2005 at the request of DPSC.

CHAPTER 5 VERIFICATION OF ACHIEVEMENT OF PILOT PROJECT

5.1 Achievements of the PLP

5.1.1 Review of the PLP Performance in May 2005

(1) 1st stage achievement as of May 2005

On 5th May 2005, just after the Study Team's arrival in Havana, a joint inspection by C/P and the Study Team was conducted to observe the condition of the on-going PLP. The findings from this inspection are described below.

1) Segregated discharge and collection

The condition of segregated discharge from households was not of a high enough standard to verify the effectiveness of this measure in the master plan. The poor state of the segregation process is described below.

Table 5.1.1 shows the evaluation based on the site inspection of 5th May 2005. The observers consisted of the C/P and the Study Team who visited the site together and evaluated the condition of the segregated discharge. The appropriateness of segregated discharge of waste was scored into five grades as shown in Table 5.1.1 below.

The evaluation result was worst in the category of recyclable material. Although it seemed some residents had tried to follow the instructions for segregated discharge, the general impression was that it needed much improvement.

Table 5.1.1 Evaluation of Segregated Discharge on 5th May 2005

Category of Waste	Appropriateness of Segregated Discharge						Total
	A	B	C	D	E	No Answer	
Kitchen Waste	4 6%	21 29%	14 19%	17 24%	15 21%	1 1%	72 100%
Recyclables	0 0%	4 6%	10 14%	26 36%	32 44%	0 0%	72 100%
Others	3 4%	17 24%	20 28%	16 22%	15 21%	1 1%	72 100%

Note: Evaluation (A to E) was scored based on the observer's judgment of the ratio of appropriate disposal of waste in waste bins. Scoring is based on the following criteria: A: appropriate disposal in waste bin was more than 90%, B: 80-89%, C: 70-79%, D: 60-69%, E: Less than 59%. Total observation No.: 72 station observations.

2) Community composting

The community composting project was not implemented as scheduled. There are two main reasons for that:

- The building that had been planned for the community composting yard had not been built.

Actually, the area for the composting yard had been secured for the PLP. However, since the proposed protective building was not completed as scheduled, the C/P tried to operate the community composting without it, but this meant that the waste had to be piled in the open air. The condition of the pile could not be managed because it was difficult to control moisture and temperature under direct sunshine. After discussion with the Study Team, the C/P stopped the composting process on this pile.

The compost yard with a roof structure was completed on 30 May 2005. This yard is made up of pillars and a roof that shades the compost pile from direct sunshine and rainfall. The composting operation was then resumed.

- Insufficient segregation to supply the raw material for community composting

The quality of the segregated kitchen waste was poor as mentioned above. The material designated as kitchen waste included not only organic material other than food waste but also a great deal of inorganic waste. The fermentation would not progress when organic material was mixed with non-biodegradable substances. Therefore, it was very difficult to obtain properly segregated kitchen waste for community composting during the PLP period.

3) Home composting

The home composting was regarded as progressing well. Although the procurement of 40 bins from a foreign country was delayed because of transportation troubles, the distribution was completed by the end of March.

Local residents were recognized as being cooperative. School students in junior high school had participated in monitoring work on behalf of the adults in the local community. This kind of mobilization of students has also been seen in the case of a mosquito control program in Cuba.

This arrangement for monitoring was arranged by the C/P because the students were usually reliable and active, and because it was difficult to assign adults in the community for the work requiring frequent attendance. Teachers in the school understood the purpose of the PLP, and had supported students' activity by approving it as having the same value as their regular classes.

4) Awareness-raising

The following activities were originally planned as awareness-raising programs:

- Workshops attended by the Study Team, C/P, the community leaders and the residents of the PLP area to explain the objectives and outline of the PLP and to hear the opinions of the residents. They were also used to raise the environmental awareness of the residents.
- Meetings among C/P, community leaders and the residents to strengthen the understanding of the residents about the PLP as well as to raise the environmental awareness of the residents
- Distribution of pamphlets about the PLP to the residents
- Meetings with the households participating in the home composting program and distribution of handouts to explain the composting process
- Distribution of environmental campaign materials, namely calendars and T-shirts.

Awareness-raising activities were carried out according to the original plan. By 5th May 2005, the following activities were completed.

- Two workshops, i.e., a pre-implementation workshop and a mid-implementation workshop, were carried out.
- 23 meetings were held.
- Pamphlets were distributed to all the households in the PLP area.
- Several meetings for participating households were held to explain the home composting operation.
- 1,000 calendars and 300 T-shirts were distributed to the residents and to community based organizations.

(2) Measures taken for improvement

1) Overall betterment and priority area selection

Based on findings from the joint inspection in early May 2005, it was found that improvement was necessary in segregated discharge and community composting.

To improve the segregation process, four stations were selected as priority stations to attempt improvement, Station Nos. 27, 32, 33 and 34 (for location of stations, ref. Figure 5.1.3), where more intensive awareness-raising of the residents was needed with closer monitoring of the disposal conditions. Selection of the priority stations was done by the C/P, considering the environmental awareness level of the residents and the number of households discharging MSW to the stations. Two types of station were selected, one type with a relatively large number of households (33 and 34) and the other having a small number of households (27 and 32).

To improve the quality of community composting, C/P and the Study Team agreed that the community composting facility should be completed as early as possible with a roof structure to eliminate the adverse effect of rainfall during the rainy season on the composting process. Due to financial difficulty, however, the facility was not completed until near the end of May 2005.

2) Improvement of segregated discharge and collection

The conceivable reasons for mixing of waste and for non-segregated discharge were considered to be as follows:

- Insufficient recognition of the PLP
- Misunderstanding of the need for segregated discharge and classification
- Uncooperative discharge by people who do not care about MSWM issues.

In order to solve these issues, the need for improved instruction and public relations was emphasized. The stickers for waste bins showing classification of waste were revised, and the explanation paper was distributed to residents to remind them of the PLP. The applied measures for improvement are listed in Table 5.1.2.

Re-classification of segregated discharge was undertaken for clarification at this stage. The containers to take material classified as recyclable waste were renamed as 'recyclable containers' to make the use of these resource

materials clear. As there are many kinds of paper in MSW, it was considered necessary to clarify the classification of types of paper. In order to prevent misunderstanding of the classification of some paper, all types, including cardboard, were classified as “Others” in the re-classification. Table 5.1.3 describes the waste classifications adopted initially and after the clarification.

As stated above, four stations were selected as the areas/stations to be prioritized for efficient improvement in the limited implementation time. The reasons why these stations were selected as priority stations are described in Table 5.1.4.

Table 5.1.2 Applied Measures for Improvement of Segregated Waste

No.	Measures	Applied Date and Duration
1.	- The area and stations for MSW collection, part of the PLP area, were selected to be prioritized for improvement.	6 th - 31 st May, 2005
2.	- An additional meeting with residents in the priority area was held to introduce and explain the PLP for segregated collection. - Illustrations of material classification in segregation and an explanation paper regarding the PLP were distributed to all households in the target area.	13 th - 14 th May, 2005
3.	- Daily monitoring was introduced to evaluate the condition of segregated collection in the priority stations.	21 st - 31 st May, 2005
4.	- Watchmen who would stand at the priority stations were arranged to lead the behavior of residents in discharging MSW to waste bins. People from the community and school students in the area were asked to play this role.	21 st - 31 st May, 2005
5.	- The designs of stickers attached to waste bins were revised. The classifications of the three categories of MSW were illustrated with drawings as well as by text.	21 st May 2005
6.	- The classification of “recyclable waste” was simplified so that it could be understood by residents. i) The disposal of recyclable materials: plastic, glass, metal, aluminum, to be classified as “recyclable waste”, was limited to only one container. ii) Paper, which included various kinds and had many uses, seemed to be difficult for residents to segregate and was, therefore, excluded from “recyclable waste”. iii) Cloth was also excluded.	21 st May 2005

Table 5.1.3 Waste Classification in Segregated Collection

Category	Initial Classification (4 th May - 20 th May)	Clarified Classification (21 st May - 31 st May)
Kitchen Waste	Food waste such as vegetables, fruit and rice	Same as initial classification
Recyclable Waste	Glass, plastic, aluminum, metals, cloth, paper and cardboard	Vessels and bottles for food and drink, which are made of glass, plastic, aluminum and metals (renamed as ‘Recyclable Containers’)
Others	Unusable non-bulky materials and household waste, toilet paper, cloth, wet paper, and others	Other materials which are not included in the above two categories. Cloth, paper and cardboard were included in this category.

Table 5.1.4 Reasons for Selection of Priority Stations

No. of Station	Reasons for Selection of Stations for Improved Segregation
No. 27	The area covered by this station is not highly populated compared to the other two stations i.e. No. 33 and 34. This was located close to 33 & 34. C/P intended to compare the effect of measures in comparison with 33 & 34.
No. 32	This station was selected in an area not previously involved in the PLP because C/P wanted to start the campaign with new families in order to compare the results with those families already informed about the PLP.
No. 33 and 34	The area covered by these two stations is populated and the community is actively supportive of the PLP. This was a good environment for the C/P to enhance activities for awareness-raising. (These two stations were actually in the same location. Their bins were two sets of six waste bins placed close to each other. Therefore, these were treated as one station in monitoring.)

3) Improvement of community composting

Because of the mixture of incorrect materials, re-segregation of discharged kitchen waste at the Campo Florido landfill site after collection/transportation was actually too difficult, although workers had been assigned for that task. The following two measures were taken to improve the community composting operation:

- Improvement of segregation and collection

These aspects would be improved by measures mentioned above in “improvement of segregated discharge and collection”.

- Preparation for better processing for composting

In this regard, the need for the earliest practical preparation of the roofed compost yard, which had not been completed, was raised with the responsible people again.

4) Reinforcement of awareness-raising activities

To improve the disposal segregation, awareness-raising activities were intensified for the priority four stations. Specifically, the following activities were carried out intensively in May 2005, targeting the residents and community leaders for the priority stations and aiming at further upgrading of their awareness of the importance of segregated discharge:

- A meeting with the community leaders (Attendance: 11)
- A meeting with members of every CDR (Committee for Defense of Revolution) in the area (Attendance: 57)
- A meeting with the CPC’s (Communist Party of Cuba) district nucleus for the area (Attendance: 7)
- Three neighborhood debates, 1 in each CDR (Attendance: 61)

- A neighborhood debate at the Public Health local office (Attendance: 31)
- Visits to households (about half of the households in the priority area)
- A meeting with students and teachers of the Council's secondary school (Attendance: 12).

5.1.2 Segregated Discharge and Segregated Collection

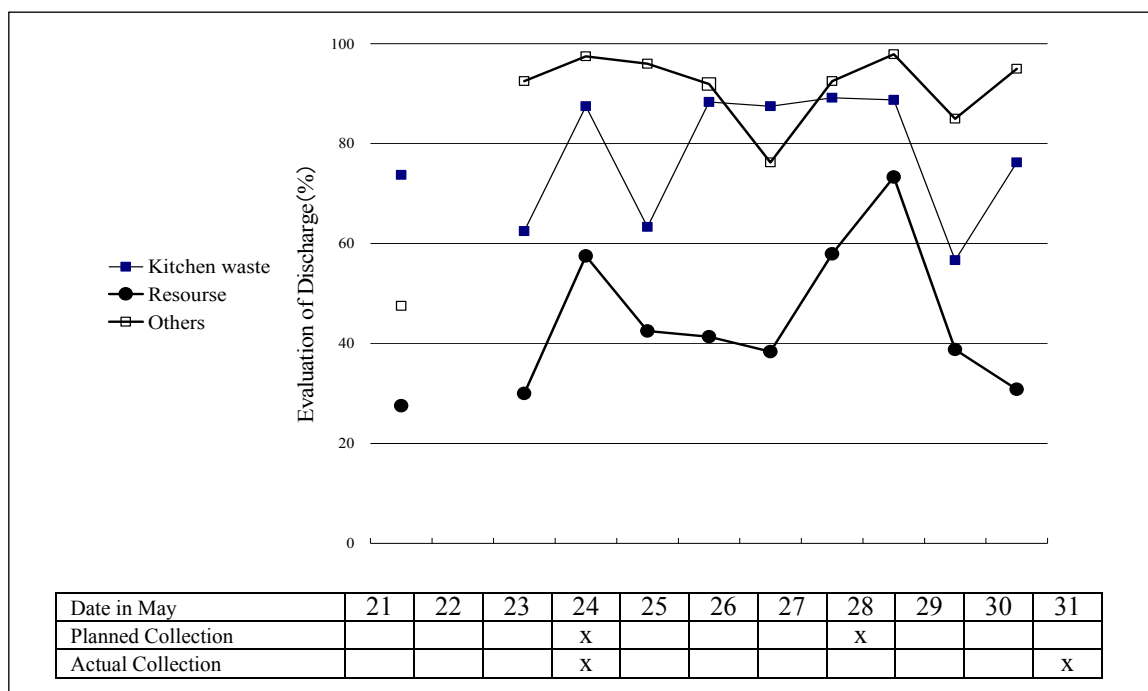
(1) Segregated discharge

1) Achievement in priority stations

At the prioritized four stations, the C/P as well as the Study Team carried out daily monitoring of segregated discharge during the period 21 - 31 May 2005. During the inspection for monitoring, the C/P and the Study Team jointly observed the ratio of properly discharged waste into the defined waste bins to evaluate the effect of improvement of the segregated discharge after the intensified awareness-raising activities. In addition, the condition of waste discharge in each bin was recorded with pictures as a visual record.

Figure 5.1.1 illustrates the results of the monitoring, which shows the ratio of properly discharged waste observed by visual assessment by the C/P and Study Team members. The ratio (%) shows the average value of the four priority stations. The observation showed relatively high values on the 24th and 29th of May. The ratios of all three categories observed during the 10 days 21 - 31 May showed higher values compared with those in the previous period before the intensified awareness-raising activities (ref. Table 5.1.2). This indicated that segregated discharge could be much improved with the implementation of an intensified awareness-raising program.

On the other hand, the ratio decreased on 30th May after reaching a high value on 29th May. This was caused by a delay in collection work (collection was scheduled on 28th, but was actually done on 31st as shown below). The waste bins overflowed on 30th May when the observers visited the stations. It was thought that people gave up any attempt at proper segregation of waste since there was no space in the waste bins.



- Note:
1. The above figure shows the ratio of waste properly discharged into designed waste bins as observed by monitors (C/P and Study Team). The ratio shows the average value of the observation at the four priority stations.
 2. The monitoring period was: 21st to 31st of May for Station Nos. 27, 33 & 34 and 24th to 31st of May for Station No. 32.
 3. Collection of waste was scheduled twice a week during the period, but actually not performed as scheduled.

Figure 5.1.1 Results of Daily Monitoring of Segregated Discharge in the Priority Area

Table 5.1.5 summarizes the ratios of properly discharged waste by station and by type of waste as observed during the 21st to 31st May period. The maximum ratio of kitchen waste and resource materials was more than 70 %. This indicated a high potential for improving the performance of residents for appropriately segregated discharge if the residents are educated through proper awareness-raising programs.

Table 5.1.5 Ratio of Properly Discharged Waste in the Prioritized Area

Unit: %

Station No.		No. 27	No. 32	No. 33&34	Average
Kitchen Waste	Maximum	80	95	100	89
	Average	55	83	95	77
	Minimum	0	53	90	57
Recyclable Waste	Maximum	95	70	90	73
	Average	33	35	73	44
	Minimum	10	13	45	28
Others	Maximum	100	98	100	98
	Average	77	92	93	87
	Minimum	0	84	63	48

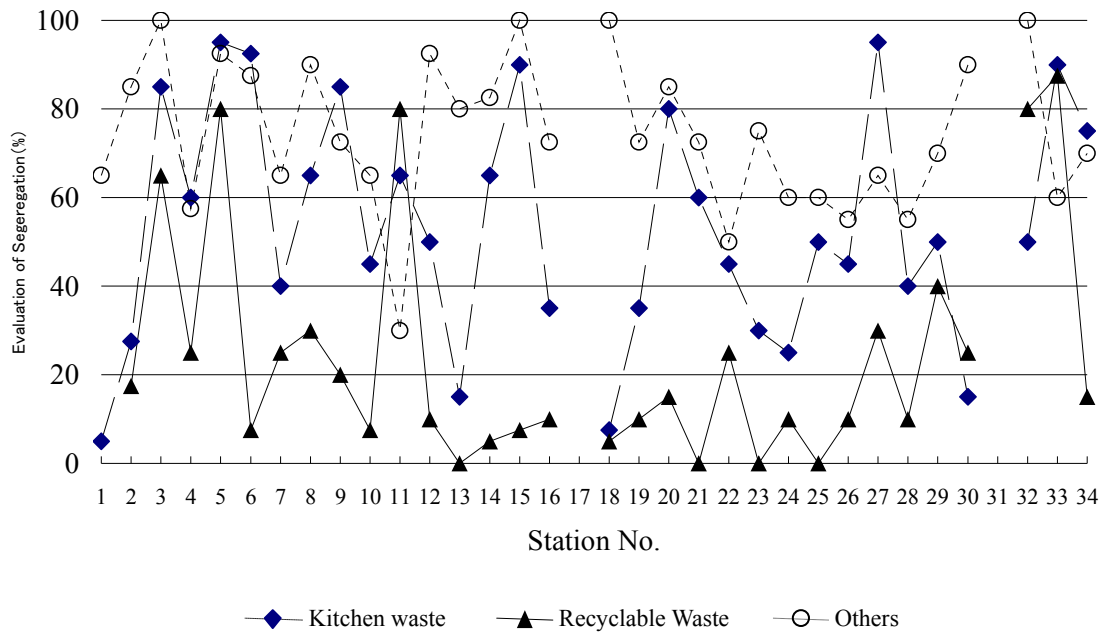
- Note:
1. The value in the table shows the ratio of properly discharged waste to total waste by station and waste category.
 2. Monitoring period: 21 to 31 May for Nos. 33, 34, & No. 27 and 24 to 31 May for Station No. 32.

The following were identified through observation in the field and hearing from residents in the priority areas:

- Failure of proper collection of waste would certainly affect the condition of segregated discharge. If the bin designated for the waste is full due to delay of the waste collection, people tend to deposit the waste into other waste bins that have some space for the discharge.
- People would lose motivation for participation in segregated discharge when other associated operations were not conducted properly. For instance, some residents were very disappointed when they saw that all the waste was collected by just one trip of a truck by mixing the three segregated wastes, when they had been properly deposited into categorized waste bins.
- Leaders in the community play a vital role. For instance, one community had a good leader. Because of her devotion to the PLP, by providing door-to-door instruction, guidance at the station, etc., the community performed well in waste segregation.

2) Ratio of properly deposited waste in 34 stations

Figure 5.1.2 shows the results of monitoring the segregated discharge at 34 stations that accounted for half the waste from all stations. This monitoring covers the stations in which the intensified awareness raising had not been conducted. The result of monitoring is regarded as representing the condition of segregated discharge without the intensified awareness raising. Generally, the ratios observed were at low levels compared with the results obtained for the four prioritized stations.



Note 1. The values in % show the ratio of properly discharged waste for each category in the segregated discharge operation in the PLP.
2. Monitoring was conducted on 6th June at 34 stations.

Figure 5.1.2 Result of Monitoring Stations without Measures for Improvement

3) Effect of measures for improvement

Table 5.1.6 shows a comparison of the percentages of segregated waste discharged properly “during” and “after” the aforementioned improvement measures. The values shown in the column “during measures” represent the percentage of waste properly segregated at the four stations, while the figures in all the “after measures” columns represent the ratios at the selected four stations and at all monitored stations observed on 16 June and 6 July, whereby no additional improvement measures had been conducted at the latter set of all stations.

The figures in the table show that the ratio of properly segregated discharge for “Kitchen Waste” and “Recyclables” at the four selected stations was as high as about 90% and 70% respectively while the measures were being taken. However, after the measures ceased, the values at those stations went down to 75% and 50% on average respectively. On the other hand, the average values at all stations were much lower than at the four selected stations, being 54% and 25%, respectively.

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 are regarded as representing the potential level of

improvement that could be attained if intensive awareness-raising and guidance for the residents are carried out. With this observation in view, and after discussion with the Cuban side, the Study has 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 of the M/P.

Table 5.1.6 The Percentage of Segregated Waste Properly Discharged during and after the Measures for Improvement

Status(time)	At four selected collection stations			At all collection stations		
	During measures		After measures	After measures		
Monitoring date	21 st -31 st May	16 th June	6 th July	16 th June	6 th 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 the leftmost column represent the highest values observed during the period when the measures were being taken and the other values are the average of those observed at the stations on each monitored date
3. On the monitoring day on 6th July 2005, the number of collection stations for segregated collection had been increased to 49 from 34 on 16th June 2005.

In September 2005, the JICA official mission visited some stations at which segregated discharge activity should have been taking place. They observed that the segregated discharge was not being conducted, and discharged waste was mixed to the same extent as in the early stages of the PLP in May 2005. This fact strongly suggests that the executing agency shall deploy continuous efforts on a long term basis until accomplishing the improved performance of segregated discharge by the residents.

(2) Segregated collection

1) Review of condition of stations

During the PLP implementation, a review was undertaken to survey the actual condition of collection stations, such as the number of households covered by the station and the number of bins actually installed. The survey was conducted progressively and covered 64 stations in total. Each station had three bins or more installed as required, depending on the actual volume of waste. The result is shown in Table 5.1.7.

Table 5.1.7 Review of Condition of Collection Stations

Number of Stations Reviewed	Number of Households Covered by Stations*	Number of Bins Installed	Review Date
21	480	61	4 Mar 05
22	839 (+359)	66	3 Apr 05
31	1,260 (+421)	93	10 Apr 05
33	1,275 (+15)	103	17 Apr 05
64	2,046 (+771)	196	1 July 05

Source: * UPPH, July 2005

2) Collection schedule

Initially, collection of waste was planned every day for kitchen waste and resources materials and every three days for other waste. Based on the actual amount of waste collected, however, it was judged that the bins have enough capacity to store the segregated waste for four to five days and accordingly the collection schedule was revised.

The revised collection schedule is shown in Table 5.1.8. The collection was conducted on Tuesday and Saturday considering the arrangement of vehicles.

Table 5.1.8 Change of Collection Schedule

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

3) Quantity of collected waste

The quantity of collected waste was surveyed in the area covered by 34 stations consisting of No.1 to No.34. Figure 5.1.3 shows the location of the 34 stations.

As mentioned before, four priority stations were selected for the intensified awareness-raising activity. The selected four stations were Nos. 27, 32, 33 and 34. These 4 stations formed three pick up points, No. 27, Nos. 33 & 34 and No. 32 as Station Nos. 33 and 34 were very close together.

The quantity of waste collected from the 34 stations (33 locations if No. 33 & No. 34 are counted as one location) was 1,567 kg/day or 7,857 L (liter) on average and its bulk density was estimated to be 0.2 kg/L. The waste was comprised of 24% resource materials (recyclables), 27 % kitchen waste, and the remaining 49% was other waste.

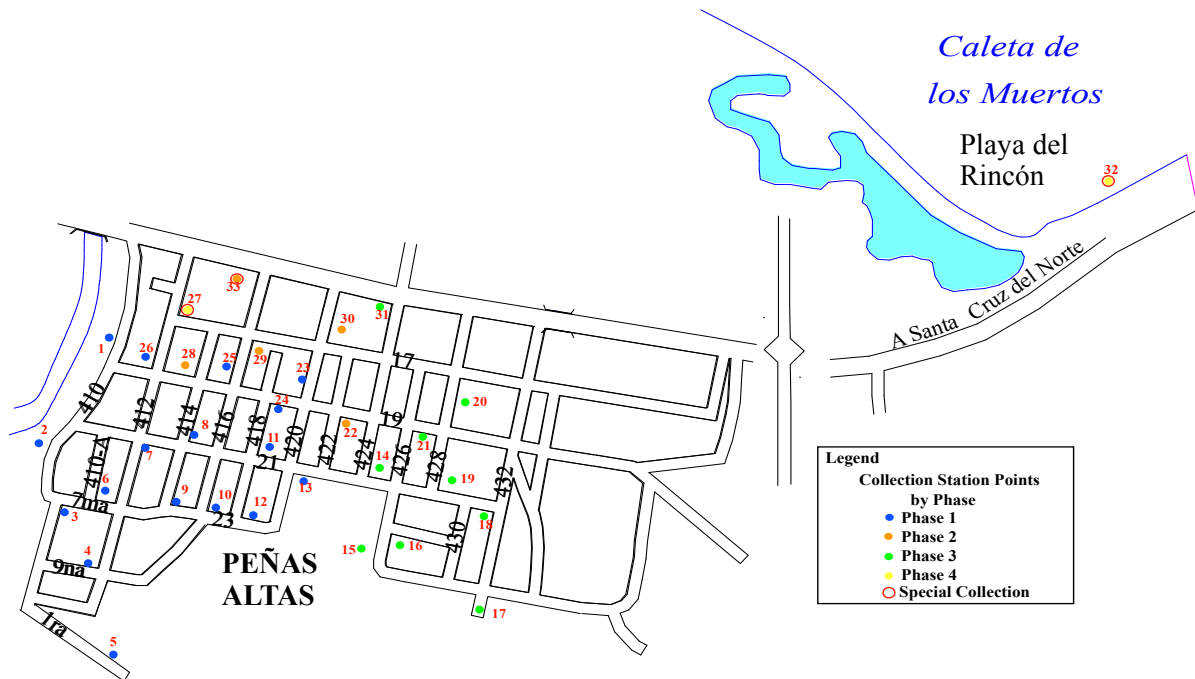


Figure 5.1.3 Location of Bin Stations

The quantity of waste collected from the four priority stations (Stations Nos. 27, 32, 33 & 34) was 800 kg/day and its bulk density was 0.3 kg/L.

4) Condition of bins

Keeping the bins in workable condition is a requirement for proper operation of segregated discharge. In this context, the condition of bins was surveyed in the selected area twice during the PLP. Table 5.1.9 shows the condition of the bins installed under the PLP and used for three months. The table also shows, for comparison, the result of the survey for old bins having been used for 2 to 4 years. The bins used for the PLP were in general kept in good condition during the period.

Table 5.1.9 Conditions of Waste Bins

(Unit: Number of bins)

Condition of Bin	Bin Used for 2-4 years (Data: 2 March 2005)	Bin Used for 3 months (Data: 30 April 2005)
Shaft broken	0 (0%)	0 (0%)
Body broken	6 (28%)	0 (0%)
No wheels	12 (57%)	0 (0%)
No lids	0 (0%)	1 (1%)
In good condition	3 (15%)	92 (99%)
Total number of bins	21 (100%)	93 (100%)

5) Collection vehicles and number of staff

A Pegaso 18 m³ C/T vehicle equipped with a mechanical lifting and compacting system was dispatched by UPPH for the PLP. The vehicle is ten years old. It had no difficulty in performing the work, but it had several mechanical breakdowns due to hydraulic pump malfunctions and flat tires. The fuel efficiency in terms of travel distance per liter of fuel was about 2.8 km/liter as shown in Table 5.1.10, which compared favorably with the average of other UPPH vehicles. In general, the 18 m³ C/T used for the PLP was operated in relatively good condition, partly due to the relatively low loading on the vehicle (30% load).

Table 5.1.10 Fuel Consumption of the 18 m³ C/T

Description	C/T used for PLP*	C/T used in Centro Havana**	C/T used in Havana Vieja**	UPPH ⁷ STD ***
Collected Weight (kg)	2,200	15,100	23,200	-
Fuel (liter/day)	40	48	32	-
Travel distance (km)	110	81.8	68.3	-
Collection points	31	79	114	-
Fuel consumption (km/liter)	2.8 (30% load)	1.7 (100% load)	2.1 (100% load)	3.0

* data collected from the PLP ** data quoted from a Time & Motion survey

*** UPPH standard figure

(3) Influence of segregated collection on resource material collection by ERMP

According to ERMP of Havana City, the recovered materials were recycled as summarized in Table 5.1.11. The resource materials that will be recovered from MSW for recycling in the M/P will be recycled in a similar way using the existing routes for the short term. Recycling will contribute to save resources, which are presently imported from foreign countries.

Table 5.1.11 Utilization of Recovered Material by ERMP in Havana City

Materials	Method of Utilization
Steel, iron, and stainless steel scrap	After processing in the raw materials recovery companies, the materials are used to make corrugated bars, beams and metal structures in the iron and steel industry.
Bronze, copper, aluminum, lead, zinc, nickel and other non-ferrous metals	These materials are consumed in Cuban non-ferrous foundries to make cables, profiles, carpentry tools, home tools, etc.
Paper	It can replace virgin pulp in the paper industry and be made into notebooks, boxes and other articles.
Plastics	This material is crushed and processed in the plastic industry to make new plastic containers, tanks, buckets and other utensils.
Glass containers	Containers are repeatedly used by refilling with drinks.

Source: ERMP of Havana City

ERMP of Havana City collects recyclable materials, mainly from the industrial sector, but this state-controlled company also recovers material from municipal solid waste as well by using the channels of groups such as CDR and MRF. The recovery routes are supported by the voluntary activities of the communities and schools in Havana City. This group collection activity is not strictly scheduled nor controlled. For example, the activities for collection are not implemented regularly, and the timing of transport of collected material to the factories is decided by the availability of equipment for that transport.

In the Guanabo district of Habana del Este municipality where Peñas Altas, the PLP site, belongs, the Guanabo district office of ERMP has managed material recovery by CDR and MRF. The quantity of materials collected by CDR and MRF in Guanabo district in 2004 to 2005 is shown in Table 5.1.12 and Figures 5.1.4 to -5.1.7.

The amount of paper and cardboard collected in March and April 2005 was small compared to that in January and February. It seems that this decrease followed the decreasing trend from January 2005. Especially in the case of CDR, this trend has been recognized from November 2004 before the implementation of the PLP. The quantity of plastic, aluminum and glass bottles collected in March and April 2005 was also less than that of January and February, but this can be regarded as being within a range of normal fluctuation in the year. From these observations, it was deemed that the collection of resource materials under the PLP conducted from March 2005 did not have a notable effect on the material recovered by group collection. In this Study, it was assumed that the material recovered by segregated collection under MSWM would not compete with, but be a complement to the existing group collection managed by ERMP.

In the monitoring survey conducted in the PLP, residents reported that they would not have provided the material to the group collections even had they known of such activities.

Table 5.1.12 Quantity of Material Collected through Groups in Guanabo

Group	Material	Unit	2004												2004 Mean
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
CDR	Paper and cardboard	ton	6	5	5	4	5	6	6	6	5	5	6	5	5
	Plastic	ton	1	1	2	1	1.5	1	1	1.5	1.5	1.5	2	1	1
	Aluminum	ton	1	1	1	2	1	2	1	3	1	2	1	1	1
	Glass bottles	Unit	3,000	3,000	3,000	2,500	3,000	3,000	3,000	5,000	2,000	3,000	3,000	4,000	3,125
MRF	Paper and cardboard	ton	1	1	2	1	2	1	2	1	2	2	2	2	2
	Plastic	ton	2	3	1	1	1	1	1	3	3	3	2	1	2
	Aluminum	-	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
	Glass bottles	Unit	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Total	Paper and cardboard	ton	7	6	7	5	7	7	8	7	7	7	8	7	7
	Plastic	ton	3	4	3	2	3	2	2	4	4	4	4	2	3
	Aluminum	ton	1	1	1	2	1	2	1	3	1	2	1	1	1
	Glass bottles	Unit	5,000	5,000	5,000	4,500	5,000	5,000	5,000	7,000	4,000	5,000	5,000	6,000	5,125

Group	Material	Unit	2005			
			Jan	Feb	Mar	Apr
CDR	Paper and cardboard	ton	4	3	1	2
	Plastic	ton	5	4	2	1
	Aluminum	ton	3	2	1	1
	Glass bottles	Unit	3,500	3,000	3,000	3,000
MRF	Paper and cardboard	ton	No data	1	1	1
	Plastic	ton	No data	1	1	1
	Aluminum	-	No data	No data	No data	No data
	Glass bottles	Unit	No data	No data	No data	No data
Total	Paper and cardboard	ton	4	4	2	3
	Plastic	ton	5	5	3	2
	Aluminum	ton	3	2	1	1
	Glass bottles	Unit	3,500	3,000	3,000	3,000

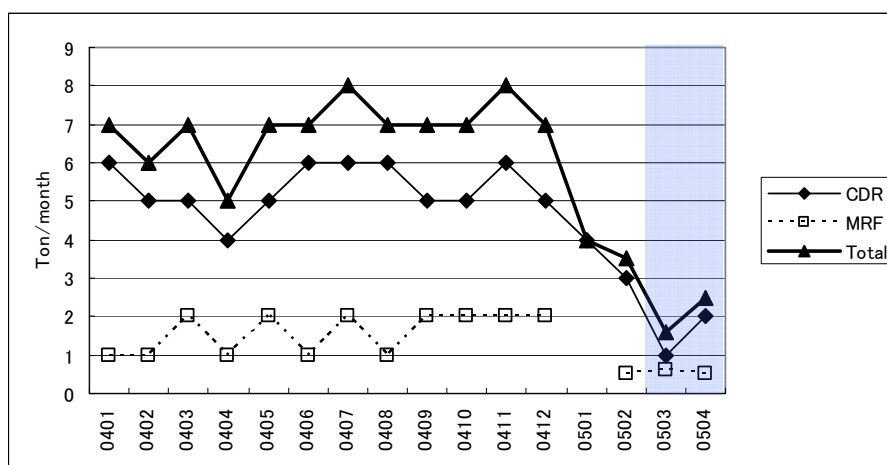


Figure 5.1.4 Quantity of Paper and Cardboard Collected by Groups in Guanabo

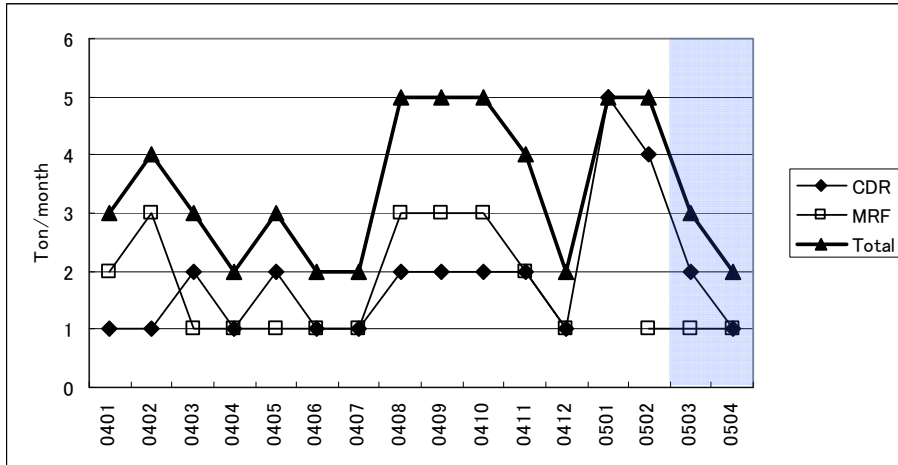


Figure 5.1.5 Quantity of Plastic Collected by Groups in Guanabo

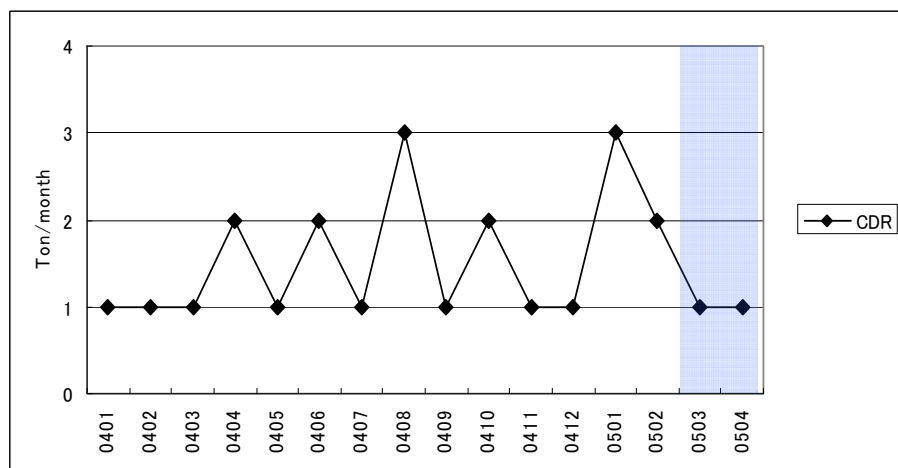


Figure 5.1.6 Quantity of Aluminum Collected by Groups in Guanabo

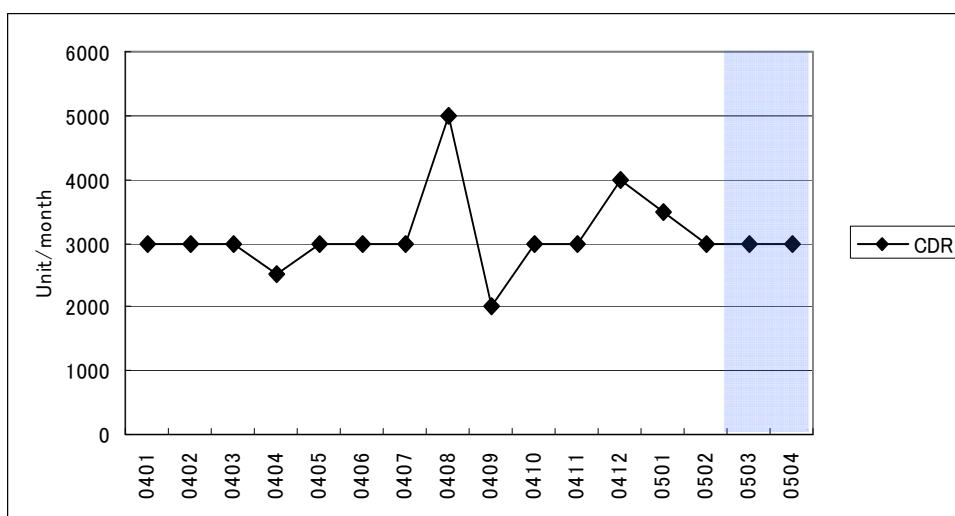


Figure 5.1.7 Quantity of Glass Bottles Collected by Groups in Guanabo

5.1.3 Composting

(1) Community composting

During intensive awareness-raising for the four priority stations, the segregation of kitchen waste was improved in the area as shown in Table 5.1.6, reaching almost 90% of the waste being appropriately segregated².

After the intensive awareness-raising period, community composting was continued by using the kitchen waste segregated from the priority stations. Kitchen waste for community composting in the PLP was collected during the period from 24th May to 7th June. The quantity of collected kitchen waste is shown in Table 5.1.13. The waste received in one week was treated as the waste for one batch of composting. The quantity of kitchen waste in each collection varied from 92 kg to 250 kg, 182kg on average.

Contamination of inappropriate waste for composting was observed at rates of 16 to 33%, requiring manpower for re-segregation, but no contamination of hazardous substances like syringe needles or other medical waste was observed.

Table 5.1.13 Quantity of Kitchen Waste Collected for Community Composting

Composting Batch No.	1st	2nd		3rd	Average
Receiving Period (planned)	22 nd – 28 th May	29 th May – 4 th June		5 th June – 11 th June	
Date of receiving kitchen waste	24 th May	31 st May	4 th June	7 th June	—
Received waste quantity (kg)	250	241	143	92	182
Total received waste in receiving period (kg)	250	384		92	—
Residue (kg)	40	80	25	21	41.5
Ratio of residue (% in weight)	16%	33%	17%	23%	23%
Quantity of raw material for composting (kg)	210	161	118	71	140
Total of raw material for composting (kg)	210	279		71	187
Number of receiving stations	3	4	4	4	—

The fermentation process seemed to be progressing on track in June 2005 when the Study Team left Havana. At that time, the yard had not been paved yet. The temperature in the waste pile increased to 40–60 degrees Celsius by fermentation.

After the Study Team left, however, the composting operation was not conducted properly. The roof of the composting yard was blown off due to a hurricane, and this made it difficult to conduct the compost production in the designated manner. It was observed when the JICA official mission and Study Team visited the site in

² As stated in Subsection 5.1.2, this improvement lasted only for a limited period after the intensive awareness-raising activity in June 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.

September 2005, that the waste collected and piled at the site was contaminated by many hazardous materials such as syringe needles, other medical wastes, and batteries, and no compost of marketable quality had been produced.

(2) Home composting

1) Quantity of kitchen waste utilized in home composting

Table 5.1.14 shows the estimated quantity of waste utilized in home composting. The data were derived from the records taken by 29 households out of a total 40 households to which home composting was introduced. The quantity of kitchen waste used for home composting was estimated as 1.2 kg/household/day.

Table 5.1.14 Quantity of Kitchen Waste utilized in Home Composting

Total quantity of kitchen waste utilized	3,615 L/29 households
Number of household-days of monitoring	1,383 household/days
Quantity of kitchen waste utilized in a household per day	2.6 L/household/day 1.2 kg/household/day *

Note: *Bulk density applied for calculation of weight: 0.45 kg/L, which was obtained in the waste quality and quantity survey conducted under the Study in April 2004.

The use of kitchen waste for home composting will reduce the quantity of waste discharged to the public waste discharge system. Assuming 4 persons per household and 0.7 kg waste generation per person/day, the average waste generation in each household is 2.8 kg/day. Kitchen waste for home composting corresponds to 43% reduction of waste disposal to public systems as calculated below.

$$R (\%) = W_{hc} / W_g = 1.2 / 2.8 = 42.8 (\%)$$

Where R: Ratio of waste reduction (%)

W_{hc}: Amount of kitchen waste utilized in home composting (kg/household/day)

W_g: Waste generation in each household (kg/household/day)

2) Utilization of compost produced by home composting

The composting seemed to have been done relatively well except for mixing of improper substances such as plastics, which was observed in some houses.

Judging from the smell, moisture and color of the compost, the fermentation of kitchen waste was taking place under relatively good conditions. It appeared that the home composted product was of acceptable 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 during the PLP. Nevertheless, these were only observations made during the PLP, and further confirmation of the quality would be required before the introduction of home composting on a larger scale could commence.

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

3) Perception of odor caused by home composting

Table 5.1.15 shows the summary of monitoring of odors from home composting. According to the results of the monitoring during the PLP, less than 10% of the residents felt that the odor caused by home composting was unpleasant. Also, 17 of the 29 house owners who recorded the monitoring data had never felt that the odor was unpleasant. On the other hand, three house owners reported unpleasant odor on 20% of days (once per five days on average) during the monitoring period.

Table 5.1.15 Summary of Monitoring of the Perception of Residents regarding Odors Generated by Home Composting

Answer from Household	Ratio
Unpleasant odor	9%
A little odor	58%
No odor	33%

5.1.4 Awareness-Raising Activities

Workshops and meetings held for raising the awareness of residents in the entire PLP area are described in preceding Subsection 2.1.3. In addition, the following activities were conducted for each location of the PLP areas:

Awareness-Raising Activities for the PLP	
In Peñas Altas Area:	
<u>Pre-implementation stage:</u>	
Meetings:	
<ul style="list-style-type: none"> • 1 with Guanabo Council leaders (Attendance: 14) • 1 with Peñas Altas community leaders (Attendance: 51) • 1 with Peñas Altas residents from each electoral district (Attendance: 349) 	
Workshops:	
<ul style="list-style-type: none"> • 1 WS with Peñas Altas community leaders 	

- 1 WS with the people from Peñas Altas's electoral district No. 63 (Attendance: 61)
- 1 WS with the people from Peñas Altas's electoral district No. 81 (Attendance: 49)
- 1 WS with the people from Peñas Altas's electoral district No. 39 (Attendance: 39)

Post-implementation stage:

Meetings:

- 1 with Peñas Altas's community leaders; CDR, FMC and Delegate (Attendance: 56)
- 1 with Peñas Altas residents from each electoral district. (Attendance: 251)
- 1 in every CDR from each electoral district at Peñas Altas (Attendance: 367)

Workshops:

- 1 neighborhood debate with the participation of the people from Peñas Altas electoral district No. 63 (Attendance: 71)
- 1 neighborhood debate with the participation of the people from Peñas Altas electoral district No. 81 on the subject of segregated discharge (Attendance: 69)
- 1 neighborhood debate with the participation of the people from Peñas Altas electoral district No. 39 with the subject of segregated discharge (Attendance: 32)

During additional awareness-raising in the selected 4 Station areas for improvement of segregated discharge:

Meetings:

- 1 with the community leaders (Attendance: 11)
- 1 with every CDR members in the area (Attendance: 57)
- 1 with each CPC (Communist Party of Cuba) district nucleus for the area (Attendance: 7)
- 3 neighborhood debates, 1 in each CDR (Attendance: 61)
- 1 neighborhood debate at the Public Health local office (Attendance: 31)
- 1 meeting with students and teachers from the Council's secondary school (Attendance: 12)

Other activities;

- Visits to households for guidance on segregated waste discharge
- Voluntary work by C/Ps and residents in the area

In Campo Florido Area:

(For households not involved in home composting)

Pre-implementation stage:

Meetings:

- 1 with the Council's leaders (Attendance: 17)
- 1 with the residents from each of Peñas Altas's electoral districts (Attendance: 69)

Workshops:

- 1 WS with the Council leaders (Attendance: 16)
- 1 WS with the Council area residents (Attendance: 61)
- 1 neighborhood debate with the Council area residents (Attendance: 39)

Post-implementation stage:

Meetings

- 1 with the Council leaders (Attendance: 13)

(For households involved in home composting)

Meetings:

- 1 with the Council leaders (Attendance: 15)
- 1 with the households participating in the home composting activity (Attendance: 33)
- 1 with students and teachers from the Council's secondary school (Attendance: 13)

Workshops:

- 1 WS with the households participating in the home composting activity (Attendance: 35)
- Monitoring at households.

Other Workshops in which the Community Residents Participated:

Pre-Implementation stage:

- WS with Education local authorities
- WS at Hotel Atlántico.

Post-Implementation stage:

- WS at Hotel Ambos Mundos
- WS at Hotel Nacional

5.1.5 Waste Weight Measurement

(1) Installation of truck scale

A set of truck scales was installed at a DMSC field office located 6 km from Campo Florida landfill. The truck scales were used for weighing the waste hauled to the composting yard and landfills.

First, a mounded soil foundation was constructed. Then sieved fine sand was put on the foundation and a flat foundation was constructed using a spirit level. On the mounded and flat foundation, an iron plate with the dimensions of 6m long x 3.2m wide x 30mm thick was placed and on it the truck scale installed.

An access ramp was built to facilitate smooth movement of trucks onto the truck scale.

(2) Portable truck scale equipment

A set of portable truck-scale equipment was procured from Japan. The equipment can measure a weight up to 40 tons, and is composed of rubber mats with sensors for measuring the weight of trucks and a recorder for recording the weights. The sensor cables are connected to the recorder.

When JICA 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 used for the temporary weighing the quantity of waste disposed during the JICA Study. In future, when When the DPSC next uses this portable truck scale to obtain data on solid waste quantity as well as the PLP of the JICA Study, the steel plates should be again be prepared for safety and accurate measurement.

(3) Procedure for measuring the weight of vehicles

1) Measurement of weight

The vehicle moves on to the truck scale and puts its front tires on the mats. The mats are reset as required to adjust to the position of the tires. The measured weight of the front tires is indicated on the display of the recorder.

After finishing the measurement of the weight of the front tires, the vehicle turns around and moves backwards to the truck scale and put its rear tires on the mats. Similarly, the measured weight of the rear tires is indicated on the display of the recorder.

2) Automatic calculation and print-out of the result by recorder

The total weight of the front and rear tires of the vehicle is automatically calculated in the recorder and indicated on the display. Then the measuring result is printed out. If the empty weight of the truck is already known or measured, it is held in the recorder memory by inputting it in advance. Accordingly, the net weight is also printed out.

3) Filling of record format

The result of truck weighing was also recorded in a work record format. Recording in the format included date and time of arrival of truck, driver's name, vehicle number, classification of vehicle, total, empty and net waste weights, % of volume to full capacity by visual check, classification of waste, collection area and name of organization that owns the vehicle.

5.1.6 Cell Construction and Daily Soil Covering

(1) Cell construction with cover soil

The cell method, which is the most popular landfill operation method today, involves containing solid waste in cells topped with a layer of cover soil. The size of each cell is determined by the quantity of solid waste per day. Since each cell forms a separated part divided by soil cover, it works as a firebreak. It prevents solid waste from being scattered, emission of bad odors, and breeding of harmful pests.

(2) Waste disposal by push-up method

Spreading and compaction of disposed waste was done by adopting the push-up method, where a bulldozer spread the waste upward with compaction. The

advantage of this method is that it is easy to make a uniform landfill layer and compaction is also easy, especially when the compaction layer has to be established as early as possible.

(3) Outline of cell construction and soil covering at the Campo Florido landfill site

1) Landfill method: Cell method

2) Hauled waste: 150 m³/day

3) Size of cell after compaction with cover soil: 10 m long x 6 m wide x 1.4 m high

4) Cover soil quantity before compaction: 16 m³/day or 20 tons/day

5) Heavy equipment for landfill operation: bulldozer, wheel loader or shovel loader, and dump truck (one of each).

(4) Construction of a dyke by using reclaimed waste

To divide the PLP landfill area from the existing landfill area a dyke was constructed by reclaiming the waste deposited earlier. The PLP area was approximately 5,000 m². The dyke was covered by soil to prevent plastic bags from scattering and to confine the release of odor.

(5) Construction of access road to operation area

In advance of starting cell construction with daily soil covering, an access road to the work area was constructed for ease of access of collection vehicles and heavy equipment.

(6) Installation of poles for cells

To facilitate the landfill operation, the boundaries of the cells were marked with the installation of poles with blue cloth flags. Each cell has the numbering pre-determined in the design drawing.

(7) Cell construction and soil covering

Cell construction and soil covering were conducted using the following procedures:

1) Vehicle arrival and unloading

When a waste collection vehicle arrives at the landfill, the supervisor of landfill operation checks the hauled waste to fill out the record format. In addition to the weight measured by the truck scales, the volume of waste on

the truck was recorded by visual check. After the check by the supervisor, the collection vehicle unloaded the waste at the area designated by the supervisor.

2) Measurement of volume of the unloaded waste

After unloading the waste, the dimension of the unloaded waste is measured and the volume is estimated. The estimated volume is used for the estimation of the requirement for heavy equipment and the necessary volume of daily cover soil. The data is also used to estimate the bulk density of the unloaded waste by referring to the record of weight measured by the truck scales.

3) Removal of toxic wastes and recyclables

Hauled waste contained various kinds of waste from toxic waste like car batteries to recyclables such as metals and tires. These were segregated for the safety of the workers, for reduction of risks of aggravating the leachate, or for recuperation of recyclables.

4) Spreading of waste with heavy equipment

Unloaded waste is spread to a thickness of 30 - 50 cm, pushed up along the slope of the lower cell layer, and compacted by bulldozer. By repeating the spreading operation, the bulldozer creates a cell with a slope of approximately 20 degrees at the steepest. The height of cell so created was approximately 120 cm.

5) Soil covering

In the PLP, cover soil was obtained from a small mountain located in the neighboring area to the landfill. A bulldozer excavated soil and a shovel loader loaded it onto a truck. The soil was hauled by truck and unloaded near the compacted cell.

The bulldozer then spread the soil to cover the compacted waste layer until the cover soil layer reached about 20 cm.

It was observed that soil covering certainly created improved conditions in the landfill area. For instance, the number of flies reduced and unpleasant odor diminished significantly. However, exposure of plastic bags from cover soils, though not large in quantity, was observed. Improvement in soil cover operation was noted as necessary for future work.

(8) Fuel supply

Heavy equipment such as bulldozer, wheel loader, shovel loader and trucks needed fuel for operation. This was supplied by a fuel supply vehicle twice a week.

5.2 Verification of the Effectiveness of the Projects Proposed in the Master Plan

5.2.1 Segregated Discharge and Segregated Collection

(1) Segregated discharge

In the priority stations, the performance of waste segregation in the priority stations showed the potentiality of improvement depending on the consciousness of 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 measures as described in Subsection 5.1.1, are implemented in advance.

Judging from the improved performance in segregated discharge in Peñas Altas during the intensified awareness-raising activities, the residents appeared to be capable of understanding the instructions for three-way waste segregation. They actually followed the instructions on how to segregate the waste in their own houses and how to discharge it into the designated waste bins.

The following were noted in the implementation of the PLP:

- 1) Classification of waste segregation and waste bins for segregated discharge to be clear-cut to the residents

In the measures for improvement of segregated discharge, the following two measures were considered effective, and these were noted to be taken into account in the M/P:

- Application of simple classifications for the three waste categories

Better segregation at generation points is possible by giving waste generators a clear understanding of the classification into the three categories. Especially at the beginning of the application of waste segregation, the categories of classification should be easy for the residents to understand because it is the first experience of segregated discharge for them. As described in Table 5.1.3, the classification of waste was simplified after the improvement measures were introduced, especially for the waste category of recyclable waste: i.e., the recyclable

resource waste was defined as vessels and bottles for food and drink, such as beer bottles, aluminum cans for beverages, etc.

- Identification of waste bins to make it easy for people to deposit the waste into the right bins

After the improvement measures were introduced, stickers in different three colors were attached to waste bins to indicate the waste classification of each category visually. The stickers showed the classification by illustration as well as text. This visual guidance made people aware of the way waste segregation is done and the right waste bins to use.

Originally, it was planned, as indicated in a pamphlet prepared for awareness-raising, that three different colored waste bins would be used in the PLP. However, because of constraints in the procurement, waste bins of the same color were used for all three categories of waste. Nevertheless, three different colors were used for the stickers as was originally planned.

In the implementation of the M/P, the waste bins are to be planned to have similar visual indications, so as to be very clear for the residents, including the use of bins of three different colors.

- 2) Necessity of awareness-raising and instructions to promote the cooperation of residents

Of all the waste collection stations, the performance level of waste segregation was only acceptable at the four priority stations in the Peñas Altas area in which additional improvement measures were undertaken. The key activity in improvement measures was raising the awareness of the residents as described in Subsection 5.1.1.

It was actually demonstrated in the improvement in the Peñas Altas area that intensive instruction to the people, especially at the beginning, is indispensable for successful segregated collection and that the improvement measures taken in the Peñas Altas area were effective for enhancement of proper segregated discharge.

In addition to holding workshops to raise awareness at strategic places, meetings and discussions at community and group level were effective. Distribution of instruction leaflets and campaign materials such as T-shirts and calendars is also necessary. The M/P is to include intensive

awareness-raising programs incorporating the experiences from the PLP, which are described in Subsection 5.2.3.

However, the JICA Advisory Committee and JICA Study Team observed that the performance of residents to segregate discharge had surely declined after termination of the intensive awareness-raising programs. Considering this difficulty for establishment of public participation, the program should be continued steadily with great patience for several years.

(2) Segregated collection

The following experiences from the PLP are to be reflected in formulation of the M/P:

- Waste bins procured and used in the PLP were acceptable for storage and loading activities.
- Keeping the bins in good condition is essential for efficient operation of waste collection.
- Use of an 18 m³ C/T for segregated collection was considered to meet the workload envisaged for the M/P in terms of capacity and operational efficiency.
- Three workers including a driver would be enough to form a collection team.
- The collection time is about 3.5 hrs per trip for 33 bins along the route.
- The collection schedule needs to be reviewed to meet the actual number of stations and the quantity of segregated waste in each category.

After the PLP, the JICA official mission and Study Team observed the following during the monitoring conducted in September 2005:

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

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

5.2.2 Composting

(1) Community composting

Through the conduct of the PLP, the following were identified for reflection in the M/P:

- Raw material for community composting could be obtained from municipalities through the segregated collection of kitchen waste.
- Actually, in the PLP, the collection of kitchen waste was not conducted properly. Due to poor segregation in kitchen waste disposal, picking impurities out of the kitchen waste at the landfill site after transportation was too tough, although workers had been assigned for that at the landfill site. The experience in the PLP suggested that community composting should be put into practice only after the performance of segregated discharge of kitchen waste reached an acceptable quality level.
- Even if segregated discharge is practiced, some presence of impurities is inevitable. Final segregation (re-segregation) before the composting process is necessary to remove materials unsuitable for composting. The removal needs to be conducted manually.
- Owing to the delay of completion of the composting yard at Campo Florido landfill, the trial production of compost at the yard had to be limited to only three piles of waste. The temperature of piled waste was observed to have risen to 40 - 60 degree C, which indicated that the piled kitchen waste began to ferment.
- It is recommended that the yard for community composting should be provided with a roof and the necessary structures for storage and processing in order to ensure proper processing and produce a reliable quality of compost.
- The PLP was not able to completely confirm the quality of compost production during the PLP period. The Cuban side shall confirm the quality in another pilot level community compost production project prior to the development of main projects.

(2) Home composting

The operation of home composting was regarded as good in general on account of the favorable cooperation of residents.

1) Possibility of application of home composting

It was verified that home composting can be applied at households located in semi-urban areas where households generally own enough space to allow composting and sometimes the house owners also own farm and agricultural land. This land is expected to consume the produced compost.

2) Effectiveness of reduction in waste disposal

The effectiveness of waste reduction by home composting was verified by monitoring. The reduction was roughly estimated as 43% of waste generated from households (ref. Subsection 5.1.3 (2)).

3) Capability of residents for home composting

It can be expected that residents will cooperate with the introduction of home composting. Kitchen waste was properly segregated for home composting by residents in the PLP. The segregation of kitchen waste for home composting was much better than that deposited into segregated collection waste bins. People can distinguish kitchen waste suitable for composting.

It was feared that the offensive odor as well as propagation of insects accompanied with home composting might prevent people from cooperating in the PLP, but no significant complaints were detected in the monitoring.

4) Attention in applying home composting

Households are to be reminded of the following when home composting is introduced:

- Households must have an area in which to place the home compost bin
- Households must take reasonable care with composting in the houses
- Households must assume a potential for annoyances such as odor and worms
- Home composting would not always be suitable in households that are using kitchen waste for feeding domestic animals.
- Households appeared to need appropriate technical guidance and support with provision of detailed guidelines describing the method of home composting

These issues have been taken into account in the formulation of the M/P.

5.2.3 Awareness-raising

As stated in preceding sections, three workshops were carried out before, during and after the implementation of the PLP, respectively. Also, 36 meetings (including 15 small workshops at group level, ref. Subsection 5.1.4) were carried out with the aims of strengthening the awareness of the residents of the need to improve their waste segregation performance, and obtaining more active cooperation with the operation of the PLP. This included eight additional meetings held in the areas containing the four priority stations in the Peñas Altas Community. In addition, one workshop was conducted inviting school children and teachers.

The Study concluded that these awareness-raising activities were effectively done. On this basis, the Study team proposes that a similar approach to awareness-raising programs be implemented in the M/P.

The effectiveness of awareness-raising activities conducted in the PLP was assessed from viewpoints (1) to (5) as stated in the following:

(1) Assessment from the results of the Post-implementation Awareness-raising Workshop

Invited residents who participated in the PLP expressed the view that the environment-friendly MSWM carried out in the PLP could be expanded into a full-scale operation covering the whole City. Some representative opinions are given below.

1) Segregate discharge and collection

- Colors of the waste bins should be different, each according to the kinds of waste for easy perception.
- Containers or bins should be provided to households for storage and for bringing the waste to the waste bins.
- In order to prevent failure of segregated discharge, collection of waste should be conducted regularly as scheduled.
- In order to prevent offensive odor and generation of worms, kitchen waste should be collected within 72 hours.

2) Home composting

- Home composting is considered as one of the means of recycling and worth doing.
- Home composting can be done if the house has a garden or small yard.
- Home composting can save time for carrying the waste to the waste bins.

3) Environment-friendly landfill

- Campo Florido landfill did not generate any offensive odor during the PLP operation.
- The community understands the advantage of environment-friendly landfill and is willing to accept it.

4) Awareness-raising

- Most of the residents cooperated with the PLP including segregated discharge, but some did not. Continuous awareness-raising efforts are deemed to be essential.
- Schools, in particular primary schools, should be involved so that the students can lead the awareness-raising when they grow up.

(2) Assessment from the results of Pre and Post Implementation Awareness Surveys

Results of the Pre and Post Implementation Awareness Surveys were analyzed to assess the improvement of awareness level and willingness for cooperation with MSWM through comparison of survey results before and after the implementation of the PLP, in particular with regard to the environment-friendly MSWM aspects. As summarized below, the improvement is significant both in understanding and willingness for cooperation. Therefore awareness-raising activities in the PLP were regarded as having been effectively conducted.

1) Comparison before and after PLP (whole PLP area: 180 samples)

With regard to answers from the sampled households in the whole PLP area, both the level of understanding and willingness for cooperation improved significantly as shown in Table 5.2.1. In particular, the level of the understanding was substantially improved.

It is noted however that the willingness for cooperation for landfill is about 10 % lower than the level of understanding, whereas they are at similar levels for the other issues. This suggests that a continuous effort to raise awareness would be needed for the local community's acceptance of landfill.

Table 5.2.1 Comparison of Awareness Level and Willingness for Cooperation before and after the PLP (Whole PLP Area)

Issues	Unit: %		
	Pre Survey (before PLP)	Post Survey (after PLP)	Improvement (%)
1. Segregated collection (disposal)			
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
6. Average			
1) Understanding	53.0	95.1	42.1
2) Willingness for cooperation	74.9	92.6	17.7

2) Comparison before and after PLP implementation (Peñas Altas community)

Table 5.2.2 shows the awareness levels and willingness for cooperation in Penas Altas community before and after the implementation of the PLP. Similar to the case of the whole PLP area, both the level of understanding and willingness for cooperation have been improved significantly.

It is noted however that willingness for cooperation with landfill is about 5% lower than the level of understanding whereas they are at similar levels or the willingness for cooperation is higher for the other issues.

Table 5.2.2 Comparison of Awareness Level and Willingness for Cooperation before and after PLP (Peñas Altas Community)

Issues	Unit: %		
	Pre Survey (before PLP)	Post Survey (after PLP)	Improvement (%)
1. Segregated collection (disposal)			
1) Understanding	83.0	98.0	15.0
2) Willingness for cooperation	85.0	97.0	12.0
2. Landfill			
1) Understanding	59.0	91.0	32.0
2) Willingness for cooperation	14.0	86.0	72.0
3. Composting			
1) Understanding	13.0	83.0	70.0
2) Willingness for cooperation	41.0	88.0	47.0
4. Recycling			
1) Understanding	85.0	97.0	12.0
2) Willingness for cooperation	92.0	95.0	3.0
5. Awareness-raising			
1) Understanding	86.0	91.0	5.0
2) Willingness for cooperation	95.0	95.0	0.0
6. Average			
1) Understanding	65.2	92.0	26.8
2) Willingness for cooperation	65.4	92.2	26.8

3) Comparison before and after PLP implementation (Campo Florido community: 80 Samples)

Table 5.2.3 shows the awareness levels and willingness for cooperation in Campo Florido community before and after the implementation of the PLP. Similar to the other cases, both the level of understanding and willingness for cooperation has been improved significantly.

Also similar to the other cases, willingness for cooperation for landfill is lower than the level of understanding, i.e., by about 16 %.

**Table 5.2.3 Comparison of Awareness Level and Willingness
for Cooperation (Campo Florido Community)**

Issues	Pre Survey	Post Survey	Unit: %
			Improvement (%)
1. Segregated collection (disposal)			
1) Understanding	89.0	97.5	8.5
2) Willingness for cooperation	94.3	95.0	0.7
2. Landfill			
1) Understanding	68.1	98.7	30.6
2) Willingness for cooperation	10.0	82.5	72.5
3. Composting			
1) Understanding	22.0	98.8	76.8
2) Willingness for cooperation	59.3	98.8	39.5
4. Recycling			
1) Understanding	81.0	100.0	19.0
2) Willingness for cooperation	90.0	96.0	6.0
5. Awareness-raising			
1) Understanding	89.0	100.0	11.0
2) Willingness for cooperation	86.8	92.5	5.7
6. Average			
1) Understanding	69.8	99.0	29.2
2) Willingness for cooperation	68.1	93.0	24.9

4) Awareness level and willingness for cooperation in the whole PLP area,
Peñas Altas and Campo Florido

The level of awareness and willingness for cooperation in each area of the whole PLP area, Peñas Altas and Campo Florido, were compared as shown in Table 5.2.4. The figures in the table show those measured in the post survey after the PLP. The level of understanding is higher in Campo Florido than Peñas Altas in most of the issues, while willingness for cooperation is almost same.

Table 5.2.4 Awareness Level and Willingness for Cooperation in Whole PLP Area, Peñas Altas and Campo Florido

Issues	Whole	Peñas Altas	Unit: %
			Campo Florido
1. Segregated collection (disposal)			
1) Understanding	98.0	98.0	97.5
2) Willingness for cooperation	96.0	97.0	95.0
2. Landfill			
1) Understanding	94.4	91.0	98.7
2) Willingness for cooperation	84.5	86.0	82.5
3. Composting			
1) Understanding	90.0	83.0	98.8
2) Willingness for cooperation	92.8	88.0	98.8
4. Recycling			
1) Understanding	98.3	97.0	100.0
2) Willingness for cooperation	95.5	95.0	96.0
5. Awareness-raising			
1) Understanding	95.0	91.0	100.0
2) Willingness for cooperation	94.0	95.0	92.5
6. Average			
1) Understanding	95.1	92.0	99.0
2) Willingness for cooperation	92.6	92.2	93.0

5) Comparison between the priority area and non-priority area in Peñas Altas community

Comparison was made between the figures analyzed for (i) the area covered by the four priority stations where additional awareness-raising programs were implemented and (ii) the other areas in Peñas Altas, excluding the area of (i).

As shown in Table 5.2.5, the level of understanding is about same. Willingness for cooperation for segregated discharge is higher in the priority station area (i), though the difference is small.

**Table 5.2.5 Awareness Level and Willingness for Cooperation in Peñas Altas
(Priority Station Area vs. Other Areas)**

Unit: %

Issues	(i) Priority Station Area	(ii) Other Areas in Peñas Altas	Difference(i) – (ii)
1. Segregated collection (disposal)			
1) Understanding	98	98	0
2) Willingness for cooperation	100	98	+2
2. Landfill			
1) Understanding	88	94	- 6
2) Willingness for cooperation	82	74	+8
3. Composting			
1) Understanding	84	82	+2
2) Willingness for cooperation	84	76	+8
4. Recycling			
1) Understanding	94	100	-6
2) Willingness for cooperation	92	98	-6
5. Awareness-raising			
1) Understanding	92	90	+2
2) Willingness for cooperation	94	96	-2
6. Average			
1) Understanding	91.2	92.8	-1.6
2) Willingness for cooperation	90.4	88.4	+12.0

6) Comparison between home composting participants and non-participants in Campo Florido

As shown in Table 5.2.6, no clear difference is observed for most items, including the understanding and willingness for composting. A slightly different attitude was observed in the willingness for cooperation for landfill.

Table 5.2.6 Comparison of Awareness Level and Willingness for Cooperation between Home Composting Participants and Non-Home Composting Participants in Campo Florido Community

Unit: %

Issues	(1) Non Home Composting	(2) Home Composting	(3) Difference: (2) – (1)
1. Segregated collection (disposal)			
1) Understanding	97.5	97.5	0
2) Willingness for cooperation	92.5	97.5	+5
2. Landfill			
1) Understanding	100.0	97.5	-2.5
2) Willingness for cooperation	87.5	77.5	-10.0
3. Composting			
1) Understanding	100.0	97.5	-2.5
2) Willingness for cooperation	97.5	100.0	+2.5
4. Recycling			
1) Understanding	95.0	97.5	+2.5
2) Willingness for cooperation	97.5	100.0	+2.5
5. Awareness-raising			
1) Understanding	100.0	100.0	0
2) Willingness for cooperation	85.0	90.0	+5
6. Average			
1) Understanding	98.5	98.0	-0.5
2) Willingness for cooperation	92.0	93.0	+1.0

(3) Assessment of the results of actual performance of segregated discharge

One of the objectives of awareness-raising was to improve the performance of segregated discharge. In this context, the effect of awareness-raising activity was assessed from the actual achievement in segregated discharge. The comparison was made in terms of the ratio of segregated discharge properly conducted in the four priority stations against that in the whole Peñas Altas area.

Table 5.2.7 Ratio of Properly Segregated Waste in Four Priority Stations and the Whole Area of Peñas Altas

Unit: %

Category of Segregation	(A) Priority Stations	(B) Whole Area	Difference: (A) – (B)
Kitchen waste	89	54	35
Recyclables	73	24	49
Others	98	74	24
Average	87	51	36

Note: Additional awareness-raising activities were conducted for the priority stations

Source: Table 5.1.6

For the priority stations, eight additional meetings for awareness-raising were held aiming at further improvement of segregated discharge, on top of the 23 meetings held earlier for the whole area. As can be seen in the table, the ratio of appropriately segregated waste was substantially improved in the priority stations. This indicates that provision of intensive awareness-raising programs, like the

ones conducted for the priority stations, would certainly contribute to improvement of segregated discharge.

(4) Assessment from the results of home composting

As described in Subsection 5.2.2 (2), home composting was carried out successfully in general. This owes much to awareness-raising activities conducted at meetings held before starting the home composting in 40 households in the Campo Florido community. Close monitoring and guidance during the operation stage was also a reason for successful implementation of home composting. In the implementation of the M/P, a similar effort for awareness-raising is essential.

(5) Overall verification of the awareness-raising program

The awareness-raising program and activities carried out in the PLP were verified as appropriate and effective in most of the aspects stated above. However, it has been verified that a continuous effort for an adequate length of time is required to achieve a satisfactory level of awareness of the residents and to receive cooperation from them. The figures in Tables 5.2.1 to 6 suggest that a longer time would be required to achieve the residents' acceptance for landfill construction.

5.2.4 Waste Weight Measurement

The following were observed in the operation for the PLP:

- Portable truck scales used in the PLP needed to measure truck weight by mounting the truck twice; first weighing the front wheel load and second the rear wheel load. It took more time than the case of stationary truck scales that can weigh by a single mounting of the truck.
- It was impossible to weigh the waste hauled by H/C since the truck scales site was located approximately 6 km away from Campo Florido landfill. Travel of H/C to the distant site just for weighing was practically difficult.
- Sometimes, vehicles skipped the weighing at the truck scales and moved directly to Campo Florido landfill site. This was also because of the location of the truck scales site a distance away from the hauling route to the landfill.
- The weighing of trucks was not conducted when the weighing facility was not open or the facility had power failure or when there was heavy rain.

The following shall be taken into account in the M/P:

- Weighing equipment is to be installed at the landfill site with a firm supply of electricity, on a flat, hard and mounded foundation having enough width and

length and at a place with a roof so that the operation can continue even in rainy weather.

- Competent staff are to be arranged who can give direction to the vehicle drivers, operate the equipment according to the manual, and conduct the recording accurately.

5.2.5 Cell Construction and Daily Soil Covering

Cell construction with daily soil covering finished fairly satisfactorily. During the operation, the following were observed:

(1) Increase in operation cost

Fuel costs for implementing this procedure were estimated at CUC0.5 per ton of waste. This means that operation with cell construction and soil covering cost 5 times more than without as recorded at Calle 100 where cell construction and soil covering are not performed (ref. Data Book K1).

This fact indicates that the operation of equipment, including type of equipment and sequence of operations, needs to be planned carefully so that total fuel consumption is minimized.

(2) Frequent trouble with equipment

During the PLP operation period, equipment broke down frequently due to trouble with the engines, lifting equipment, tires, and so on. The main reason was aging of the equipment (10 years) coupled with excessive wear and tear of machine parts which was observed to be due partly to lack of proper maintenance.

(3) Control of cover soil quantity

Cover soil for the PLP was obtained from a hill located near the Campo Florido landfill. Control of the cover soil quantity was based on truck-loaded volume measurement. Since the exact quantity of hauled waste was not fully understood due to the reasons stated in Subsection 5.2.4, determination of the required quantity of cover soil sometimes had to be based on visual judgments on the site.

It was learned in the operation of the PLP that measurement of the quantity of hauled waste is essential from the point of view of cover soil quantity control.

5.3 Feedback to the Master Plan

Summarizing the findings and observations in the PLP as described in Section 5.2 above, the following were derived as lessons learnt from the PLP. These lessons have been reflected in the formulation of the M/P.

5.3.1 Segregated Discharge and Segregated Collection

(1) Segregated discharge

The following items learnt from the PLP were noted as feedback to the segregated discharge proposed in the M/P.

- 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 the number of stations/bins will be planned for each area considering the volume of waste in each category, collection efficiency, and convenience for residents.
- Efficiency of collection work depends largely on the condition of bins. Of importance is to keep the 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 means of procurement of 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 conditions of bins being kept in good condition, a team of three 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 three years, to assure the success of segregated collection before commencement of the actual work.

5.3.2 Composting

(1) Community composting

The following items resulting from the PLP were noted as feedback to the community composting proposed in the M/P:

- 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 5.2.2). 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 for further study in the M/P.

- As mentioned above, at least three years will be needed before the community composting system in conjunction with the segregated discharge and collection can be verified and the proposed project in the M/P commenced.

(2) Home composting

The following items resulting from the PLP were noted as feedback for the home composting proposed in the M/P:

- Home composting is recommended for the 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 animals. Kitchen waste usable for home composting might be limited in such households so 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.

5.3.3 Awareness-Raising

Based on the results of the verification of the awareness-raising program carried out in the PLP, the following were reflected in the formulation of the M/P.

- 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 objective area of the M/P covers several municipalities or the whole city.
- The experiences of the community based 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 during the PLP operation can 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 for the full year.
 - Awareness-raising workshops will be held everywhere as required so that every household would attend at least once. A pamphlet with illustrations of the categories of municipal waste will also 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.

5.3.4 Landfill Operation

(1) Waste Weight Measurement

Based on the results of the verification of waste weight measuring carried out in the PLP, the following were reflected in the formulation of the M/P.

- Truck scales shall be installed at all the 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.

(2) Cell Construction and Daily Soil Covering

Based on the results of the verification of cell construction and daily soil covering carried out in the PLP, the following were reflected in the formulation of 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 survey and study are recommended to find the availability of cover soil material for each of the planned landfills.
- Cell formation and soil covering will require extra equipment and fuel for their operation. A minimum cost operating method shall be proposed in the M/P.

5.3.5 Summary of Feedback Items to be Incorporated in the Master Plan

Table 5.3.1 summarizes in a tabular form the feedback items incorporated in the formulation of the M/P. The statements in the table are mostly extracted from the descriptions in Subsections 5.3.1 to 5.3.4.

Table 5.3.1 Summary of Feedback from Pilot Project to the Master Plan

Component	Main Points of Verification in PLP	Feedback to the M/P
1. Segregated collection		
1-1 Segregated discharge	<ul style="list-style-type: none"> • Achievement in the PLP was not so favorable at the initial stage. The ratio of properly segregated waste was 51 % on average (see Table 5.1.1-2). • After the intensified awareness-raising program conducted for the four priority station areas, the ratio was improved to a level of 87 %. This suggested the potential for improvement of segregated discharge. • However, after the above intensified awareness-raising program, the ratio declined back to the initial level. 	<ul style="list-style-type: none"> • Simple classification of segregated discharge is recommended so that the residents can adapt to it without difficulty. • Classification under each category shall be shown clearly on the waste bins with illustrations. • Waste bins of different colors shall be used for each category of segregated waste so as to be explicit to the residents. • Considering that the residents might not recognize any visible benefit from segregated discharge, intensive and continuous awareness-raising activity should be carried out to convince the residents of the benefit of segregated discharge and collection. • The M/P shall assume that a certain time period will be required until the quality of segregated discharge by the residents is improved to an acceptable level.
1-2 Segregated collection	<ul style="list-style-type: none"> • No particular difficulty was encountered in the PLP operation. • With the use of new waste bins in the PLP, average collection time was much shorter in the PLP area. • In the PLP, frequent breakdown of equipment was observed. This must be improved. 	<ul style="list-style-type: none"> • Frequency of the collection shall be studied for each area based on the volume of each category of waste actually deposited into bins • In addition, minimization of operation cost for segregated collection should be studied. • Keeping the waste bins in good condition reduces the collection time. Proper maintenance of bins is essential. • Operation of collection vehicles shall be carefully planned so as to attain the best efficiency with the minimum number of vehicles, e.g. proper collection route, dispatch of the right number of vehicles, etc. • The number of work crew for each 18 m³ C/T collection unit may be 3 workers including a truck driver. Training of the collection workers is essential to reduce the collection time. • In view of the importance of equipment operation efficiency, the M/P shall consider improving the equipment condition by means of procurement of new equipment and reinforcement of repair/maintenance capability.

Component	Main Points of Verification in PLP	Feedback to the M/P
2. Composting		
2-1. Community composting	<ul style="list-style-type: none"> • Kitchen waste collected for composting contained many impurities, removal of which was tough work for the workers. • Owing to delay in completion of the roofed composting yard, only 3 piles of compost were produced. Though the quality of compost was not able to be confirmed, observation revealed that fermentation was in progress. 	<ul style="list-style-type: none"> • Community composting using segregated kitchen waste as raw material is proposed in the M/P. • After collecting the waste, final segregation (re-segregation) at the composting site is proposed. • Composting shall be done at a composting yard with a roof structure. • Demand for the compost shall be identified in the M/P, such as demand for parks, green areas and farmlands. • The necessity of setting up quality standards for compost shall be recommended in the M/P. • Feasibility of community composting will depend largely on the quality of segregated discharge. Planning of the community composting project in the M/P shall take into account the time frame required for gradual improvement of segregated discharge. • The quality of compost actually produced in the PLP was not able to be fully confirmed due to the limited period of the PLP. The M/P shall assume the requirement of a sufficient time period to investigate the quality of compost production. The marketability of compost produced is also a subject of further study in the M/P. • It is required to attain the necessary support by an expert organization such as MINGARI for the development of compost quality and its market.
2-2. Home composting	<ul style="list-style-type: none"> • Home composting was fairly well conducted with the cooperation of households. • 29 households out of 40 showed active participation by recording their composting. 	<ul style="list-style-type: none"> • Home composting will be recommended for the households in the semi-urban municipalities where there is adequate garden space with plants and trees to which compost can be applied. • Consideration shall be given to households feeding domestic animals, at which the kitchen waste usable for home composting might be limited. Those households may be excluded from the home composting plan in the M/P. • The volume of compost able to be produced from home composting shall be estimated in the M/P, in due consideration of the ratio of households which would actually be willing to participate in home composting activities. • As well as community composting, it is also necessary to attain the technical support by an expert organization such as MINGARI.

Component	Main Points of Verification in PLP	Feedback to the M/P
3. Recycling	<ul style="list-style-type: none"> • Residents were not able to carry out proper segregation of recyclable materials, especially paper materials. Hence, reclassification of recyclable items was obligatory during the PLP. • The ratio of properly segregated waste was relatively low during the initial period (24%). It was, however, improved to 73% after intensified awareness-raising activity (ref. Table 5.1.6). 	<ul style="list-style-type: none"> • Recycling by means of segregated collection will be recommended in the M/P. The work shall be regarded as a supplement to the existing recycling activities being conducted through group collection, where the main objective is to maximize the quantity of recycling. Nevertheless, further monitoring is proposed to confirm the effectiveness of the work. The need for monitoring shall be stated in the M/P. • Classification of recycling materials should preferably be simple so that the residents can follow without difficulty. • Owing to the time constraint afforded for awareness-raising, paper materials were excluded from the category of recyclables in the PLP. However, paper materials are one of the valuable resources for recycling and hence shall be included as one of the items of recyclable materials in the planning of the M/P. • Planning in the M/P shall consider the fact observed in the PLP that the ratio of properly segregated recyclable materials was relative low (ref. Table 5.1.6) • It is necessary to consult with EREMP for the demarcation of recycling activity between their existing group collection system and the proposed recycling with segregated collection system.
4. Landfill Operation		
4-1. Waste weight measurement	<ul style="list-style-type: none"> • No particular difficulty was observed except for forced inconvenience due to the location of truck scales some distance away from the landfill. 	<ul style="list-style-type: none"> • Truck scales shall be installed at the landfill sites, recycling plant and composting yard. • 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 future planning of SWM.
4-2. Cell formation and soil covering	<ul style="list-style-type: none"> • No particular difficulty was experienced in the PLP except the relatively frequent breakdown of equipment. 	<ul style="list-style-type: none"> • Dyke and cell formation and daily soil covering is virtually the primary component of environment-friendly landfill operation. This shall be proposed as an essential requirement in the M/P. • Detailed survey and study are recommended to find out the availability of cover soil material for each of the planned landfills. • Extra equipment and fuel will be required for cell formation and soil covering operation. A minimum cost operation method shall be proposed in the M/P.

Component	Main Points of Verification in PLP	Feedback to the M/P
<p>5. Awareness-raising</p>	<ul style="list-style-type: none"> • Awareness-raising activities conducted in the PLP were assessed as fairly successful. Residents' understanding for the PLP and willingness for cooperation have been much improved as revealed by the post-PLP questionnaire survey. 	<ul style="list-style-type: none"> • Similar attempts to the awareness-raising program carried out in the PLP shall be made in the M/P. The program consisted of raising awareness for segregated collection, home composting and environment-friendly landfill. In conducting the awareness-raising activities, maximum involvement of community based organizations such as CDR, Women's Union and Youth Union is recommended. • Awareness-raising in the M/P shall consider the use of mass media such as radio and TV in view of the size of population involved, since the objective area of the M/P covers several municipalities or the whole City. • The experience of the PLP shared by the community based organizations and residents having involvement with the PLP shall fully be utilized in working out the awareness-raising programs for the other areas in the M/P. Videos and photos of PLP operation will also be useful tools. • With regard to the awareness-raising for segregated discharge, at least the following shall be done: <ul style="list-style-type: none"> - Before implementing full-scale introduction of segregated collection for the municipalities, awareness-raising activities should be commenced one year ahead and continued for the full year. - Awareness-raising workshops shall be held everywhere, as required, so that every household would attend at least once. Also, a pamphlet with illustrations of categorized municipal waste shall be distributed to every household. - The instruction paper for home composting prepared and used for the PLP shall be distributed to every household in the sub-urban municipalities. • With regard to environment-friendly landfill, awareness-raising shall be carried out targeting the entire municipality where the landfills will be constructed with special emphasis on the adjacent communities, since the agreement of the municipal government as well as the residents is essential. Awareness-raising of all the citizens of Havana City should also be carried out to convince them of the desirability of the concept of environment-friendly landfill.

PART 4 THE FEASIBILITY STUDY

CHAPTER 1 SELECTION CRITERIA AND PROCESS

1.1 Selection Criteria

Projects proposed in the MSWM Master Plan were evaluated to identify a priority project for which a feasibility study would be carried out as a part of the Study. The criteria and process of selecting the priority project were as follows.

The projects proposed in the M/P were evaluated by two categories of evaluation criteria, order of priority criteria and soundness criteria.

The order of priority criteria comprised the following items:

- Urgency
- Scale of impact
- Priority of the Cuban Government
- Sustainability
- Needs for the F/S

The projects were evaluated using a three-level scoring system, with one as the lowest score and three as the highest score. So the highest possible score would be 15 and the lowest would be five.

There were three soundness criteria:

- Technical certainty: whether or not the project could be implemented and operated with proven technology.
- Possibility of financing: (i) whether or not the funds required would be adequate for the immediate project, and (ii) the possibility of external finance.
- Conformity with the Study schedule: whether or not the F/S could be completed within the timeframe and financial allocation of the Study

If the soundness of one or more items was doubtful, the project was not further considered for selection as a priority project.

The selection was made through the process of (i) priority criteria, (ii) soundness criteria, and then (iii) overall comparison.

1.2 Candidates for the Priority Project for the Feasibility Study

As shown in Table 1.2.1, two projects scored 14, followed by three projects with a score of 13 as given below.

Table 1.2.1 Evaluation of the Candidate Projects for the F/S

Candidate Project	(i) Urgency	(ii) Scale of Impact	(iii) Priority Order of Cuban Gov.	(iv) Sustainability (Financial & Technical)	(v) Needs for the F/S	(vi) Total Score	(vii) Technical Certainty	(viii) Possibility of Financing	(ix) Conformity with Study Schedule	Overall Rating
1. Sanitary Landfills										
1.1 Calle100										
1.1.1 Redevelopment of used area (Height raising of the existing landfills)	3	3	3	1	3	13	Require in-depth survey	Difficult to finance in a short period	Extension of Study period is required	—
1.1.2 Development of the unused area (24 ha)	3	2	2	3	3	13	No particular difficulty	- do. above	- do. above	1
1.2 3Combination of 1.1.1 & 1.1.2	3	3	3	1	3	14	Require in-depth survey	- do. above	- do. above	—
1.3 New Guanabacoa	3	2	3	3	3	14	No particular difficulty	- do. above	- do. above	1
1.4 Closing of 9 Special Period Landfills	3	1	3	3	1	11	- do. above	Possible	Possible to complete the F/S within Study period	6
1.5 Procurement of heavy equipment for landfill	3	2	3	2	2	12	- do. above	- do. above	- do. above	4
2. Collection/Transport										
2.1 Procurement of collection vehicles	3	2	3	2	2	12	- do. above	- do. above	- do. above	4
2.3 Procurement of equipment for maintenance workshop	2	2	2	2	1	11	- do. above	- do. above	- do. above	6
3. Others										
3.1 Renovation of recycle center	2	2	2	2	1	9	- do. above	- do. above	- do. above	8
3.2 Establishment of new composting center	2	2	2	2	1	9	- do. above	- do. above	- do. above	8
3.3 Package of 1.5, 2.1 and 2.3: Heavy equipment, collection vehicles, maintenance workshop	3	3	3	2	2	13	- do. above	- do. above	- do. above	1

- (1) Highest scoring projects:
 - 1.2 Simultaneous development of the unused area and re-development of the existing landfill area in the Calle 100 landfill
 - 1.3 New Guanabacoa landfill
- (2) Second highest score projects:
 - 1.1.1 Re-development of the used area at the existing Calle 100 landfill
 - 1.1.2 Development of the unused area at the existing Calle 100 landfill
 - 3.3 Equipment procurement package comprising procurement of i) heavy equipment for landfills, ii) collection vehicles, and iii) equipment/tools for maintenance workshops

Among the above-mentioned five projects, there was a question whether the item 1.1.1, “re-development of the used area at the existing Calle 100 landfill project”, can be implemented by means of proven technology with a reasonable cost comparable to the cost for new development of a landfill. Further, the work requires in-depth geological and topographical surveys, which were considered impossible to complete within the available period. Therefore, the “re-development of the used area at the existing Calle 100 landfill project” and combinations involving it, i.e., item 1.1.1 and accordingly item 1.2 were dropped from the list.

The remaining three projects were considered to comply with the ‘technical certainty’ criterion above. Accordingly, these three projects were compared with regard to the other two soundness criteria items as well as the total score as given in Table 1.2.2.

Table 1.2.2 Candidates for Priority Project for the F/S

Projects	Total Score	Possibility of Financing	Conformity with Study Schedule
1.4 New Guanabacoa landfill	14	Difficulty in financing foreseen	Extension of Study period is required
1.1.2 Development of unused area of Calle 100 landfill	13	- do.above -	- do.above -
3.3 Equipment package	13	Possible	The F/S can be completed within Study period

As shown in Table 1.2.1, only item 3.3, “equipment package project”, was considered to have a reasonable possibility of financing and the total score was only 1 point below the highest. Therefore, the “equipment package” was selected as the priority project for the F/S.

CHAPTER 2 THE FEASIBILITY STUDY ON THE PRIORITY PROJECT

2.1 Details of the Priority Project Package

The procurement of equipment was selected as the priority project because of the urgent need to improve the MSWM system of Havana City. It was proposed through discussion between the DPSC and the Study Team that the equipment to be procured would include vehicles for waste collection/transportation, equipment for landfill operation and equipment/tools for maintenance workshops.

The items of equipment proposed for the procurement are shown in Table 2.1.1.

Table 2.1.1 List of Equipment to be Procured under the Priority Project

Category	Equipment	Specification	Quantity
Equipment for landfill operation	Bulldozer	228Hp, 28 ton	9 units
	Dump truck	8m ³ , 270 Hp	6 units
	Water tank truck	10m ³	3 units
	Power shovel	0.8m ³ , 145 Hp	4 units
	Shovel loader	2.2m ³ , 206 Ps	2 units
	Wheel loader	2.4m ³ , 141 Hp	2 units
	Tow truck		1 unit
Collection vehicle	Compactor truck	18m ³ , GVW20-26 ton	12 units
Equipment for workshops	Workshop equipment for vehicles; such as AC arc welding machine, argon welding machine, engine arc welder etc.	Refer to Section 5.9 of Part 2 for detailed list of items	62 items in total incl. tools
	Workshop equipment for landfill operation; such as engine generator, air compressor, hydraulic jack, bench drill, etc.	Refer to Section 5.10 of Part 2 for detailed list of items	28 items plus 2 mobile workshops

2.1.1 Heavy Equipment for Landfill Operation

(1) Equipment Currently Owned by UPPH

The list of heavy equipment presently owned by UPPH and their current conditions are shown in Table 2.1.2. As shown in the table, most equipment is 15-20 years old, and most are in a deteriorated state with some items no longer usable.

Table 2.1.2 List and Current Conditions of Heavy Equipment Presently Owned by UPPH

Name of Equipment	Name of manufacturer and Type	Country of Origin	Specification	Year of Production	Starting Year of use	New	Second-hand	Location	Current condition
Bulldozer	KOMATSU	Japan	220 HP	1982	1988		○	Calle 100	in operation
	FIAT FD20	Italy	220 Hp	1982	2000	○		Calle 100	in operation
	FIAT FD20	Italy	220 Hp	1982	1999	○		Calle100	No use
	FIAT FD20	Italy	220 Hp	1982	1999	○		Calle100	No use
	TY 220	China	220 Hp	1991	2002	○		Calle100	No use
	FIAT FD20	Italy	220 Hp	1982	2000	○		Ocho Vias	No use
	FIAT FD20	Italy	220 Hp	1982	2000	○		Guanabacoa	in operation
	FIAT FD20	Italy	220 Hp	1982	2000	○		Guanabacoa	under repair
	FIAT FD20 with KRAZ motor	Italy	230 Hp	1980	1990		○	Tarara	in operation
Tractor compaction roller	TAINO	Cuba	160 Hp		1999	○		Workshop	in operation
Motor Grader	DZ122A	Russia	180 Hp		1987	○		Workshop	in operation
Wheel Loader	KOMATSU	Japan	Bucket Cap.2.5 m ³	1991	2002		○	Workshop	in operation
Shovel Loader	TAINO equipped with a Fiat engine	Cuba	Bucket Cap.3 m ³	1990	2001		○	Workshop	in operation
Water Tanker	SKODA	CZECH	Cap. 7 m ³	1982	1993		○	Ocho Vias	No use
	PEGASSO	Spain	Cap. 6 m ³	1980	1982		○	Workshop	in operation
	ZIL130 equipped with a KAMAZ engine	Russia	Cap. 4 m ³	1990	2002	○		Workshop	in operation
Cabin	PEGASSO	Spain	Load 30 ton	1984	2000		○	Workshop	No use
Trailer	TAINO	Cuba	Load 36 ton	1990	2002	○		Workshop	No use
Flat Truck	KAMAZ	Russia	Load 10 ton	1991	2002	○			in operation

Source: UPPH

Most of the heavy equipment listed in Table 2.1.2 was donated by other countries with only nominal payment by the Cuban Government. As far as the table indicates, most of all above equipment were started to use for solid waste management purpose around 2000 after long time from their production year.

DPSC and the DMSCs have insufficient budget to acquire new heavy equipment and spare parts, and the existing heavy equipment has to be kept in use through repeated repairs, sometimes using parts scavenged from other equipment that has been taken out of service. DPSC requests the budget from the Government for spare parts every year, but the amount approved is usually limited. In this year (2005), DPSC acquired CUC0.25 million for the replacement of parts for bulldozers.

In Japan, heavy equipment is generally abandoned or replaced every 8 to 12 years. In Cuba, the life of collection vehicles and equipment is regarded to be about 10 years. Hence, it is assumed that the life of new heavy equipment is around 10 years and that of second-hand heavy equipment 6 years. The annual repair cost of heavy equipment is roughly assumed as 7% of the initial procurement cost. These aspects were taken into account in the planning of O/M of the equipment.

(2) Procurement of Equipment

Proper operation of landfills will require using an appropriate amount of equipment, especially in the case of sanitary and environment-friendly landfill operation using cell construction method with daily waste covering with cover soil. Without sufficient heavy equipment, there would be no improvement in the landfill operation.

According to the M/P, Calle 100 Extension (24 ha) and New Guanabacoa landfills are scheduled to commence operation from 2007. It is planned that the heavy equipment should preferably be procured by that time. Table 2.1.3 shows the specification and cost of heavy equipment to be purchased before 2007:

Table 2.1.3 Heavy Equipment to be Purchased before Year 2007

Equipment	Specification	Unit Cost (1,000 USD)	Y 2006		
			Procurement Number	Cost (1,000USD)	
1. Heavy Equipment for landfill operation					
(1) Expansion of Calle 100 or New Site					
	Bulldozer	228 Hp, 28 ton	331	7	2,317
	Wheel Loader	13.3 ton, 141 Hp, bucket volume 2.4 m ³	168	1	168
	Power Shovel	Bucket volume 0.8 m ³ , 145 Hp, 19.3 ton	235	3	705
	Dump Truck	8m ³ , 17.9 ton, 270Hp	69	3	207
	Water Tanker	10m ³ , with spray gun	78	2	156
	Shovel Loader as emergency	2.2 m ³ , 206 Ps, 21.22 ton	150	1	150
	Tow Truck		135	1	135
(2) New Guanabacoa					
	Bulldozer	228 Hp, 28 ton	331	2	662
	Wheel Loader	13.3 ton, 141 Hp, bucket volume 2.4 m ³	168	1	168
	Power Shovel	Bucket volume 0.8 m ³ , 145 Hp, 19.3 ton	235	1	235
	Dump Truck	8m ³ , 17.9 ton, 270Hp	69	3	207
	Water Tanker	10m ³ , with spray gun	78	1	78
	Shovel Loader as emergency	2.2 m ³ , 206 Ps, 21.22 ton	150	1	150
Sub-total of heavy equipment				27	5,338

Note: Part of equipment listed in Table 5.10.13 in Chapter 5 of Part 2 are procured

The procurement cost of heavy equipment was estimated as approximately US\$5.4 million equivalent.

2.1.2 Collection Vehicles

(1) Outline of the priority project

This F/S only covers the procurement of additional vehicles required for the introduction of segregated collection. The procurement of replacements for existing old equipment shall be planned separately.

The M/P foresees that UPPH will start segregated collection service from 2010 in two urban areas. The target municipalities are Playa and Habana del Este (total population 205,187). The equipment will be put into service in 2010, accordingly.

Regarding the type of vehicles, a comparative study for the M/P concluded that 18 m³ C/T collection vehicles would be more suitable than other alternatives for the reasons that this would require the smallest number of vehicles and involve lower operating costs. The specifications of 18 m³ C/T collection vehicles are shown in Table 2.1.4.

Table 2.1.4 Specifications for 18 m³C/T Collection Vehicles

Items			Specification
Body capacity			18.0 m ³
Hopper capacity			2.2 m ³
Gate size (width x height)			2,000 x 1,450 mm
Operation control system			Electrical hydraulic control
Discharging system			Horizontal ejection
Loading time (one cycle)			26 –28 sec
Discharge time			50 sec
Plate thickness (mm)	Body	Floor	3.2
		Roof	2.3
		Side	2.7
	Hopper	Side (upper)	4.5
		Side (lower)	4.5
		Bottom	8.0
	Discharge plate		
Press plate			4.5
Gross vehicle weight (GVW)			20,000 – 26,000 kg
Recommendable wheelbase (mm)			5,800 –6,000

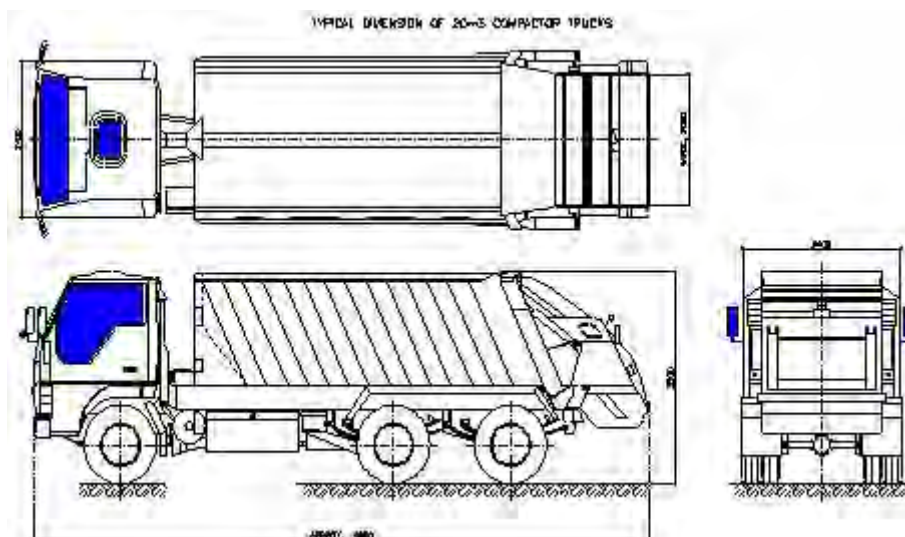


Figure 2.1.1 Typical Dimensions of 18 m³ Compactor Trucks

The required number of vehicles for two Municipalities, Playa and Habana del Este, where segregated collection will be introduced in 2010, would be as shown in Table 2.1.5. In the case with segregated collection, 26.9 C/Ts will be required. In the case without segregated collection, i.e. with mixed collection, 15.5 C/Ts will be required. Thus, the difference between those cases should be the required

number of vehicles for introduction of segregated collection in the two municipalities as follows;

$$26.9 - 15.5 = 11.4 \rightarrow 12 \text{ C/Ts.}$$

Table 2.1.5 Required Number of Vehicles for Segregated Collection in Playa and Habana del Este in 2010

Items/Year	Playa	Habana Del Este	Total
(Unit)			
With Segregated Collection			
For Kitchen Waste	11.1	2.0	13.1
For Recyclables and Others	10.6	3.2	13.8
Total	21.7	5.2	26.9
Without Segregated Collection (Mixed Collection)			
For Mixed Waste	12.6	2.9	15.5

For Detail, See Data Book

In the Master Plan, vehicle number for each Municipality and each collection category is rounded up to integer. However, for the feasibility study, total required number was estimated as shown in the above table in order to minimize the investment cost.

2.1.3 Equipment for Workshops

(1) Outline of the proposed procurement

The improvement of workshop capability is an extremely high priority to improve the repair and maintenance of vehicles and heavy equipment and, therefore, ensure that equipment will have a longer life and better performance.

The repair equipment to be procured shall preferably be of simple model that would be operated manually or semi-automatically (not of a sophisticated type). Of the items to be procured, the equipment applicable to major repairs will be supplied to the UPPH central workshop, and items for routine maintenance will be supplied to DMSC's workshop.

In preparing the procurement list, the first priority was given to equipment/tools for the overhaul/repair of engines followed by gas/electric welding equipment for the bodies of vehicles, mechanical tools for other repairs.

In view of the need for urgent procurement, the target year of supply is 2007.

(2) Equipment and tools for repair and maintenance of collection vehicles

1) Repair machines and equipment

The items of repair machines and equipment to be procured are listed in Tables 5.9.14 and 5.9.15 in Part 2 and Data Book L in detail, respectively. The machines include 15 items such as lathes, a radial drilling machine, grinding machines, bench cutters, etc. The equipment includes 23 items such

as welding machines, air compressors, tire changer, etc. The machines and equipment will be supplied to UPPH and all DMSC workshops.

2) Work tools and materials

In addition, various types of work tools will also be supplied to the UPPH and DMSC workshops. There are 24 types of tools to be procured as shown in Table 5.9.16 in Part 2 and Data Book L. The tools consist of spanners, hammers, and wrenches as well as metal materials.

(3) Equipment for central workshop for landfill

As mentioned in Section 5.10.8 of Part 2, a central heavy equipment workshop has been constructed by UPPH at Diez de Octubre Municipality. This central workshop will cover most of the repairs to equipment operating at the landfills.

In addition, two trucks equipped with repair and maintenance equipment/tools (called here 'mobile workshops') will be provided to deal with the daily needs of repair and maintenance of equipment at landfills.

1) Procurement of equipment for the central workshop

The list of equipment is given in Table 5.10.14 in Part 2. The procurement cost is estimated at approximately US\$135,000. The life of the repair equipment is deemed to be 7 years applying the rate for general machinery.

2.2 Implementation Program

2.2.1 Implementation Schedule

Table 2.2.1 shows a proposed procurement schedule. Heavy equipment for landfill operations and equipment for the workshops will be procured on an urgent basis so as to be put into service preferably in 2007, and collection vehicles in 2010, according to the schedule proposed in the M/P. The actions for procurement of the former would need the earliest commencement.

Table 2.2.1 Implementation Schedule for Equipment Procurement

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

2.2.2 Implementation Agency

The agency responsible for the implementation of this project will be DPSC, under which UPPH acts as the executing body. UPPH shall have close coordination with the consultant and contractor in order to implement the project smoothly.

2.2.3 Procurement Works

The implementation of the priority project requires the following works related to the procurement:

- Preparation:
 - Detailed design
 - Preparation of tender documents
 - Tender and tender evaluation
 - Contract
- Procurement:
 - Inspection of products
 - Trial operation and adjustment at factories
 - Marine and inland transportation
 - Receipt and inspection of the equipment
- For operation:
 - Registration of the vehicles and equipment
 - Assembly and installation of the equipment for workshops
 - Construction and/or modification of workshop facilities
 - Budget preparation for equipment operation

Some of these works will be conducted by employing local or foreign consultants as required. Some works will require cooperation with other authorities concerned.

2.2.4 Quality Control Plan

The quality control plan for the project is as follows:

- Specifications and quality of the equipment in the contract documents will be inspected.
- Quality inspection will be carried out at the factory by the time of completion of equipment assembling or before shipping.
- Assembling and installation of the workshop equipment will be conducted and supervised by a specialist dispatched by the supplier.
- Approved licenses for the waste collection and transportation vehicles issued by the agency responsible for motor vehicle registration will be inspected.
- Mechanical functioning of the loading arm of collection vehicles will be checked during the operational testing period in the factory.

2.2.5 Operating Organization

After the procurement of equipment is completed, DPSC/UPPH will be responsible for the operation and maintenance of equipment. Inclusive of the personnel at maintenance workshops, the following number of personnel shall be assigned to the work:

Table 2.2.2 Required Number of Staff

Organization	Nos. of Staff	Notes
Segregated Collection and Transportation	661	For the work in 2010 (collection and disposal of 574 tons/day of waste)
Landfill Operation: Calle 100	90	
Landfill Operation: New Guanabacoa	41	

2.3 Cost Estimate

2.3.1 Heavy Equipment and Machinery for Landfill Operation

The total procurement cost and concerned cost such as engineering cost of the equipment for the landfill operation is shown in Table 2.3.1 in addition to O/M cost.

Table 2.3.1 Implementation Cost of Equipment Relevant to Landfill

Item	Cost (US\$)	Cost (CUP)
Capital Cost	5,856,000	0
Procurement Cost		
Heavy Equipment for Landfill Operation	5,338,000	0
Repair Equipment for Central Workshop	135,000	0
Sub total for Procurement Cost	5,473,000	0
Engineering Cost (2%)	109,000	0
Physical Contingency (5%)	274,000	0
O/M Cost (2007 -2015)	4,500,000	10,157,000
Total Implementation Cost	10,356,000	10,157,000

Note: All costs are rounded to the nearest thousand,

2.3.2 Collection Vehicle and Related Workshop Equipment

As same as above, the total implementation cost of the collection vehicles and relevant workshop equipment is shown in Table 2.3.2.

Table 2.3.2 Implementation Cost of Collection Vehicles and Related Workshop Equipment

Item	Cost (US\$)	Cost (CUP)
18 m³C/T vehicle		
Capital Cost	1,669,000	0
Procurement Cost	1,560,000	0
Engineering Cost (2%)	31,000	0
Physical Contingency (5%)	78,000	0
O/M Cost (2007 -2015)	546,000	2,727,000
Total Implementation Cost	2,215,000	2,727,000
Workshop equipment		
Capital Cost	809,000	0
Procurement Cost	756,000	0
Engineering Cost (2%)	15,000	0
Physical Contingency (5%)	38,000	0
O/M Cost (2007 -2015)	303,000	2,424,000
Total Implementation Cost	1,112,000	2,424,000
Total (US\$)	3,327,000	5,151,000

Note: All costs are rounded to the nearest thousand,

2.4 Evaluation of the Project

2.4.1 Concept of Evaluation

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

The economic evaluation was considered to be not relevant in this case for the reasons that; (i) procurement of the equipment is essential to enable proper conduct of MSWM in the City irrespective of economic viability, and (ii) the project is a component of the overall set of projects in the M/P, and a separate evaluation of the economic viability was thought difficult. An assessment of the economic viability of the overall set of the M/P projects is presented in Part 2 of this Report.

2.4.2 Technical Soundness

The technical soundness of the project was assessed with respect to the following three aspects:

- 1) The need of procurement of the equipment was technically justified in the M/P. The equipment are essential for conducting the works proposed in the M/P, the collection vehicles for segregated waste collection, the heavy equipment for environment-friendly landfill operation, and the workshop equipment for proper repair and maintenance of equipment
- 2) Equipment procured under this project is all of conventional type similar to the existing equipment currently in operation. The skills and technical knowledge for operation and maintenance (O/M) of the equipment are already possessed by the 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 the UPPH manual, both the collection vehicles and heavy equipment must be in service for a period of 9-10 years. Moreover, longer service life is expected if proper O/M is conducted.

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

2.4.3 Financial Viability

The financial viability of the operating agency, either UPPH or any new Aurora Enterprise (holding company) established, 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 2.4.1 below shows the cost stream of the project covering both the procurement and O/M costs.

Table 2.4.1 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: The above cost covers both the initial procurement cost and O/M cost.

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

As in the case included in the M/P, the Study analyzed both ‘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 2.4.2 below shows the cost stream of the above two cases. The breakdown details are presented in Data Book D.

Table 2.4.2 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: Case-A: Depreciation cost excluded from cash account; Case-B: Depreciation cost included

Salvage value of equipment at year 2015 was estimated as US\$1.7 million, which was regarded as minus cost in 2015. Cost expressed at 2005 price

(2) Revenue stream

A revenue stream was constructed also in a similar manner to 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 the ratio of the cost of this project to the total cost of all the M/P projects (pro-rata estimation). This is based on the concept that a proportional portion of the total revenue can be attributed to the investment in the procurement of equipment under this F/S project.

The revenue stream so derived is shown in Table 2.4.3 below. For a conservative estimate, it was assumed that the revenue will accrue from the year 2010 after the collection vehicles procured under this F/S project are put in service.

Table 2.4.3 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

** Changed to commercial and public institutions (but other than MSWM agencies) that dispose of waste to landfills

(3) Financial Balance during Operation

Table 2.4.4 shows the financial balance up to the evaluation horizon of 2015 for both 'Case-A' and 'Case-B'.

Table 2.4.4 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 of the foreign currency in ‘Case-A’ will not become positive even in 2015, and the accumulated loss of the foreign currency at the end of 2015 is US\$2.95 million. On the other hand, the accumulated surplus of the local currency at the end of 2015 is only CUP1.85 million. Considering this balance, the operating agency would need financial support to meet the O/M cost.

‘Case-B’ shows that 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 for the foreign currency portion, which must be subsidized by the State for the same reasons as stated for the M/P.

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

(4) Sensitivity Analysis

A sensitivity analysis was made in a manner similar to the M/P (ref. Subsection 5.17.5 (5) of Part 2). The results are shown in terms of revenue-cost balance in Table 2.4.5 and 2.4.6 for ‘Case-A’ and ‘Case-B’, respectively.

Table 2.4.5 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 2.4.4)	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 to 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 to 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 Base Case: Depreciation cost excluded from the cash account of the operating agency (See Para. (1) above for details)
 2 The figures are expressed in revenue-cost balance
 3 FC: Foreign currency, LC: Local currency
 4 CUP0: Compost price is zero, CUP1,250: Compost price CUP1,250/ton

Table 2.4.6 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 2.4.4)	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 to 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 to 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 Case-B: Depreciation cost included in the cash account of the operating agency (See Para (1) for details)
 2 Other notes: Same as described for Table 2.4.5

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

2.4.4 Socio-environmental Aspect

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

After the equipment is put in service, the following aspects shall be taken into consideration:

- 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 environment around the areas by reducing odors, the propagation of insects, the scattering of plastics, and the risk of fire outbreaks. The direct beneficiaries are the people living in the within one kilometer of each of the two landfills, estimated as 38,000 people.
- 2) Heavy equipment for the landfills will be operated mostly within the compound of the landfill sites, which are isolated from residential areas. Nevertheless, the operation shall pay attention not to cause noise and dust problems in the surrounding area.
- 3) Supply of 12 new collection vehicles (18 m³ C/T) will increase the total number of vehicles operated for waste collection in the City. The operation shall take care to not cause traffic jam during waste collection and also pay attention to minimizing exhaust gas, noise and dust. The equipment shall be maintained in a good state so as not to cause a nuisance on the public roads.
- 4) Equipment for workshops will be used in a confined workshop area and will have no direct affect on the socio-environmental conditions outside the workshops.

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

PART 5 CAPACITY DEVELOPMENT

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

1.1 Objective and Target of the Capacity Development Program

1.1.1 Objective and Target

The primary objective of the capacity development program (CDP) was to strengthen the ability of the C/Ps to prepare the M/P for MSWM. In conducting the CDP, the following specific targets were adopted:

- The Cuban C/Ps would develop a sense of ownership of the Study through the recognition that the M/P was to be worked out with their active participation and initiative.
- The Cuban C/Ps would acquire the ability to revise the M/P in future as the need arises and further formulate new M/Ps for other cities with some assistance from foreign advisers/experts.

At the end of the Study, the C/Ps were required to present the formulated M/P at a seminar that was held to disseminate all the achievements of the Study.

The C/P consisted of two groups of employees dispatched from two key government bodies, DPSC and CITMA. The following capacity development objectives were assigned to the groups as follows:

DPSC group:

- Upgrade management capacity for MSWM
- Strengthen basic knowledge of MSWM
- Acquire the ability to plan, design, and operate and maintain environmentally-friendly landfills
- Acquire the ability to plan efficient collection and transportation of waste
- Acquire the ability to plan for segregated waste collection
- Acquire the ability for middle and long term planning for MSWM
- Acquire the basic knowledge of 3Rs

CITMA group:

- Develop the capacity to establish an integrated legal system for MSWM
- Develop the capacity to promote the research and implementation of 3Rs
- Develop the capacity to identify environmentally-friendly landfill technology appropriate for use in Cuba

- Develop the capacity to determine criteria for the construction of environmentally-friendly landfills
- Develop the capacity to identify the criteria for appropriate leachate treatment

1.1.2 Assignment of C/P for CDP

Each Study Team member was responsible for the capacity development of a C//P assigned to him/her. The following pairing of C/Ps and Study Team members was determined through the discussion with the Cuban side:

Table 1.1.1 Pairing of C/P and Team Members

Responsibility	C/P	Team Member
1. Leader	Odalys Garcia	Masatoshi Akagawa
2. Sub Leader	Juan Herrera	Shigeru Kanaya
3. Collection & Transport	Wladimir Fraguela	Satoshi Shibasaki
4. Recycle/Quantity & Quality Analysis	Odalys Goicochea	Takahiro Kamishita
5. Final Disposal	Aymara Infante	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

Ms. Odalys Garcia was assigned to hold two positions: (i) Chief C/P to lead the other C/Ps in the work of the M/P formulation and (ii) Organization/Institution. The total number of C/Ps for the CDP initially assigned was, therefore, nine persons¹.

1.2 Project Design Matrix for CDP

The CDP was conducted by applying the project design matrix concept (PDM) from the project cycle management (PCM) method. A PDM sets out (i) the overall goals of the CDP, (ii) the targets of the CDP for C/Ps, (iii) the expected outputs, (iv) the activities included in the CDP, (v) the inputs required from the C/Ps and the Study Team, and (vi) the preconditions assumed for the activities.

In order to check the progress of CDP for each C/P, a PDM was prepared at three occasions: at the beginning of the Study (PDMi), during the second study in Cuba (PDMm), and during the third study in Cuba (PDMf).

Based on the PDM format, individual capacity programs for all nine C/Ps were jointly prepared by the C/P and the Study Team as contained in Data Book O.

¹ In addition to the nine original C/Ps, one person, Mr. Andrez Ruiz, joined the C/P group at a later stage. Therefore, 10

1.3 Method and Approach for Capacity Development

1.3.1 Method of Capacity Development

The methods adopted for capacity development were:

- (i) On-the-job training
- (ii) Workshops
- (iii) Overseas training

On-the-job training was carried out for the C/Ps to acquire the basic knowledge and experience by means of working together with the Study Team members.

On-the-job activities included:

- Carrying out field surveys, such as solid waste quality/quantity survey, time and motion survey, water quality survey and others,
- Conducting sector studies, which included solid waste volume projections, optimum collection/transport plan, environmentally-friendly or sanitary landfill plans, and improvement of the existing organization and legal structure,
- Working out a future long-term vision/scenario for MSWM and the master planning integrating the sector studies, and
- Setting up criteria for selecting the PLP, and its implementation program and organization as well as cost estimation.

In some cases, the Study Team provided a basic idea and/or option to initiate the planning process and then asked the C/Ps to elaborate other ideas and/or options as homework. The ideas and plans were then discussed together at meetings of the C/P and Study Team members to review the advantages, weak points, and constraints and then formulate an optimum plan.

Workshops (WS) were held to enable extensive discussion of proposals by government officials, community people, mass organizations, SC members, and other stakeholders depending on the subject.

Overseas training was conducted in Japan for two C/Ps. These people acquired knowledge of practices in Japan by visiting MSWM facilities, receiving lectures, and exchanging discussions with personnel involved in MSWM.

1.3.2 Approach to CDP Implementation

Prior to the CDP, the C/Ps had never been involved in any MSWM M/P studies. The CDP was therefore carried out to provide a wide range of knowledge ranging

C/Ps in total worked on the Study.

from basic knowledge to planning practices by means of: (i) lectures/learning, (ii) on-the-job training/joint work, and (iii) self-reliant work. The CDP was conducted throughout the course of the Study as shown in Table 1.3.1 below.

Table 1.3.1 Capacity Development at Respective Stages of the Study

Method	First Year		Second Year						
	First Study in Cuba		Second Study in Cuba				Third Study in Cuba		
	WS	The M/P	WS	The M/P	The F/S (Formulation)	Pilot Project	WS	The M/P	The F/S (Evaluation)
Lecture/ Learning	Attend lectures & WS	Learn planning methodology	Attend lectures & WS	Learn planning methodology	—	—	Attend lectures & WS	Learning planning methodology	—
On-the-job training /Joint Work	Organize WS	Discussion on the contents	Organize WS	Discussion on the contents	Discussion on contents	Cooperative preparation	Organize WS	Discussion on contents	Discussion on contents
Self-reliant work with Team's Advice and Guidance	Give presentation	—	Give presentation	—	—	Implement	Give presentation	Give presentation of the M/P	Give presentation of the F/S

Note: WS: Workshop, The M/P: The Master Plan, The F/S: The Feasibility Study

1.4 Evaluation and Verification of the Capacity Development Achievement

1.4.1 Evaluation of Capacity Development Achievement

Evaluation of capacity development achievement was done through three steps.

- (i) Evaluation by the C/P himself/herself
- (ii) Evaluation by the Team member who was responsible for capacity development of the C/P
- (iii) Final evaluation by the Evaluation Committee, taking into account evaluations (i) and (ii).

In the evaluation, PDMb (originally set target and output) and PDMe (final target and output) were compared to assess the degree of actual achievement relative to that planned at the beginning.

The evaluation committee comprised:

- Team Leader and Vice Team Leader of the Study Team, and
- Chief C/P, Vice Chief C/P

When one of the committee members (either the Chief C/P or Vice Chief C/P) was evaluated, Ms. Odalys Goicochea (C/P for Recycle/Quantity & Quality Analysis) joined the evaluation on behalf of that C/P.

Monthly capacity development meetings were also held once a month at the end of the month or early part of the following month in order to discuss the progress of the CDP and the program for the following month.

1.4.2 Verification of Capacity Development Achievement

The achievements of the CDP were verified at the end of the Study period by evaluating the C/P's performance in presenting the results of the Study outputs at the final seminar. The C/P's performance was verified by both the quality of the presentation materials he/she prepared and the quality of his/her presentation.

1.4.3 Schedule of Evaluation and Verification

The evaluation was conducted on two occasions: the first was the mid-term evaluation at the Interim Report stage in November 2004 and the second was the final evaluation at the Draft Final Report stage in July 2005.

The verification was conducted when the C/P made his/her final presentation of study outputs at the seminar held in July 2005.

CHAPTER 2 IMPLEMENTATION OF THE CAPACITY DEVELOPMENT PROGRAM

2.1 Capacity Development Workshops and Seminar

2.1.1 First Capacity Development Workshop

(1) Objectives of the workshop

The objectives of the capacity development workshop were as follows:

- 1) Inform and publicize the objective and contents of the CDP of the Study, and
- 2) Exchange opinions on the contents of the CDP and on the method of evaluation of the CDP achievement.

(2) Proceeding of the CDP workshops

The workshops were carried out at the initiative of the C/Ps with the cooperation and advice of the Study Team. The workshops were conducted in the following manner:

- All presentations and speeches were in Spanish, except for the presentations made by the Team.
- The Master of Ceremonies was a C/P.
- The main presenters were C/Ps. All presentation papers and handouts were prepared by the C/Ps.
- The C/Ps kept a record of the workshop in Spanish and the Team translated it into English.
- The Team took photographs and video.

After the presentations, a group discussion was held to freely exchange opinions on the CDP and the method of evaluating the achievements of the C/Ps.

(3) Coordinators and presenters

One coordinator was appointed from among the C/Ps and one from the Study Team. The C/P coordinator performed the role of Master of Ceremonies of the workshop. The personnel assigned to the workshop proceeding are as shown in Table 2.1.1.

Table 2.1.1 Coordinator of First Capacity Development Workshop

	Coordinator	Master of Ceremony	Presenter
C/P	Ms. Odalys Goicochea	Ms. Odalys Goicochea	Ms. Odalys Garcia Mr. Juan Herrera Mr. Almeida
Team	Mr. Masatoshi Akagawa	-	Mr. Masatoshi Akagawa

(4) Participants

People/Parties who attended the workshop included:

- Counterparts
- Study Team members
- Steering Committee (SC) members
- Representatives of ministries/organizations involved in MSWM
- The JICA representative in Cuba

(5) Achievement

The first CDP workshop was held over 3 hours following the agenda provided in Data Book N. The Study Team firstly introduced the structure of the CDP and then three C/Ps made presentations of their individual CDP. After these presentations, the participants were divided into three groups to discuss the CDP and its evaluation method. A representative of each group presented the results of the group discussion.

Consequently, the PDM-based CDP proposed by the Study Team was agreed to by all groups. Based on the opinions presented by the group discussions, it was agreed that the method of evaluating the achievements of the CDP would comprise the following three steps:

- (i) the C/P's own evaluation,
- (ii) evaluation by the Study Team member assigned to the C/P, and
- (iii) evaluation by the Evaluation Committee.

2.1.2 Second Capacity Development Workshop and Interim Evaluation of Achievement

The Second CDP Workshop was held on 19 Nov. 2004 to evaluate the interim achievement of capacity development of each of the nine C/Ps. The agenda and results of the evaluations are given in Data Book N and Data Book P, respectively.

2.1.3 Third Capacity Development Workshop and Evaluation of Achievements

The Third CDP Workshop was held on 11 July 2005 to evaluate the achievement of capacity development of the 10 C/Ps (nine original C/Ps plus an additionally assigned C/P). The agenda and results of the final evaluation are given in Data Book N and Data Book Q, respectively.

The degree of achievement ranges from excellent to fair: Excellent (1 C/P), good (6 C/Ps) and fair (3 C/Ps). It should be noted that all 10 C/Ps expressed

satisfaction with their involvement in the CDP and their willingness to use the experience for MSWM in the country in the future.

The C/Ps made presentations on the outputs of their work as well as their capacity development achievement at the Seminar held at the final stage of the Study in September 2005. The C/Ps prepared the materials for their PowerPoint presentation in cooperation with members of the Study Team and then made the presentation themselves. The capacity development achievements were verified by evaluating the quality of the C/P's presentation with reference to the depth of understanding displayed by the presenter and the audience understanding of the presentation. Final evaluation was based on the verification results for each C/P.

2.1.4 Capacity Development Workshop for DMSC

(1) Objective of the workshop

The objectives of the Capacity Development Workshop for DMSC were as follows.

- 1) Transfer knowledge and experiences accumulated by the C/Ps through the CDP to DMSC managers and officers with the aim of upgrading MSWM in the suburban areas serviced by DMSC, and
- 2) Strengthen the understanding of the C/Ps of the study outputs through the act of preparing presentation materials and PowerPoint presentations.

(2) Proceeding of the workshop

The Workshop was carried out at the initiative of the C/Ps and with the cooperation and advice of the Study Team. The workshop was conducted in the following manner:

- All presentations and speeches were in Spanish except those by the Team.
- The Master of Ceremonies was a C/P.
- The Presenters were C/Ps.
- The C/Ps prepared all the presentation papers and handouts so that these resources could be utilized for other technology transfer opportunities.
- The C/Ps kept a record of the workshop in Spanish

(3) Coordinator and presenters

A C/P was appointed as the coordinator and a C/P assumed the role of master of ceremonies of the workshop, as shown in Table 2.1.2.

Table 2.1.2 Coordinator of DMSC Capacity Development Workshop

Coordinator & Master of Ceremony	Presenters
Ms. Odalys Garcia	Ms. Odalys Garcia Mr. Juan Herrera Mr. Andres Mr. Almeida Ms. Odalys Goicochea Ms. Aymara Ms. Elida

(4) Participants

People/Parties who were invited to the workshop included:

- C/Ps
- Managers and staff of all 15 DMSCs in Havana City
- The Study Team
- SC members
- Ministries/Organizations involved in MSWM

(5) Achievement

The Workshop for DMSC was held in September 2005 according to the agenda given in Data Book N. All the presentations were made by C/Ps utilizing PowerPoint.

In the presentations, the main emphasis was placed on the M/P and the PLP. The presentation of the M/P focused on the methodology of plan formulation as well as the technology for individual aspects of MSWM. A presentation was also given regarding lessons learned from the PLP, especially the experiences that should be taken into consideration when implementing full-scale projects in the future.

2.1.5 Seminars

(1) Objective of seminars

The objectives of the Seminars were as follows:

- To inform and publicize the outputs of the Study, comprising a) the M/P, b) PLP, c) F/S on the priority project, and
- To inform and publicize the achievements of the capacity development of C/Ps.

(2) Proceedings of seminar

As with the workshops, the seminars were carried out at the initiative of the C/Ps with the cooperation and advice of the Study Team. The seminars were conducted in the following manner:

- The main presenters were C/Ps.
- Most of the presentations were in Spanish.
- A C/P was appointed as the master of ceremonies (MC) and the Study Team Leader as co-MC.
- Two coordinators were appointed, one each from among the C/Ps and the Study Team.

(3) Participants

People/parties involved or with an interest in solid waste management in Havana City were invited, which included:

- Ministries/organizations concerned with MSWM
- Representatives of Havana City administration
- Representatives of local communities including Havana del Este municipality, Peñas Altas council and Campo Florido council
- Representatives of the aid organizations
- Representatives of the Embassies

2.1.6 Capacity Development Components in Other Meetings and Workshops

Efforts were made to include capacity development activities in other meetings and workshops as much as possible.

(1) Steering Committee meetings

From the third Steering Committee meeting to the sixth Steering Committee meeting, arrangements were made so that the study outputs would be presented mainly by a C/P as a part of their capacity development. With this in view, the C/Ps and Study Team members cooperated closely on the preparation of the presentation materials. Major outputs for the presentations are given below.

SC Meeting	Study Output
Third	Interim Report
Fourth	Progress Report (2)
Fifth	Outline of Draft Final Report
Sixth	Draft Final Report

(2) First dissemination workshop

With a view to disseminate the purpose and major outputs, as well as the implementation schedule of the Study, the First Dissemination Workshop was held on 12 March 2004. It is noted that this workshop was programmed so that the C/Ps should take the initiative as a part of the CDP. The Chief C/P explained the component and work flow of the Study as well as the structure of the master plan.

The Vice Chief C/P explained the selection criteria and candidate projects for the PLP. The agenda of the workshop is given in Data Book N.

(3) Second dissemination workshop (Pre-implementation workshop)

A workshop was organized on 29 Oct. 2004, called the Second Dissemination Workshop or Pre-Implementation Workshop, to make the communities aware of the implementation of the PLP. The workshop included awareness-raising of the community on the need for environmental protection, in particular those related to MSWM. Attendees to the workshop included various parties and organizations at the central level as well as the community level, such as CITMA, DPSC, community leaders, CDR and others.

To reinforce the understanding of the people about an environment-friendly approach to MSWM, group discussion was held on the following subjects:

- Group 1: Citizen participation in segregated collection
- Group 2: Promotion/acceptance of sanitary landfill
- Group 3: Citizen Participation in composting and recycling

(4) Awareness-raising workshop for school children in the PLP area

Another workshop was held to raise the awareness of children and teachers of the primary schools located in the PLP area. Details of the workshop are given in Part 3 - Pilot Project.

(5) Post-implementation workshop

1) Objectives

A post-implementation workshop was held to survey the residents' opinions after the implementation of the PLP. The main points were:

(a) Opinion on the PLP:

- Hear the opinions of the residents in the PLP area with regard to the problems/difficulties experienced and possible improvements to PLP operation

(b) Awareness level for MSWM:

- Grasp the awareness level of the residents in the PLP area with regard to MSWM after implementation of the PLP

(c) Applicability of the segregated discharge/collection:

- Obtain information to judge whether segregated discharge/collection is applicable to the urban area under the management of UPPH of

Havana City, together with the information on desirable improvement measures

(d) Applicability of home composting:

- Obtain information to judge if home composting is applicable to the sub-urban area of Havana City, together with the information on desirable improvement measures

(e) Acceptability of environment-friendly landfill:

- Obtain information to judge if landfill construction and operation in the vicinity can be acceptable for residents on the condition that the landfill will be of an environmentally-friendly type

(f) Awareness-raising program:

- Obtain information to work out effective programs for awareness-raising about the new MSWM system and an organization to be responsible for such awareness-raising

2) Participants/invitees

The following personnel participated in the workshop:

- (a) Residents: 20 residents in total; 10 each from Peñas Altas and Campo Florido communities
- (b) Community leaders, staff of ministries/organizations including CDR and the Women's Union, school teachers and school pupils
- (c) All members of the SC, C/Ps and the Study Team

3) Workshop organization

The workshop was held with the following personnel assignment:

- (a) Master of Ceremonies (MC): Odalys Goicochea
- (b) Co-MC: Akagawa
- (c) Coordinator: Hosono
- (d) Facilitators for group discussion:
 - Group A: Segregated discharge Herrera
 - Group B: Home composting Kanaya
 - Group C: Environment-friendly landfills Andres
 - Group D: Awareness-raising Elida
- (e) Interpretation and translation: 4 translators
- (f) Records of group discussion: 4 translators

4) Workshop agenda

(a) Agenda

Agenda is as given in Data Book N.

(b) Subjects of group discussion

- Necessity and benefit of environment-friendly MSWM initiatives such as composting, segregated collection, environment-friendly landfills
- Cooperation for segregated discharge
- Cooperation for recycling
- Cooperation for home composting
- Acceptance and cooperation of the construction and operation and maintenance (O/M) of environment-friendly landfills
- Cooperation for the activities for awareness-raising

2.2 On-the-Job Training

2.2.1 Field Survey and Data Analysis

During the course of the first and second study in Cuba, the Field Survey No.1 (during the dry season) and Field Survey No.2 (during the rainy season) were carried out; they comprised the following:

- (1) Waste quantity and quality survey (dry and rainy seasons)
- (2) Recycling market survey
- (3) Survey of municipal solid waste (MSW) quantity hauled to landfills
- (4) Time and motion survey
- (5) Water quality survey (dry and rainy seasons)
- (6) Environmental awareness survey

During these surveys, the Study Team conducted technology transfer to the C/Ps through on-site training and/or discussion in the office on the following subjects:

- (i) Objective and contents of the survey
- (ii) Methodology of the survey including those for sampling and analysis
- (iii) Interpretation of survey outputs and their incorporation into the planning

2.2.2 The Master Plan Formulation

Major components of technology transfer regarding the M/P formulation included:

- (1) Determining the structure and components of the the M/P of MSWM
- (2) Analysis of workflow and interrelations among the work activities included in the M/P with identification of the critical path

- (3) Methodologies of the integrated M/P formulation including formulation of economic development strategies and scenarios, target setting, project formulation, and phased implementation
- (4) Methodologies for sector plan formulation including determination of macro-frame, recycling target, estimation of solid waste volume, improvement of collection efficiency, time and motion study, sanitary landfill planning, environmental and social considerations, organization and institutional strengthening, and evaluation of the M/P

2.2.3 Pilot Project Formulation and Implementation

Formulation of the pilot project (PLP) was carried out by joint efforts of the C/P and the Study Team. Discussion meetings between the C/P involved and the Team members concerned were held more than 20 times. The activities of the PLP formulation and the allocation of works between the C/Ps and Team are shown below in Table 2.2.1.

Table 2.2.1 Formulation of Pilot Project

Activity	Share of Work	
	C/P	Team
Working out candidate projects	*	***
Working out selection criteria	*	***
Formulation of project package	**	**
Site selection	***	*
Working out the details of each component	*	***
Working out procurement method	**	**
Working out implementation plan	*	***
Cost estimation and cost sharing plan	**	**

Note: Number of “*” indicates the degree of initiative and involvement.

Either the Study Team or C/P took initiative for each activity and proposed a plan. The plan was then discussed between the two sides. In the next meeting, the other side proposed a modified plan for discussion. After intensive discussion and planning works by both sides, the final plan for the PLP was formulated with due consideration for the practicality of implementation.

Through the process of plan formulation, intensive technology transfer was attempted on the following subjects in particular:

- (1) Methodology of plan formulation for a PLP
- (2) How to design a sanitary landfill and segregated collection
- (3) Preparation of specifications for the spare parts required for the repair and maintenance of heavy machinery that is currently out of service

2.3 Training in Japan

Two counterparts, the Chief C/P and Vice Chief C/P, were invited to Japan by JICA for training from 21 July through 10 August 2004. The training program conducted is shown in Data Book N.

Site visits to various MSWM facilities were arranged, including those for collection/transport, incineration, recycling, sanitary landfill and industrial waste treatment. Strong support was received from the Advisory Committee and organizations involved in MSWM. The Advisory Committee members gave lectures regarding the legal and institutional framework of MSWM in Japan, experiences in MSWM and industrial waste management in Japan, and also examples of practices adopted in several developing countries. The Study Team also conducted lectures regarding the planning methodologies of the M/P formulation and collection and transport systems. The C/Ps reported that the training in Japan was very useful for them.

CHAPTER 3 EVALUATION OF THE ACHIEVEMENT OF CAPACITY DEVELOPMENT

3.1 Achievement of Capacity Development of Individual Cuban Counterparts

Although their degree of involvement in the Study activities varied, all ten C/Ps contributed to the production of the Study, covering the formulation of the M/P, preparation of the F/S, and formulation and implementation of the PLP. Through this involvement in the Study activities, the C/Ps developed their abilities considerably.

The achievement of capacity development of the ten C/Ps was evaluated based on the degree of achieving the target initially set down for each individual C/P. The results of the evaluations are described in Data Book Q.

Of the ten C/Ps, one C/P was evaluated 'A: Excellent', while seven were evaluated 'B: Good), and two were evaluated 'C: Fair'. No C/P was evaluated as 'D: Not sufficient'. Of the ten C/P, nine expressed that they would continue in their current job and utilize the knowledge and experience gained through the Study to improve. One C/P would be transferred from the City to a planning ministry as a specialist. However, he would continue to be involved in solid waste management, and hence, the knowledge and experience he gained would be utilized at the ministry.

The achievements of the ten C/Ps are, therefore, evaluated as successful, and the knowledge transferred and experiences gained are expected to contribute to the improvement of MSWM in Havana City and further in Cuba.

3.2 Overall Achievement of the Counterpart Groups

The ten C/Ps were appointed from DPSC and CITMA: six from DPSC and four from CITMA. Besides the targets set for individual C/Ps, the targets of achievement were set for each group of DPSC and CITMA.

The targets assigned to each group and the evaluation results are summarized in Table 3.2.1 below. As seen in the table, the achievement of capacity development was evaluated as either 'A: Excellent' or 'B: Good'. This indicates that the capacity development initially intended was achieved.

Table 3.2.1 Evaluation of Capacity Development of C/P Group

Item of Capacity Development	Evaluation by		
	C/P Representative*1	Team Member	Evaluation Committee
DPSC:			
Upgrading of the management capacity for MSWM	A	B	B
Strengthening of the basic knowledge of 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 waste collection and transport	A	B	B
Acquiring the planning capacity for segregated waste collection	B	B	B
Acquiring the planning capacity for middle and long term planning for MSWM	B	B	B
Acquiring the basic knowledge of 3Rs	B	A	A
Overall	B	B	B
CITMA:			
Capacity development for improvement of the legal system of MSWM	B	B	B
Capacity development for promotion of the research and implementation of the 3Rs	A	A	A
Capacity development for working out an environment-friendly technology of landfill suitable for Cuba	B	B	B
Capacity development for working out the criteria for the establishment of an environment-friendly landfill	B	A	A
Capacity development for working out the criteria for leachate treatment	B	B	B
Overall	B	B	B

Note: *1 Evaluation was performed by Ms. Odalys Garcia (Chief C/P) for DPSC and by Mr. Juan Herrera for CITMA (Vice C/P)

It is noted that the PLP was planned and implemented with the initiative of the Cuban C/P groups. In particular, in the operation of the PLP, the two groups collaborated nicely; DPSC assumed responsibility for operation, while CITMA contributed the environmental monitoring and awareness-raising. Though small in scale, the PLP is a forerunner to future environment-friendly MSWM and the experience obtained through its implementation is considered very valuable for the implementation of full-scale environment-friendly MSWM covering the whole City.

It is also noted that the two groups, either separately or in collaboration, made presentations of the Study outputs at Steering Committee meetings and various workshops. They also played the role of facilitators in the workshops. These experiences will be useful for conducting similar presentations and dissemination activities that would be required in future for project mobilization and public relations to proceed properly.