

4.4 Institutional, Organizational and Financial System

4.4.1 Institutional System

In Decree No. 311 under the Constitution of the Republic of Honduras (Chapter XI: Departmental and Municipal Regimen), Article No. 294 states that the national territory is divided into departments that are, in turn, divided into autonomous municipalities administered by publicly elected corporations.

Article No. 295 states that a single municipality constitutes the Central District comprising the former cities of Tegucigalpa and Comayagua.

Article No. 298 pronounces that the municipal corporations shall function independently of state powers and their duties shall be governed by the Law of Municipalities.

Article No. 2: "The Law of Municipalities" defines the municipality as populations or associations of people residing within a municipal term, governed by a municipality that enforces and extends its authority within its territory and is the basic structure of the State and immediate cause of civic participation.

In Honduras, the municipality is obliged to undertake Solid Waste Management, and in consideration of the close association with public health, its legal basis are governed as follows.

a) In Decree No. 311 (Constitution of the Republic) Chapter VII: "Health", Article 145 establishes the right to protect public health together with the citizens' duty to participate in the promotion and preservation of their personal health and that of the community. Through the Department of Public Health and Social Assistance, the state shall coordinate all activities of both the centralized and decentralized organizations within the health sector by means of a National Health Plan.

b) In Chapter XX, Section two: "Cleanliness" (under Decree No. 76: "Law of Police" - revised in 1933 and still in force), several articles regulate the involvement of both the citizens and the mayors in maintaining the cleanliness of the community.

c) Articles 12 and 13 in Decree No. 134-90 (Title III : "Law of Municipalities") state that the municipal autonomy is based, among other things, on its ability to manage its own funds and apportion them in such a way that the outcome is beneficial to the whole municipality, with a special emphasis on the preservation of the environment and the planning, organization and administration of the municipal public services.

Moreover, the governance and principle of the municipal corporation is the objective of the municipalities, and specifically, that which refers to:

- Aesthetics, cleanliness and hygiene of the municipality.
- Protection of the ecology, environment, and promotion of reforestation.
- Availability of local public services.

- Coordination of the methods and actions that guarantee the health and general well-being of citizens, that in effect is imposed by the public health authorities, governed by the Sanitary Code.

Article 14 states that the municipality is the governmental body that exists to maintain the well-being of its inhabitants, promote its integral development and the preservation of the environment with, among others, the following objectives:

- To obtain social and material well-being of the municipality, executing public works and service programs.
- To protect the ecosystem and the environment.

In Chapter II: "Population", Article 24 establishes that the residents outside the municipal boundaries have the right to receive municipal public services, and as customers, are obliged to pay for them in accordance with the Municipal Tax Plan and the Law of Municipalities.

d) In Chapter IV "Residual Solids", Decree No. 65-91: "Code of Health, Cleanliness of the Environment" contains the following articles that deal with specific issues related to SWM:

Article 51: Definition of solid waste.

Article 52: States that it is the duty of the municipalities to organize, hire, and assume the responsibility for cleansing, collection, treatment and disposal of waste, in accordance with the norms defined in the regulation.

Article 53: The utilization of the final waste disposal sites must be authorized by the municipality with the approval of the Department of Health.

Articles No. 54 to No. 57 establish the responsibilities of the citizens in terms of the use of service and of the Department of Health concerning the qualification of the rendering of the waste handling services.

The Regulation of Environmental Health, which is still waiting approval is to ratify the stipulation in the Code of Health and elaborates on the content of its articles.

e) In the General Environment Law, Chapter III, Decree No. 104-93 (Title II: "Environmental Management"), establishes and ratifies the municipal authority as follows:

Article 29: It binds the municipalities to assume the responsibility of urban development, regulate constructions, and provide municipal public services, basic sanitation etc. Furthermore, the preservation and restoration of the ecological balance in population centers, that is to be achieved through provision of services such as cleaning, collection and disposal of waste, are also the responsibility of the municipal governments.

In relation to "Environmental Protection and Rational Use of the Natural Resources", the obligation of municipalities is outlined regarding the regulation of the following:

The committal and elimination of solid and liquid waste, regardless of its toxicity (Article No. 54).

The treatment of residual and organic solids derived from different sources i.e. domestic, industrial, agricultural, domestic animals, public areas etc. in order to mitigate water, ground and air contamination.

The responsibility of the municipality to adopt appropriate refuse collection, treatment and final disposal systems, while also examining the potential for reuse and recycling. This process must be undertaken in conjunction with the state department under the Office of Public Health as well as other technical organizations.

In relation to the environment and public health, Article 75 states that the municipalities, within their official term and in accordance with general state policy, shall take specific control measures to mitigate environmental pollution according to the natural, social and economic conditions at that time.

f) Municipal Taxation Plan

The Municipal Taxation Plan is the fundamental tool which acts as an essential component to establish assessments, norms and procedures related to the taxation system for the municipal government of the Central District. It binds the municipal corporation to obtain annual approval for the Municipal Taxation Plan, which should conform with the Law of Municipalities.

In Article 4 of this plan, the Municipal Rate is defined as the payment made to the municipality by the beneficiaries of public services, so that financial resources are constantly maintained, accumulated and replenished.

Article No. 35 states that the service fees are based on the effective or potential loan (direct or indirect) of public services by the municipality to the taxpayer or the user.

In Chapter II: "Cleansing, Collection and Final Disposal of Solid Waste", under Article 43, the waste collection fees are set as being 0.00195 times the cadastre value of the property for households, with an annual ceiling of Lps. 300.00 and a minimum of Lps. 45.00. Furthermore, Article 44 specifies that for non-residential waste and special services, collection fees are set according to their nature and commercial activity.

Finally, it establishes the collection of other types of activities according to a table that relates it to the sales volume.

4.4.2 Organizational System

a. Organizational System of the AMDC

The organizational chart of the municipality of the Central District is presented in Figure 2-1. The chart illustrates the hierarchy and different divisions of the municipality, which are summarized below.

- 1) **Municipal Corporation:** this is the legislative assembly elected by the people and holds the highest authority within the municipal district. The Municipal Corporation of the Central District comprises the mayor and 10 counselors.
- 2) **Mayor:** the highest executive authority within the municipal district, responsible for the sanction of resolutions and decrees that the Municipal Corporation proposes, making them bylaws for the inhabitants and other authorities.

At the executive technical level, the general manager acts as the intermediary, coordinating between the political levels and the executive and operational levels.

The current administration of the Central District defines three major areas of action in the context of the municipal government, headed by 3 managers that constitute the high level executives.

The Management of Urban Development Office undertakes the construction and maintenance of the public works, regulates urban development, management of municipal public services, and is responsible for the application of laws and ordinances, and control of the environment.

The Management of Finances and Administration Office controls all aspects related to investment, budget allocation, control of revenue through taxation and its policies, accounting and administrative services, as well as purchasing supplies, etc.

The Management of Social Development Office monitors the relation between the municipal government and the community in relation to health, education, employment, sports, social participation and culture.

The current organizational system is based on the following maxims:

- Reestablish the authority level of the mayor in the municipal term of the Central District
- Initiate the modernization of the local government
- Streamline the municipal size through the reduction in the number of personnel. In the first phase from January – February 1998, the labor force has been trimmed from 4,000 down to 1,900 employees and in the final stage the number is estimated to be down as low as 1,250 employees.
- The reduction of personnel is aimed at reducing overall expenditure so that there will be more resources available for investment.
- An increase in revenue, paying special attention and providing an appropriate level of service to the "Major Contributors" that make up only 20% of the tax payers and yet contribute up to 80% of the municipal revenues.
- With the measures being taken to increase efficiency and a reduction in the size of the municipal government, there will be less fraud cases and the degree of corruption will therefore decrease.

The concept of the municipal administration is to adopt a more private-oriented and efficient administrative model under the guise of public management.

Its ultimate goal is to break away from the red-tapism that hinders the management of public services.

b. Organizational System of Cleansing Department

The current organizational system of the Cleansing Department of the Municipality of the Central District consists of a manager and five sections as described in the following.

At present, an outline of Cleansing Department's objectives and duties of its personnel are unavailable.

The proposed structure is similar to the existing one, which is consistent with the reforms at a municipal level, the objectives are simplicity, better control of the operations and reduction of unnecessary work positions.

4.4.3 Financial System

a. Financial System of the AMDC

The present financial system of the AMDC is precarious and this was also pointed out by the mission from the World Bank in 1998. Reliable financial data are very scarce. This may be attributed to having two different mayors in the space of one year. Many financial documents were lost during the transition period. Under such conditions, the team tried to find the actual financial situation by using the most reliable data at present.

In the fiscal year 1997, only 73% of the budgeted revenue was actually collected while 80% of the budgeted expenditure was spent, resulting in a deficit of Lps. 1.7 million. The deficit in 1997 was 60% of that incurred in 1996, however, there has been a deficit for the last three years. Accordingly, the accumulated deficit as of February 1998 reached Lps. 389 million, and is 1.5 times the total budget of the AMDC in 1997. A similar trend is observed in the budget executed in 1998, and therefore, solving the financial trouble is the most urgent issue for the AMDC.

The actual extent of tax collected to the potential amount collected in 1997 were analyzed and found that the collection rates of all taxes were very low. They were: 47% of the property tax; 46% of the personal income tax; 31% of the vehicle registration tax, respectively.

As for the waste collection fee, the collection rate of the residential waste fee, collected jointly with the property tax, was 49% and the collection rate of the non-residential waste collection fee, collected jointly with the business income tax, was 74%. The reason for the low rates can be attributed to the inability of the tax system to monitor and to collect taxes from people who have not paid their dues.

b. Waste collection fee

The waste collection fee is categorized as a service fee. While local tax rates are stipulated under the law, a service fee can be altered or abolished by setting by-laws.

In the Central District, 0.00195 of the fixed property valuation amount is collected for residential waste. In July 1998, the new waste fee tariff system, which consists of ten classifications in accordance with the fixed property values, was approved by the municipal council to be introduced from September 1998 (see Table 4-12). This led to an increase in the basic rate from Lps. 3.75/household/month to Lps. 5.00/household/month; the highest rate increased from Lps. 25/household/month to Lps. 200/household/month. Table 4-13 shows the waste collection fees for non-residential waste.

Table 4-12: Waste Fee Tariff for Residential Waste

Property Value	Lps./year/property	Lps./month/property
until 25,000	60.0	5.0
25,000.01 - 60,000	120.0	10.0
60,000.01 - 100,000	240.0	20.0
100,000.01 - 200,000	360.0	30.0
200,000.01 - 300,000	480.0	40.0
300,000.01 - 600,000	600.0	50.0
600,000.01 - 800,000	720.0	60.0
800,000.01 - 1,000,000	960.0	80.0
1,000,000.01 - 1,500,000	1,200.0	100.0
1,500,000.01 and over	2,400.0	200.0

Table 4-13: Fee Tariff and Waste Collection Fee for Non-Residential Waste

Category	Tariff
Agencies or bank branches, financial institutions and stock brokerages that do not declare an income	Lps.150.00
Law firms, medical consultants, all kinds of sales services carried out by natural entities, charitable institutions and other nonprofit organizations; those that do not affect the industry, trade, and service tax	Lps. 40.00
Institutions, enterprises, or business that declare zero	Lps. 25.00
Billiard parlors, per table	Lps. 20.00
Tire repair shop	Lps. 15.00
Lubrication shops	Lps. 50.00
Bar & Salon	Lps.25,001 -50,000 Lps.10,001 - 25,000 up to Lps.10,000
Bordello	more than Lps.50,000 up to Lps.50,000
Social clubs and other similar establishments	Lps. 100.00
Hotels, lodgings, pensions, boarding houses, apartments	with more than 100 rooms 51-75 rooms 26-50 rooms up to 25 rooms
Motels	Lps. 500.00
Laborers' living quarters or inns pay according to their income	more than Lps.10,000 up to Lps.10,000
Restaurants and coffee shops	higher than Lps.100,000 Lps.50,001-100,000 up to Lps.50,000
All other businesses pay for these services, on a monthly basis, according to their taxable annual income	more than Lps.4,000,000 Lps.3,000,001-4,000,000 Lps.2,000,001-3,000,000 Lps.1,000,001-2,000,000 Lps.500,001-1,000,000 Lps.300,001-500,000 Lps.100,001-300,000 Lps.75,001-100,000 Lps.50,001-75,000 Lps.25,001-50,000 up to Lps.25,000

Source: "Plan de Arbitrios", La Gaceta, 27 Dec.,1997

c. Collection Status of the Waste Collection Fee

The monthly collection amounts of the waste collection fee during 1997 are shown in Table 4-14.

Table 4-14: The Payment of Waste Collection Fee per Month

Month	With property tax	With business income tax	Total	
	(Lps.)	(Lps.)	(Lps.)	%
Jan.	125,706	3,992,451	4,118,157	20.7
Feb.	100,160	2,215,810	2,315,970	11.7
Mar.	89,227	655,335	744,562	3.8
Apr.	205,901	883,853	1,089,754	5.5
May	58,110	833,613	891,723	4.5
Jun.	65,134	729,478	794,612	4.0
Jul.	1,152,036	715,482	1,867,518	9.4
Aug.	3,024,032	533,741	3,557,773	17.9
Sep.	996,675	590,666	1,587,341	8.0
Oct.	908,995	587,260	1,496,255	7.5
Nov.	164,338	499,076	663,414	3.3
Dec.	142,469	596,451	738,920	3.7
Total	7,032,783	12,833,216	19,865,999	100.0

Source: The Cadastre Department of the AMDC

Half the waste collection fee is collected during the three months of January, February, and August.

The total waste fee revenue collected between January and July 1998, through joint billing with the fixed property tax and the business income tax, was Lps. 10,297,597, equivalent to 87% of the total waste fee revenue collected in 1997 during the same period. The waste fee revenue collected in 1998 before August has decreased, while revenues from the fixed property tax and the business income tax have increased to 1.37 times and 1.43 times the previous year respectively. The introduction of the new waste fee tariff, enforced from September 1998, lead to an increase in the invoiced amount to 1.7 times the previous year's record. The amount of waste fee collected in August and in September 1998 reached Lps. 11.2 million, equivalent to 2.2 times the collection amount during the same months in 1997. The new collection system, which gives a clearer indication of who has paid, and the tax payment campaign seem to have helped this increase.

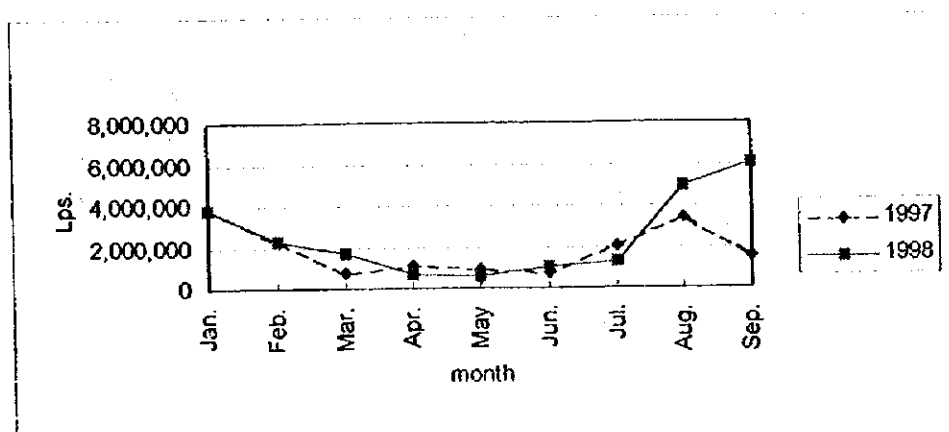


Figure 4-6: Comparison of Waste Fee Collected in 1997 and 1998

d. SWM Works Cost

The budget for SWM works in 1997 amounted to Lps.31.7 million including land purchase costs of Lps.16 million that was not used for SWM works.

The revised budget as of July 1998 is Lps. 15.3 million. By the end of July, Lps. 9.4 million (61.8% of the revised budget) was spent for SWM works. Since the expenditure for contracting out is assumed to increase in the future, the revised budget needs to be reviewed.

d.1 1998 Budget and Total Expenditure Amount from January through July

Expenditure for the major costs was compared with its budget as shown in Table 4-15.

Table 4-15: Comparison of 1998 Budget for Major Costs with Expenditure from January through July (Expenditure in Cleansing Department)

(Unit: Lps.)

Items	1998			1997*
	Budget (A)	Actual Cost until July (B)	% (B/A)	Actual Cost
Personnel Expenses	6,760,320	3,993,972	59.1	9,313,852
- Salary	5,250,320	3,548,972	67.6	7,263,008
- Overtime work	950,000	444,756	46.8	750,593
- Others	560,000	0	0.0	1,300,251
Services	3,993,000	2,724,226	68.2	1,293,000
- Rental cost of Equipment	869,000	300,500	34.6	?
- Contracting out	3,112,000	2,422,098	77.8	?
- Others	12,000	1628	13.6	?
Materials & Supplies	4,376,675	2,665,780	60.9	6,344,632
- Fuel & Lubricant	3,000,000	1,716,639	57.2	3,467,741
- Spare parts	484,109	317,921	65.7	1,904,841
- Others	892,566	631,220	70.7	972,050
Machine & Equipment	34,160	32,370	94.8	?
Others	124,000	32,401	26.1	148,166
Total	15,288,155	9,448,749	61.8	17,699,650

Note: * Estimated by JICA Study Team according to the data given by the Cleansing Department
Source: Financial Department in the AMDC.

The following points are determined from the above table.

- 1) Although the overall personnel expenses during the first seven months were within the budget allocated for this period, so far, spending on salaries have already exceeded its allotted budget.
- 2) Service cost have also exceeded its budget allocated for the first seven months. In particular, expenses for contracting out street sweeping and others services have reached the amount allocated for nine months (i.e., three quarters of the annual budget).
- 3) So far, costs for materials and supplies are on par with the amount apportioned in the annual budget. This is because the cost of fuel remained within its budget, although others exceeded the budget substantially.
- 4) In the first seven months alone, costs for machines and equipment have almost reached the amount allotted for this year (1998). Both depreciation costs and cost for contracting out collection service were excluded.

d.2 Cost Assumption for SWM Works per Cleansing Service

As the Cleansing Department of the AMDC does not keep separate accounts per cleansing service, the cost for each cleansing service was estimated based on the data obtained from the Cleansing Department as follows.

d.2.1 Spare parts, Fuel & Lubricants

The cost incurred for spare parts, fuel, and lubricants is calculated for each vehicle every month. Table 4-16 shows the total costs incurred for spare parts, fuel, and lubricants from January through June 1998.

Table 4-16: Spare parts, Fuel, and Lubricant Costs from January through June in 1998

Unit: Lps

	Total	Collection	Disposal
Spare Parts	645,810	562,575	83,235
Lubricant	259,798	220,538	39,260
Fuel	1,583,243	1,335,808	247,435
Total	2,488,851	2,118,921	369,930
cf. Total in 1997	5,372,682	5,007,056	365,626

Source: Gasto de Lubricantes y Repuestos de las Unidades Recolectoras de Basura (Monthly), Cleansing Department in the AMDC

The aggregate amount, shown in the table above, reached approximately 1.5 times (Lps. 1,689,894) the amount estimated by the Financial Department for January through June. Although the cost for spare parts, fuel, and lubricants for the collection service reached only 40 % of that in 1997, their costs for final disposal services have already equaled the costs incurred during 1997.

d.2.2 Personnel Expenses per Job Category and Number of Employees per Cleansing Service (as of July 1998)

Based on the salary record book, the personnel expenses per job category were totaled. Staff turnover is high, and the number of employees was down to 278, at the end of July 1998, from 451, recorded at the end of December 1997.

(1) Number of Employees per Cleansing Service

The number of employees per cleansing service, as of the end of July 1998, is shown in Table 4-17.

Table 4-17: Number of Employees per Cleansing Service (As of July 1998)

Description	Administration	Collection	Street Sweeping	Disposal	Workshop	Total
Officers & Operators	2	1	1	1	1	6
Secretary and others	11	0	0	0	0	11
Drivers	0	47	0	1	0	48
Workshop Mechanics	0	0	0	0	4	4
Assistant Mechanics and others	0	0	0	0	5	5
Inspectors	0	0	16	0	0	16
Supervisors	1	0	2	1	1	5
Foremen	0	0	17	0	0	17
Sub-foremen	0	0	7	0	0	7
Street Sweepers	0	0	96	0	0	96
Cleansing Assistants	0	54	0	0	0	54
Landfill Assistants	0	0	0	2	0	2
Heavy Equipment Operators	0	0	0	2	0	2
Union Official (STRAMUDIC)	5	0	0	0	0	5
Total	19	102	139	7	11	278
cf. December in 1997	21	170	222	13	25	451

Source: Information obtained from the Cleansing Department of the AMDC.

(2) Assumption of Personnel Expenses per Job Category

(a) Salary

Table 4-18 shows salary per job category and per cleansing service.

Table 4-18: Salary per Job Category and per Cleansing Service

Description	Administration	Collection	Street Sweeping	Disposal	Workshop	Total
Officers & Operators	16,000	6,000	4,500	8,000	2,500	37,000
Secretary and Others	20,900	0	0	0	0	20,900
Drivers	0	92,600	0	2,200	0	94,800
Workshop Mechanics	0	0	0	0	7,800	7,800
Assistant Mechanics and Others	0	0	0	0	7,900	7,900
Inspectors	0	0	25,100	0	0	25,100
Supervisors	2,330	0	3,500	1,600	4,000	11,430
Foremen	0	0	26,300	0	0	26,300
Sub-foremen	0	0	9,400	0	0	9,400
Street Sweepers	0	0	114,800	0	0	114,800
Cleansing Assistants	0	64,950	0	0	0	64,950
Landfill Assistants	0	0	0	2,500	0	2,500
Heavy Equipment Operators	0	0	0	3,900	0	3,900
Union Official (STRAMUDIC)	27,960	0	0	0	0	27,960
Total	67,190	163,550	183,600	18,200	22,200	454,740

Source: Information obtained from the Cleansing Department of A.M.D.C.

(b) Assumption of Personnel Expenses per Cleansing Service (January - June 1998)

Personnel expenses from January through June 1998 were estimated based on the salary per job category and per cleansing service. Bonus and overtime work (including working on holidays) were assumed to be 15% and 13% of the salary respectively. The aggregate personnel costs shown in Table 4-19 is almost equivalent to the AMDC Financial Department's budgeted amount (Lps. 3,497,639) for January through June.

Table 4-19: Personnel Costs per Cleansing Service for the First Six Months in 1998

(Unit: Lps.)

Description	Administration	Collection	Road Sweeping	Disposal	Workshop	Total
Salary	403,140	981,300	1,101,600	109,200	133,200	2,728,440
Bonus	60,471	147,195	165,240	16,380	19,980	409,266
Overtime & Paid Holiday	52,408	127,569	143,208	14,196	17,316	354,697
Total	516,019	1,256,064	1,410,048	139,776	170,496	3,492,403
cf. Total in 1997 (Half of 1997)	915,590 (457,795)	3,456,471 (1,728,235)	4,037,723 (2,018,862)	338,542 (169,271)	565,526 (282,763)	9,313,852 (4,656,926)

Note: Calculated by JICA Study Team

(3) Cost Assumptions for SWM Works per Cleansing Service

(a) Allocation of Personnel Expenses to the Administrative Section and Workshop

Based on the costs for spare parts, fuels and lubricants, and the personnel expenses per cleansing service as shown above, the cost for each cleansing service was estimated, as shown in Table 4-20. The method used for determining the breakdown of personnel expenses in the administrative section and the workshop are described below.

- The breakdown of personnel expenses in the administrative section were determined by using the ratio for individual personnel expenses, i.e., collection, street sweeping, and disposal.
- The breakdown of personnel expenses for the workshop was determined using the ratio of the cost of spare parts for collection and disposal.

Table 4-20: Costs per Cleansing Service from January through June in 1998

(Unit: Lps.)

Items	Total	Transportation and Collection		Disposal Final
		Collection	Street Sweeping*	
Spare parts	645,810	562,575		83,235
Lubricant	259,798	220,538		39,260
Combustible	1,583,243	1,335,808		247,435
Personnel Cost for Each Service	2,805,888	1,256,064	1,410,048	139,776
Distribution of Administration cost	915,590	409,867	460,113	45,610
Distribution of Workshop Cost	170,496	148,522		21,974
Total	6,380,825	3,933,374	1,870,161	577,290

The wastes collected by sweeping service are transported with domestic waste or market waste. There is no data about the volume of waste collected by sweeping service, therefore the costs of spare, lubricate and combustible are not divided to the sweeping service

(b) Cost Assumption for Contracting Out

The collection services in the southern part of Tegucigalpa and in part of the markets were contracted out to a private company from June 1998. However, payment has not yet been made by the end of September 1998. Therefore, in this report, a vehicle rental fee Lps. 300,500 (data was provided by Financial Department of AMDC) is used as the cost for contracting out for January through June. Cost for contracting out is estimated to reach Lps. 7,524,000 with the recent collection amount of 150 tons/day on average for six months.

$$150 \text{ (ton/day)} \times 22 \text{ (days)} \times 380 \text{ (Lps./ton)} \times 6 \text{ (months)} = 7,524,000$$

Street sweeping has been contracted out with Lps. 62,000/4 months for one contracted area from March, 1998. As of the end of July, 43 areas are contracted out.

Table 4-21: Expenditure for Street Sweeping Work until June in 1998

Month	No. of Contracted Areas	Contracting out Amount (Lps.)	Collected Amount (Lps.)
March	15	930,000	930,000
April	21	1,302,000	976,500
From April to June	7	434,000	217,000
Total	43	2,666,000	2,123,500

The amount which was contracted out, in total, shown in the table above reached about 1.7 times the Financial Department's estimate for various services, i.e., Lps. 1,572,138 for January through June. The amounts shown in the above table were adjusted for the unit cost calculation.

(c) Expenditure in 1998 until June

The unit costs were estimated as shown in Table 4-22 based on the above said conditions.

Table 4-22: Expenditure for SWM Works from January to June in 1998

Unit: thousand Lps.

Items	Expenditure from January to June in 1998				
	Personnel	Spares, Fuel & Lubricant	Contracting out	Others	Total
Collection & Haulage	1,256,064	2,118,921	257,571		3,632,556
Street Sweeping	1,410,048		2,123,500		3,533,548
Final Disposal	139,776	369,930			509,706
Others	686,515			597,959*	1,284,474
Total SWM Works	3,492,403	2,488,851	2,381,071	597,959	8,960,284

Note: * The costs excluding personnel costs, spare, fuel & lubricant, rental costs and various services for seven months from January until July in 1998 were Lps.697,619. Therefore the cost for six months is Lps. 597,959,000.

(d) Unit Cost Calculation

The expenditure and unit costs for solid waste management work in 1997 are summarized in Table 4-23.

Table 4-23: Unit Costs for Solid Waste Management Work in 1997

Items	Expenditure million Lps	Amount of Waste ton/year	Unit Cost	
			Lps./ton	US\$/ton*
Collection & Haulage	9.4	112,816	83.6	6.40
Street Sweeping	4.5	N.A.	N.A.	N.A.
Final Disposal	0.7	135,923	9.1	0.40
Others	3.4	N.A.	N.A.	N.A.
Total SWM Works	18.0	135,923	132.4	10.03

Note: 1 US\$ = Lps.13.2

The expenditure and unit costs for solid waste management works in 1998 are summarized in Table 4-24.

Table 4-24: Unit Costs for Solid Waste Management Works in 1998

Items	Expenditure million Lps	Amount of Waste ton/6 months	Unit Cost	
			Lps /ton	US\$/ton*
Collection & Haulage	3.6	51,480	70.6	5.23
Street Sweeping	3.5	N.A.	N.A.	N.A.
Final Disposal	0.5	61,740	8.3	0.61
Others	1.3	N.A.	N.A.	N.A.
Total SWM Works	8.9	61,740	145.1	10.75

Note: 1 US\$ = Lps.13.5

Unit cost for total SWM works increased by 7% compared with 1997. The cost for collection service is lower than that of 1997. However, the cost for collection service might increase rapidly depending on the volume of contracting out since the contracting out price is Lps. 380/ton, which is nearly six times more expensive than that of the A.M.D.C. As the result of contracting out to the micro enterprise, cost for street sweeping service for half a year is almost 80% of one full year in 1997. Moreover, unit cost for final disposal service increased by 1.5 times of last year. If sanitary landfill is practiced, the cost is assumed to increase.

(e) Assessment of the Financial Situation

The actual revenue from the waste collection fee seems to be sufficient to cover the actual expenditure consisting of only operation and maintenance. However it is not sufficient to cover expenses including the depreciation cost.

The current SWM unit costs of the Cleansing Department are considered to be very cheap, although a large portion of the SWM cost is occupied by fuel, lubricant oil, and spare parts expenditures. Their prices are similar worldwide as they are determined in the international market, and the SWM costs in most development countries exceed US\$ 10 per ton, excluding the depreciation cost. The reason why the SWM works is currently managed at a low cost by the AMDC is due to the equipment and spare parts granted in 1993. This is supported by the fact that the SWM unit cost by the operation of leased vehicle is Lps. 294/ton.

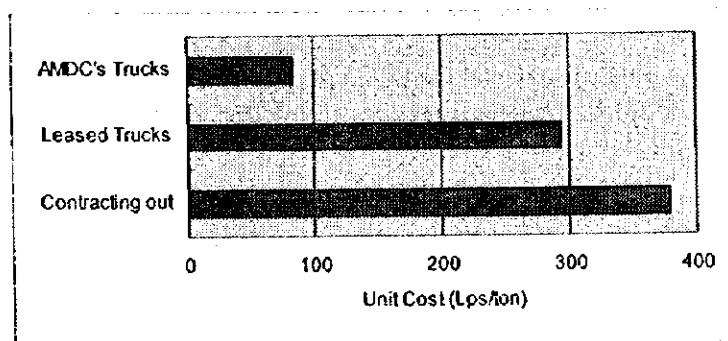


Figure 4-7: Comparison of Current Unit Costs for Waste Collection and Haulage

Since the expenditure for spare parts and fuel overshoot the budget by a large amount, the review of the collection route plan and analysis of fuel consumption costs per vehicle are required.

Occasionally, the AMDC is short of funds for overtime payment as well as for spare parts, etc. because of the extremely critical financial situation of the AMDC and the

concentration of revenue in January, February and August. It is, therefore, essential to enhance the revenue plan for the whole AMDC to enable the SWM works to stabilize, and especially to establish a monitoring system as well as to collect waste collection fees that are long overdue.

4.4.4 Management System

a. Data Control System of Collection and Disposal Waste Amount

The number of trucks hauling waste into the final disposal site is counted and recorded by the Cleansing Department. This is the only data being monitored concerning the collection and disposal amount. Because of the absence of a weighbridge to measure the waste amount at the entrance of the disposal site, the Cleansing Department estimates the amount of waste collected and disposed based on this data. The Study Team discovered that the conversion factors currently used by the Cleansing Department, to determine the weight from the number of trips, exceeds the actual figure by approximately 30%, on average. The present monitoring system of the waste amounts is, therefore, assessed to be unreliable. In addition, the collection amount for each collection area and each vehicle are not monitored at all.

b. Supervision System

The number of staff and vehicles for supervision purposes is insufficient. In addition, the work efficiency data is not recorded. Supervision is, therefore, assessed to be absent. It is essential to improve supervision in order to raise the productivity of collection, haulage and street sweeping activities.

c. Cost Control and Cost Analysis System

The costs for materials such as diesel fuel, lubricant oil, spare parts, etc., are recorded and summarized for every vehicle each month. This cost recording system is assessed to be in order. As for the labor costs, the working hours of only the staff in the Cleansing Department (approximately 50 people) are kept. The working records of about 200 employees are not kept.

Although the data of material cost is kept in order, it is not analyzed as with the labor cost. This should be rectified in order to understand the actual condition and to take appropriate measures.

d. Planning System

There is no section or department in AMDC to prepare a short term or long term plan for solid waste management. Considering the complexity and difficulty of solid waste management, the importance of planning and taking a strategic approach is becoming more apparent.

4.5 Assessment of the Current SWM

4.5.1 Technical System

At present, the most prevalent SWM technical system in the Study Area is rudimentary, composed only of collection and haulage of waste, mainly using compactors and dump trucks, and final disposal; it is exclusive of major processing, intermediate treatment or recycling systems. This system is basically appropriate for the Study Area as long as the acquisition of land for the disposal site is financially and/or socially unproblematic. However, considering the worldwide trend which incorporates conservation issues into solid waste management, a recycling system should be introduced gradually so long as it does not affect the financial sustainability of the cleansing work.

Considering the fact that the present waste collection coverage rate in the city has reached 64% and the standard of cleanliness is generally maintained, the present waste collection service level is assessed to be fair except in areas that do not receive a regular waste collection service. It is often the case that these are low income residential areas, where lack of a frequent service has left unhygienic conditions which have often been blamed for outbreaks of dengue fever. The expansion of a regular waste collection service, therefore, should be a continuous endeavor.

As for the collection and haulage system, the present compactor collection system functions adequately, however the present collection and haulage plan can be seen as inappropriate because the allocation of the present collection areas has no rational explanation. The efficiency of the dump truck collection system was found to be average; the reason is not only attributable to the type of vehicle used but also inferior road conditions, low accessibility, lack of people's cooperation in discharging manner, etc. In order to improve the general collection work efficiency, various measures, for example promoting a more conscientious discharge manner, phasing-out the dump truck collection system and replacing it with a more appropriate system, etc. should be examined.

The present recycling activities rely mainly on scavengers operating at the disposal site and collection workers' sorting work. Although both activities contribute to recycling, they are informal and also imposes negative impacts to the present solid waste management system. It is, therefore, necessary for the governmental organizations to gradually participate in recycling and strengthen the control of informal recycling activities.

As for the final disposal system, no appropriate environmental protection measures are currently taken except soil coverage. Also, bulldozers operating at the landfill are not provided with sufficient amounts of diesel fuel and entry of scavengers to the site is unprohibited. Therefore, the condition of the disposal site is unacceptable. On examination of the environmental impact the disposal site poses on its environs, it is observed that the flow of leachate from the disposal site is very minimal and the generated leachate percolates into the ground before reaching the Choluteca River. It can be predicted that the impact by leachate would be marginal because the water quality of Choluteca River are far greater and worse than the leachate from the site. This is due to the discharge of raw sewage from Tegucigalpa and Comayaguela into

Choluteca River upstream from the disposal site. In addition, the existing disposal site is located far from the water basins for the Central District. Consequently, it is concluded that the existing disposal site does not pose a serious threat to the surrounding environment. However, there are some considerable negative effects caused by nuisances, offensive odors, and unsightly view etc. because it faces the main road: the number of critics to the final disposal site is on the rise.

The existing disposal site area is 31.7 hectares, of which only 12 hectares are currently used for landfilling. Even though the final waste disposal amount is predicted to increase in future, the site has the capacity to receive waste generated in the Study Area until 2006. The existing disposal site has a favorable natural condition in terms of environmental protection and haulage of waste. The sanitary condition will be enhanced by improving some facilities, training staff in operation techniques and raising awareness among the municipalities' staff and citizens. Therefore, the best option is considered to be the utilization of the existing disposal site, for as long as possible, providing the landfill operation level is improved. In addition, planning and construction of a new final disposal site should proceed deliberately while the existing disposal site has a reserve.

All street sweeping work is carried out manually and it is effectively supported by many trash boxes recently installed along the streets. In consideration of the general cleanliness within the city that is maintained by an appropriate number of street sweepers, it is judged that the present system is appropriate except the collection system of street sweeping waste.

As for maintenance of equipment, the present technical system is believed to be suitable, considering the high operation rate of compactor trucks and the fact that many ten year-old FIAT compactors still function. However, repair works often take quite a long time. This is mainly due to the inherent bureaucracy that has a disposition to long processing procedures before spare parts are purchased.

4.5.2 Institutional and Organizational System

A comprehensive analysis of all the organizational structure that serves as basis for the cleansing service is shown as follows.

a. Legal Framework

Legislation related to SWM is found in a variety of laws, regulations, and decrees. Consequently, there is no specific legal framework to help develop SWM, creating a situation that undermines the authorities' position to manage the services effectively.

b. Institutional Structure

Figure 4-8 illustrates the structural organization of the AMDC's Cleansing Department. Although the service provided by this institution is very important and it is responsible for hundreds of workers, vehicles, and important funds, the hierarchic level of this section is comparatively low-ranking, affecting its ability to plan, manage, and operate services appropriately.

This situation leads to slow decision making and prolonged administrative transactions, specially for acquisition of spare parts for vehicles and machinery, as a result productivity is affected.

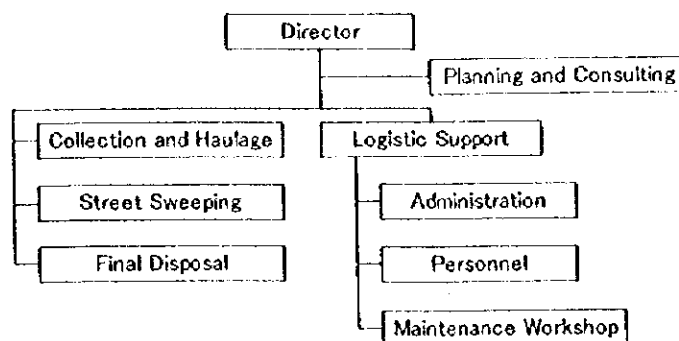


Figure 4-8: Present Organizational Structure of The Cleansing Department

c. Structure Organization for the Cleansing Department

An analysis of the results obtained during this study revealed that there is considerable weakness on the operation and the administrative structure in this section.

- Goals and objectives are poorly defined by this section; and because of this situation officials become confused, thus creating a situation where activities are uncoordinated.
- There are neither service plans nor medium and long term development plans. Authorities have not emphasized the importance of cleansing services, personnel transfer takes place with each new administration, and, as a result, there are very few plans and programs to cater for medium and long term service needs. An obvious consequence is that the system is only able to administer day to day issues, and problems are left to workers who have been with the institution over a longer period (driver and mechanics).

The following situations show the results of the institutional and organizational weakness:

- Insufficient coverage of marginal areas.
- Unbalanced collection routes.
- There is neither punctuality nor order with respect to frequencies and schedule.
- Low productivity of collection vehicles and machinery due to delays in spare parts acquisition.
- Lack of preventive maintenance.
- The dumpsite deteriorates the environment and jeopardizes public health.
- The real service cost is unknown.
- Human resources lack motivation.

d. Public Participation

It is important to note that recently there has been a change in the public's image and perception of SWM. The AMDC has been making efforts to improve the cleanliness of the city. However, this initiative should be taken together with the institution's structural reform so that the development of this public service becomes an ongoing venture; and with time, the public will be inclined to be supportive and loyal to the institution's cause.

4.5.3 Financial System

Regarding the financial situation of SWM works in 1997, the revenue from the waste collection fee, i.e. Lps. 20 million, seemed to be sufficient to cover the expenditure, which was Lps. 18 million.

However, expenditure including depreciation for vehicles and equipment donated in 1993 was Lps. 25 million, that was 1.4 times the expenditure. Considering the fact that more than 15 US\$/ton is necessary to provide sufficient collection services and more than 3 US\$/ton is necessary to dispose these waste in developing countries, at least Lps. 36 million was needed to provide sufficient SWM in the Central District.

The actual collection rates of the waste collection fees in 1997 were 49% for residential waste collection fee, which is collected jointly with the property tax, and 74% for the non-residential waste collection fee, which is collected jointly with the business income tax. Even if the collection rate of waste collection fees reach 100%, the total revenue will be Lps.32 million; it is insufficient to operate SW services and to finance the replacement of equipment.

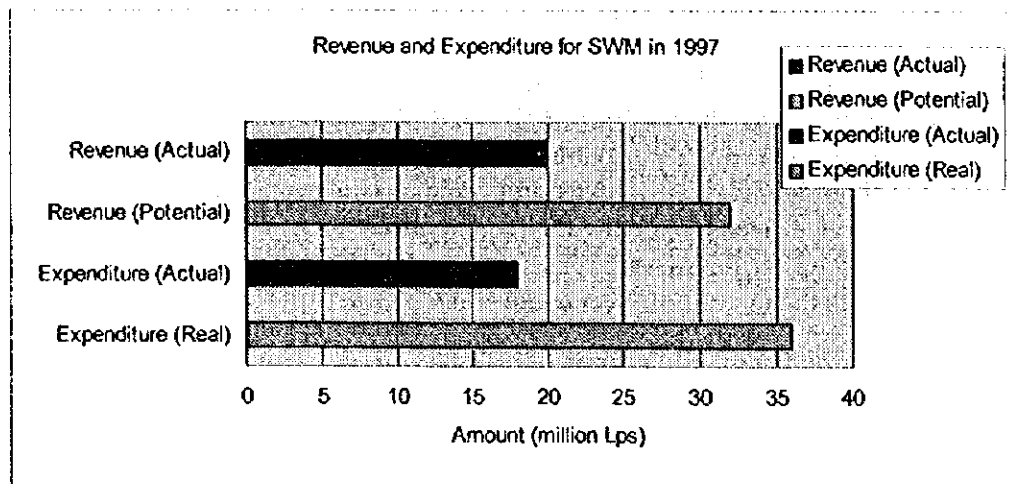


Figure 4-9: Revenue and Expenditure for SWM in 1997

The reason why the SWM works are currently managed at a low cost by the AMDC is mainly for the sake of equipment and spare parts granted in 1993. Although four years have passed and these equipment are due for renewal, no replacement plan is being prepared because the financial situation of the AMDC is extremely critical. The solid waste management works are likely to be in disarray with the expiration of the equipment's lifespan.

4.6 Identification of Important Issues

From investigations during the first phase of the study, the following five points were identified as the most important issues in the current solid waste management system.

- 1) To establish a financially sustainable and accountable solid waste management system.
- 2) To enhance the sanitary level of the existing final disposal site and to prepare an overall development plan.
- 3) To enhance the managerial capability of the Cleansing Department.
- 4) To plan appropriate collection, haulage and street sweeping systems and to establish an appropriate collection system for problematic areas.
- 5) To raise awareness among the AMDC's staff and citizens on solid waste management.

a. To Establish a Financially Sustainable and Accountable Solid Waste Management System

Currently, the revenue generated from the waste collection fee only covers the operation and maintenance costs of the overall solid waste management system. The reason why the solid waste management works for the Central District is managed arbitrarily is because the waste collection vehicles, equipment for final disposal site and spare parts were provided under the Japanese grant aid program in 1993. Although four years have passed and these equipment are soon due for renewal, no replacement plan is being prepared because the financial situation of the AMDC is extremely critical. The solid waste management works are likely to collapse with the expiration of the equipment's lifespan.

However, it is too difficult to further reduce the present SWM cost because the present costs are already very low.

In addition, although the citizens demand the AMDC for improvements, such as the enhancement of the sanitary level of the final disposal site and to expand a regular waste collection service, all new projects require additional cost.

Therefore, this is the most fundamental issue surrounding solid waste management in the Central District. In exchange for the public's acceptance and support to increase revenue, the AMDC will be obliged to provide citizens with a more accountable and transparent solid waste management system, which is absent at present. Therefore, these issues have to be established concurrently.

b. To Enhance the Sanitary Level of the Existing Final Disposal Site and to Prepare an Overall Development Program

Currently, the operation level of the final disposal system is far below the collection and haulage system. This is due to the indifference among the AMDC's staff and citizens toward the final disposal system because problems related to final disposal are not highly regarded.

Criticisms to the unacceptable operation conditions of the final disposal site are on the rise. If the AMDC does not remedy this situation, serious negative impacts are to be expected. For example, the surrounding environment will deteriorate, which will lead the neighbors to repudiate and reject the construction of a new disposal site by the AMDC, etc. To avoid such difficulties from arising, the AMDC must enhance the sanitary level of the final disposal site.

Fortunately, the existing disposal site has a favorable natural condition in terms of environmental protection and haulage of waste. It is not difficult to enhance the sanitary condition of the existing disposal site by constructing a few facilities, training staff in operation techniques, raising awareness among the municipalities' staff and citizens, etc. Considering the fact that the final disposal site is the most important issue in terms of the SWM technical system, to make the whole system stable improvement measures should be taken urgently.

c. To Enhance the Managerial Capability of the Cleansing Department

This study found the actual waste disposal amount to be half the amount estimated by the Cleansing Department. Also, the number of customers in each collection area is unknown. However, although the costs are well documented, they are not analyzed and utilized for the improvement of operation and planning. Repair works often take a long time, this is mainly due to the inherent bureaucracy that has a disposition to long processing procedures before spare parts are purchased.

Solid waste management works change daily; swift decisions and prompt actions are required to conduct SWM smoothly and to minimize the cost. To achieve resolute action, decision makers have to always interpret the present conditions correctly, however, there is no system in place to help understand the present situation. Therefore, at present it is very difficult to execute the works efficiently.

d. To Raise Awareness Among the AMDC's Staff and Citizens on Solid Waste Management

The current climate surrounding solid waste management is complex and does not allow an executing agency to just collect and carry waste to the disposal site for dumping. A successful solid waste management requires competent human resources, sufficient funding, citizens' cooperation, strong commitment by those responsible for SWM, etc. Public education on solid waste management coupled with other measures is, therefore, essential for its success.

One of the reasons why the sanitary condition of the disposal site is poor is due to the lack of awareness among the AMDC's staff and citizens, because the expenditure for the disposal site is much less than that for the collection and haulage work. This is because people generally lack interest in what happens out of sight.

Solid waste management is an integral part of urban life: people have to understand the importance of solid waste management and the responsibilities that come in hand. However, strategic programs related to this subject are not executed.

Consequently, in order to succeed and enhance the solid waste management system, one of the more effective means is the preparation and introduction of a strategic education program on solid waste management.

c. To Plan Appropriate Collection, Haulage and Street Sweeping Systems and to Establish an Appropriate Collection System for Problematic Areas

The present collection and haulage cost is very cheap, therefore, further cuts in the present costs seem to be unrealistic. However, the cost is increasing rapidly because the wage standard is on the rise. At present the labor cost occupies more than 50 % of the total SWM cost, however this percentage is expected to increase in proportion to the rise in wage standard, while the equipment and fuel costs, which are determined in international markets, will remain constant. The time to shift from a labor intensive system to a mechanized approach will not be in the distant future. It is, therefore, necessary to monitor and to analyze the costs carefully and to take appropriate actions in time.

In addition, another issue is the expansion of the waste collection system into problematic areas. This is an important task for the AMDC, which is responsible for waste collection in the Central District. However, this operation is associated with various problems as the required waste collection cost is more expensive due to the harsh physical conditions, while people who live in these areas are unable to pay for the services. It is, therefore, necessary to establish an appropriate collection system for problematic areas.

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Part 2

The Municipal Solid Waste Management Master Plan

Chapter 5

*Selection of the
Best Technical System*

5 Selection of the Best Technical System

5.1 Policy for Selection of the Best Technical System

5.1.1 Criteria for Selection

Considering the current situation and background of SWM in the study area, the following are policies for the selection of a technical system:

- 1) Systems and technologies to be adopted should be simple so that operation and maintenance are easy and inexpensive.
- 2) Foreign finance requirements for the purchase, operation and maintenance of facilities should be minimal. The use of locally available materials and services should be maximized.
- 3) Technical system proposals have to be consistent with the institutional requirements to ensure their efficiency.

5.1.2 Selection Procedure of the Best Technical System

An SWM technical system consists of various technical subsystems such as discharge and storage, collection and haulage, processing, recycling, street sweeping, final disposal, etc. A number of alternatives can be formed from the combination of these various subsystems. Hence, selection of the best technical system will be carried out according to the following procedures.

1. Examination of preconditions for selection of subsystems.
2. Identification of potential subsystem technologies for the study area.
3. Screening potential subsystem technologies.
4. Comparison of estimated unit waste collection and haulage costs for each vehicle type.
5. Selection of an optimum technical system.

5.2 Examination of Preconditions for Selection of Subsystems

The establishment of the best technical system is mainly influenced by the location and number of proposed disposal sites, that was determined based on the following policies established by the AMDC for the study in March 1998.

The existing final disposal site shall be utilized for as long as possible by improving the sanitary level and by making use of the whole site in the most effective manner.

A new final disposal site shall be constructed before the existing site is completely filled. The new site shall be sited in a location not too far from the city center so that the waste haulage distance will not exceed 15 km.

5.3 Identification of Potential Subsystems for the Central District

The screened potential subsystems for the Central District are listed in Table 5-1.

Table 5-1: Potential Subsystems for SWM in the Central District

Technical Systems	Technical Sub-systems	Sub-system Components
Discharge and Storage	• Source Separation	• Mixed discharge • Separate discharge
	• Type of Storage Equipment	• Paper or plastic sacks • Dustbins • On-site waste storage • Containers (1 to 2 m ³) • Large communal containers (more than 5 m ³)
Primary Collection	• Type of Collection System	• Handcart • Animal drawn cart • Pedal cart • Motorized cart
Secondary Collection and Haulage	• Collection Frequency	
	• Collection Method	• Mixed collection • Separate collection
	• Collection System	• Point collection • Curb side collection • Door-to-door collection • Bell collection • Public container collection
	• Collection Schedule	• Day collection • Night collection
	• Collection Vehicle	• Compactor truck • Tractor and trailer • Dump truck • Detachable truck
	• Transfer Station	
Street Sweeping	• Cleaning Method	• Manual street sweeping • Mechanical cleaning • Vacuum cleaning • Flushing
Processing and Treatment System	• Incineration	
	• Refuse Derived Fuel (RDF)	
	• Biogas Production	
	• Pyrolysis	
	• Composting	
	• Size Reduction	
	• Mechanical and Manual Sorting	
Recycling	• Government Related	
	• Private Sector Centered	
Final Disposal	• Method of Sanitary Landfill	
Maintenance of Vehicles and Equipment	• Preventive Service Workshop	
	• Full Service Workshop	

5.4 Screening Potential Technologies

5.4.1 Discharge and Storage System

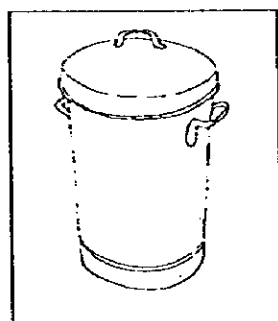
a. Introduction

Waste is generated on a somewhat continuous basis. However, collection occurs intermittently, a few times a week or perhaps daily, depending on the quantity generated at a specific location and climatic conditions. Therefore, it is necessary to provide proper on-site storage for waste until it is collected. Storage is quite important because it can have a significant effect on:

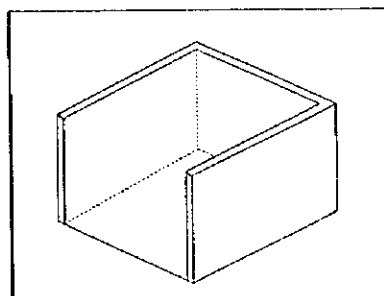
- Public health and aesthetic conditions.
- Subsequent functional elements such as collection.
- Public attitudes concerning the operation of the system.

The effects on these aspects vary depending on the generation source, i.e., residences, shops, office buildings, etc.

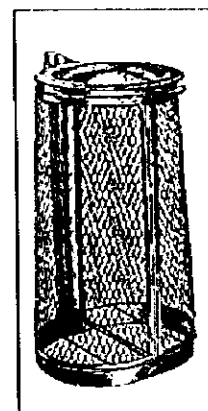
Accordingly, this section deals with on-site handling and storage systems available for the study area.



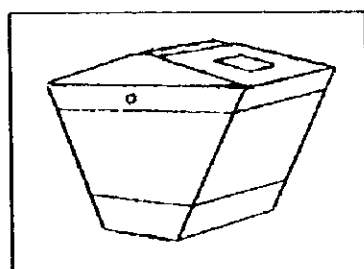
Dustbins



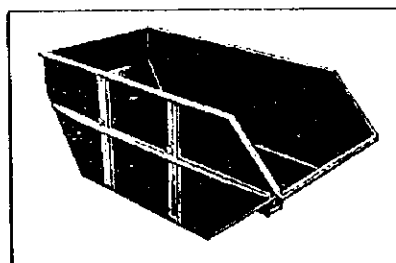
On-site Waste Storage



Paper or Plastic
Sacks



Containers (1 to 2 m³)



Large Communal Containers



Rampa (Waste Storage Hopper)

b. Conclusion of the Storage System

The absence of a proper waste storage system in the study area is one of the main reasons behind the inefficient waste collection work. To rectify these conditions, proper handling and storage systems should be introduced.

The plastic dustbin system is recommended but the use of metal drums should be discontinued.

The system whereby the waste is stored on-site is generally not recommended for residential and commercial areas, unless users are willing to shoulder the required extra costs and to maintain the storage area properly.

The large container system requires a huge investment but contributes to the reduction of large collection and haulage operation costs. However, this system is only recommendable if the problem of initial investment can be solved. The size of containers shall be determined according to their purposes and distribution. These containers are usually placed at collection points for markets and areas that have been developed without any prior planning and therefore inaccessible to waste collection vehicles. If containers are placed in residential or commercial areas, they can encourage people to discharge more waste, furthermore they can attract business people to place their wastes generated through business activities. Therefore, the method of container use requires careful considerations.

The plastic sack system that is currently in widespread use is appropriate and this system used concurrently with a waste stand is also appropriate.

The waste storage hopper system is very appropriate for markets.

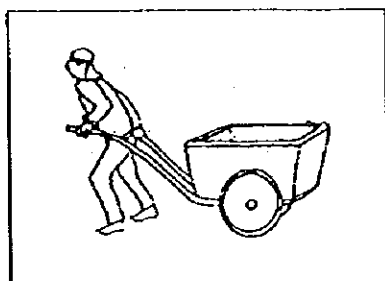
The use of a skip or plastic sacks highly depends on the collection and haulage system to be adopted. Therefore, the best storage system shall be selected from these two systems in line with the proposed collection system.

5.4.2 Primary Collection

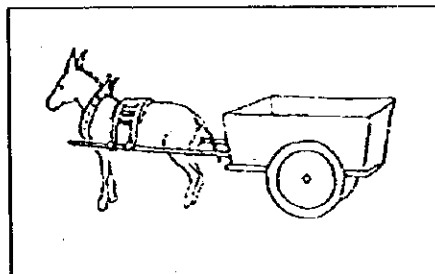
a. Introduction

In areas with inaccessible roads, waste has to be carried to designated points for collection. People living near collection points find it easy to discharge waste by themselves, but those further away have difficulties doing so. Therefore, a primary collection service, which is the haulage of waste from residences to collection points, should be established for the latter.

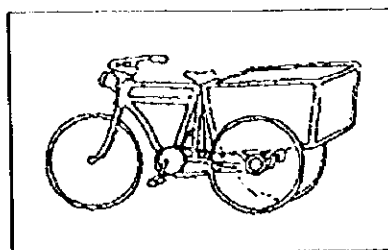
This section discusses the suitability of several potential systems for the area.



Handcarts



Animal Drawn Carts



Pedal Cart

b. Conclusion of the Primary Collection System

The primary collection system to be selected must require as little capital as possible because the fees for collecting waste through this system, based on the number of trips, are expensive in itself and also the areas proposed for this system have a limited financial capability. The mode of haulage shall also be maneuverable because the roads in areas where primary collection is needed are unpaved, very steep, and very narrow.

In conclusion, the handcart and the pedal cart systems are considered to be most suitable for the Central District.

5.4.3 Collection and Haulage System

a. Introduction

The objective of the waste collection and haulage system is to collect and to haul waste from specific locations to a disposal site at regular intervals, with minimal cost and in a reliable manner, and with due considerations for sanitary conditions. It is very important to always bear in mind that the cost for the collection and haulage of waste is by far the most expensive part of the overall waste management system.

b. Conclusion of the Collection and Haulage System

The appropriate collection and haulage system for the Central District is concluded as follows.

- | | |
|----------------------------------|--|
| Collection frequency: | • 2 or 3 times per week |
| Collection method: | • Separate discharge with commingled waste collection system |
| Collection system: | • Point collection for marginal areas
• Curb collection for standard residential areas and commercial areas |
| Collection schedule: | • Day collection for standard areas
• Night collection for congested areas |
| Collection and haulage vehicles: | • Compactor trucks for standard areas
• Detachable container trucks for marginal areas |
| Haulage system: | • Direct haulage without a transfer station |

5.4.4 Street Sweeping System

a. Introduction

Street sweeping is one of the most visible of all government services. Consciously or not, residents allow their opinions on the effectiveness of street sweeping programs influence their assessment of the credibility of their municipal leaders and local officials. Visitors instinctively rate municipalities based on their external conditions, i.e., cleanliness. Dirty cities cannot attract foreign investors. These opinions should be positively used to stimulate the residents to build a better city.

Street sweeping programs were conducted mainly to remove litter and dirt so that streets appear presentable, and traffic will not create dust. Specifically, in some areas, regular street sweeping is necessary to prevent sewers from becoming clogged. It is also recognized that dust is a potential pollutant.

Municipalities must balance the costs for adequate street sweeping and effective litter control programs, sewer improvement operations, projects to ensure safety of pedestrians and vehicle occupants, air and water pollution countermeasures, and economic development. Public education programs alone, however, will not help eliminate street litter. Debris also accumulates from air pollution fallout, animal excreta, oil drippings, parts dropped from vehicles, spillage from solid waste collection, as well as mud tracked onto pavements.

b. Conclusion of the Street Sweeping System

The flushing system is not at all suitable for the Central District in view of the current limited water resource and poor sewerage system.

The mechanical and vacuum sweeping systems are also not suitable for the Central District because they require large capital, and incur high operational and maintenance costs and in addition due to the congested road conditions in the town. This system might be applicable to the noncongested trunk roads.

Conclusively, manual sweeping is most appropriate for the Central District because of an abundant and inexpensive supply of labor force. The jobs that are generated by the sweeping system can contribute, albeit to a smaller degree, to the betterment of the Central District's economy. This system is also flexible and can cope with waste containing lots of sand.

5.4.5 Processing and Treatment System

a. Introduction

This section considers the possible options for:

- The treatment of waste by altering or removing some of its undesirable characteristics (e.g. to reduce waste volume, to render waste inert)
- The recovery of some of the wastes either as energy (gas, steam or electricity) or as usable materials (e.g. waste paper, ferrous scrap, compost)

Several criteria of prime importance in assessing the suitability and viability of any system of waste handling, treatment or recovery are as follows.

- Technical feasibility
- The degree to which the technology of the system is proven, i.e. are these plants actually in operation elsewhere?
- The reliability of the system and similar issues. (These questions are particularly important when considering latest technologies since, for example, many recovery systems are relatively recent developments).
- Its financial and economic implications: how much will the system cost to construct and operate; what are the potential benefits from savings in transport and disposal costs and from the sale of recovered products; what other economic benefits do the system offer in terms of foreign exchange savings, employment, etc. Of special importance here is the scope for actual selling and using any recovered products as this can frequently be less than is estimated.
- Its management requirements: how much qualified management and skilled labor will the system require to operate properly; how much cooperation will be obtained from the public, etc. Unless the necessary resources and skills are available, the system may be much less attractive than it initially appears.

Our assessment of the various operations below takes into account the prevailing conditions and problems in the study area, evaluating in broad terms the technical suitability and economic implications of different systems for handling, treatment and recovering solid wastes in the study area.

The following intermediate technologies are discussed in this section:

- Incineration
- Production of Refuse-Derived Fuel (RDF)
- Biogas Production
- Pyrolysis
- Composting
- Size Reduction
- Mechanical Sorting and Scavenging

These technologies are shown in Figure 5-1.

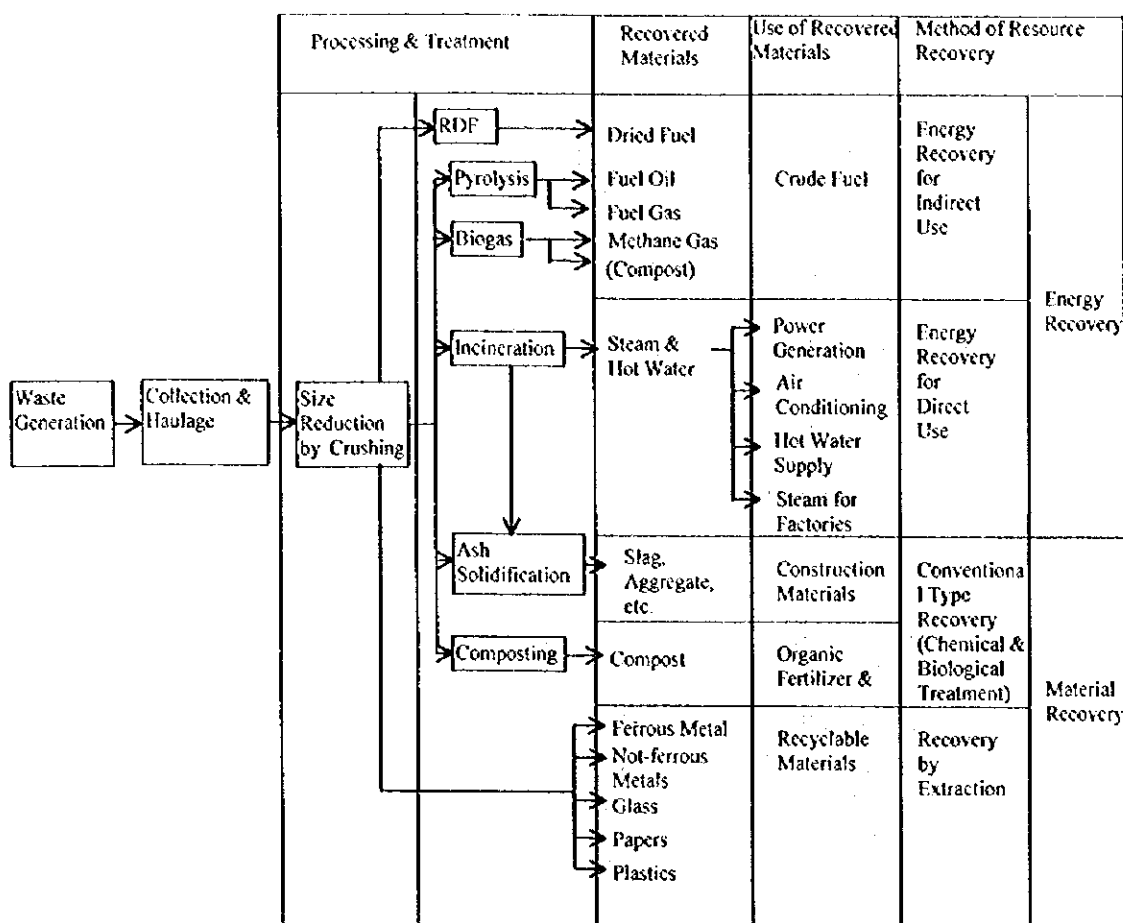


Figure 5-1: Processing and Treatment Technologies

b. Conclusion of the Processing and Treatment System

No large scale processing or treatment technology is recommended for the Central District in view of the city's current conditions. On-site/community based composting system may be adopted if there is a demand for compost in the area. Promotion of on-site/community based composting for private use, not otherwise, may be a suitable means of promoting self disposal.

Middle scale mechanical sorting comprising a simple system is recommended from a technical point of view, however, the establishment of a proper operation and maintenance system is of more importance than to successfully introduce a mechanical sorting system.

5.4.6 Recycling

a. Introduction

Most developed countries began taking various actions in the mid-1980s directed toward recycling of solid waste. The commonly accepted definition of solid waste recycling would be the utilization of one or more waste components in such a way

that they are not deposited in a landfill. Materials commonly recycled or recyclable wastes are paper, cardboard, glass, bottles, aluminum, ferrous metals, and plastics.

The primary benefits of recycling are conservation of natural resources and landfill space; however, the collection and haulage of materials require substantial amounts of energy and labor, and historically, most recycling programs are subsidized economically¹. The requirements for a successful program are that there is a strong demand for recovered materials and that the market value of the materials is sufficient to cover collection and haulage costs.

b. Present Situation of Recycling in the Central District

Table 5-2 shows the surveyed waste composition of the Central District in 1998, the standard waste composition of industrialized countries and the United States. This comparison shows that the present composition of recyclable waste in the Central District in 1998 is less than the average of industrialized countries: 29% for the Central District, 27-80% for industrialized countries, and 67.5% for the United States. However, in general the trend of waste composition of the Central District is within the range of that in industrialized countries. There are some significant characteristics of the waste in the Central District compared with the ones of developed countries.

- The percentage of kitchen waste content is quite high.
- The percentage of paper and glass waste content is lower.
- The percentage of ceramic and stone content is higher.

Table 5-2: Comparison of Waste Composition

	The Central District in 1998	Industrialized Countries in 1985 ^a	United States in 1990 ^b
Kitchen	47.2 %	20-50 %	9.0 %
Paper	11.6 %	15-50 %	40.0 %
Textile	2.8 %	2-10 %	2.0 %
Plastic	7.1 %	2-10 %	7.0 %
Grass/Wood	11.6 %	-	20.5 %
Leather/Rubber	2.2 %	-	1.0 %
Metal	1.9 %	3-13 %	9.5 %
Glass	3.5 %	4-12 %	8.0 %
Ceramic/Stone	12.1 %	1-20 %	3.0 %
		(including others)	(including others)
Others	0.1 %	-	-
Total	100.0 %	100.0 %	100.0 %

Note: Screened items are recyclable wastes.

Source:

^a: "Integrated Resource Recovery, Recycling from Municipal Refuse: A state-of-the-art Review and Annotated Bibliography", UNDP Project Management Report Number 1, S. Cointreau, et. al. 1985

^b: Integrated Solid Waste Management, Engineering Principles and Management Issues, G. Tchobanoglous, et al, McGraw-Hill, 1993

c. Alternatives

Recycling systems may be divided into two types in terms of the degree to which governmental organizations are involved: government related recycling system and private sector centered recycling system.

¹ Integrated Solid Waste Management, Engineering Principles and Management Issues, G. Tchobanoglous, et al, McGraw-Hill, 1993

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Others	0.1 %	-	-
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¹ Integrated Solid Waste Management, Engineering Principles and Management Issues, G. Tchobanoglous, et al, McGraw-Hill, 1993

c.1 Governmental Participation Dominated Recycling System

The governmental participation dominated recycling system is carried out as a means of economically controlling solid waste generation. This system obliges dischargers to conduct waste segregation and sorting, as well as separate discharge, collection and haulage. Although these activities incur additional costs they reduce the amount of waste for final disposal.

Many industrialized countries suffer from scarcity of space to construct landfills. In Japan, waste is often transported to disposal sites more than 500 km away from the main collection areas. Therefore, this system has become particularly common in industrialized countries as it reaps a considerable financial benefit by saving landfill space and reducing haulage costs.

Although a government related recycling system is considered to be more productive, they incur large collection and haulage costs, and their success is heavily dependent on public cooperation. Furthermore, because conditions prevalent in developing countries entirely differ from those in industrialized countries, the implementation of this system in the former could generate a different outcome. Therefore, this alternative is only recommendable for municipalities where solid waste management unit cost is very expensive. This is not the case in the Central District.

c.2 Private Sector Centered Recycling System

The government has an indirect and limited role in the promotion of this recycling system: that is the execution of public education programs on recycling. This system does not impose separate collection and any risk encountered is the sole responsibility of the private entities involved.

This alternative is suitable where risks and uncertainties associated with recycling are great and where the benefits could be nothing more than the additional cost this activity incurs. Accordingly, this system is recommended for the Central District.

d. Conclusion of the Recycling System

There are two problems with promoting the recycling system in the Central District. One is that there are only few reprocessing plants for recycled materials in Honduras so its haulage cost limits the expansion of the recycling business. The other is that the composition of recyclable waste in the Central District in 1998 is less than the average of industrialized countries: 29% for the Central District; 27-80% for industrialized countries; and 67.5% for the United States. Therefore the recycling business in Honduras is not stable and is risky.

In the AMDC, financial stability takes precedence over environmental protection and conservation of natural resources. Therefore, the AMDC is basically recommended not to take any steps toward recycling that would only incur large capital. The AMDC should, however, start promoting recycling by source separation and separate discharge to control the rapid waste generation increase. Since it would take considerable time before the residents can become accustomed to source separation and separate discharge, these activities should be introduced as soon as possible regardless of whether the resulting wastes can be collected and transported separately.

5.4.7 Final Disposal

a. Level of Sanitary Landfill Development and Operation

The sanitary landfill development and operation levels are classified as follows:

- Level 1: Controlled tipping
- Level 2: Sanitary landfill with a dike and daily soil covering
- Level 3: Sanitary landfill with primary leachate circulation system
- Level 4: Sanitary landfill with leachate treatment system

The prospective sanitary landfill development and operation levels are illustrated in Figure 5-2.

The sanitary landfill development and operation levels, mentioned previously, are described below.

Level 1: Controlled Tipping

Introduction of controlled tipping through:

- establishment of access to the site.
- provision of cover materials to prevent fire outbreaks and dispersion of rank odor.
- establishment of inspection, control and operational recording system for incoming waste.

Level 2: Sanitary Landfill with a Dike and Daily Soil Covering

Introduction of sanitary landfill through:

- establishment of a disposal site boundary to eliminate scavenging.
- providing sufficient cover over waste disposed.
- enclosing the disposal area with a dike.
- construction of a divider between present and future landfill areas.
- establishment of a drainage system in order to divert storm water from surrounding areas away from the disposal site to reduce leachate.
- construction of environmental protection facilities, such as a buffer zone, litter control and gas removal facilities, in order to abate direct impact on surroundings.
- installation of gas removal facilities to achieve the conditions necessary for a semi-aerobic sanitary landfill.
- introduction of amenities for staff.

Level 3: Sanitary Landfill with Leachate Circulation

Establishment of leachate control through:

- installation of leachate collection, circulation and monitoring facilities.

- installation of liners for seepage control.
- construction of a semi-aerobic sanitary landfill to accelerate waste decomposition and facilitate stabilization.
- introduction of water sprinkling for dust prevention.

Level 4: Sanitary Landfill with Leachate Treatment

Establishment of leachate treatment through:

- installation of an oxidation pond.

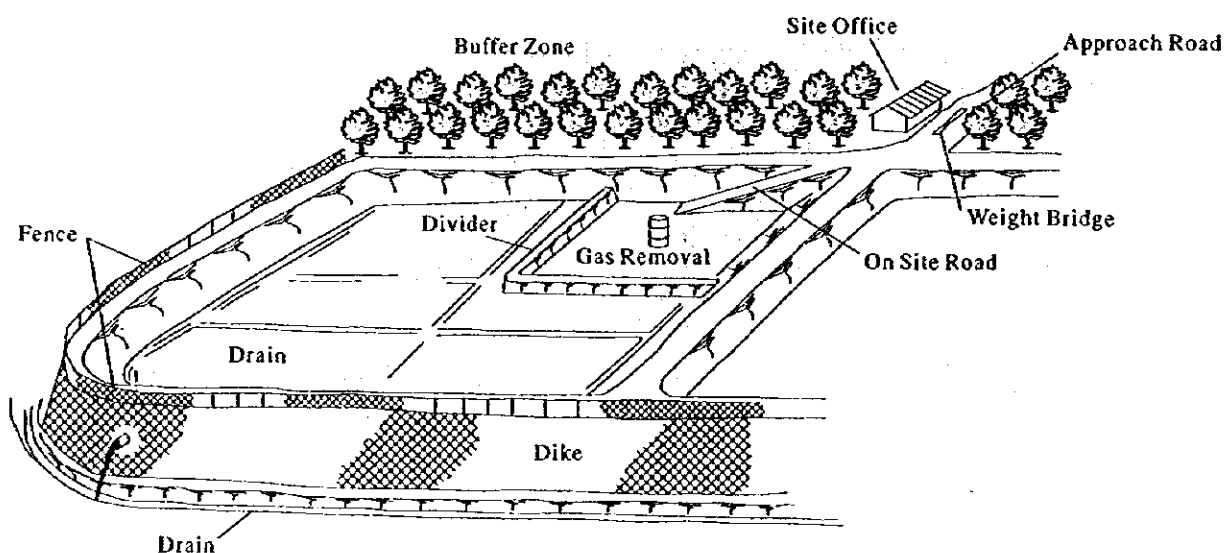
The above mentioned sanitary landfill development and operation levels are described and tabulated in Table 5-3.

b. Conclusion of the Proposed Sanitary Landfill Level

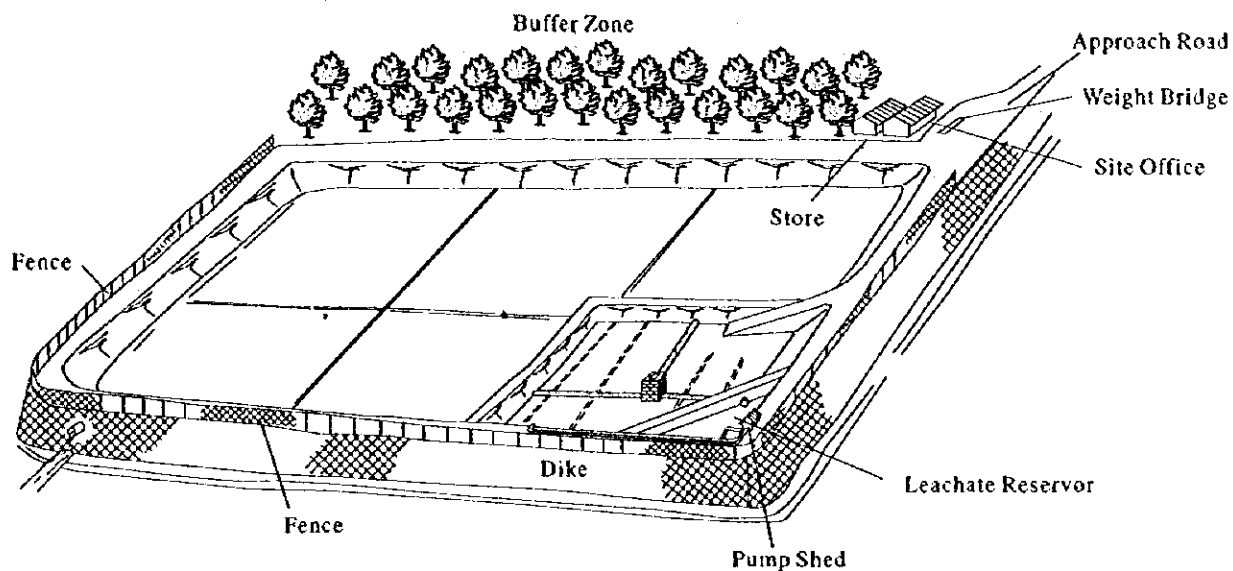
A level four sanitary landfill poses the least amount of negative impact, but requires the most expensive investment and operation cost; it is considered to be too difficult for the AMDC to introduce this advanced sanitary landfill level due to the limited financial and technical capability.

Therefore, the AMDC should aim for a level three sanitary landfill. As it is unrealistic to introduce it immediately, considering the present level one conditions at the disposal site, immediate improvements should aim for level two conditions, and level three for a new disposal site.

Level 2



Level 3



Level 4

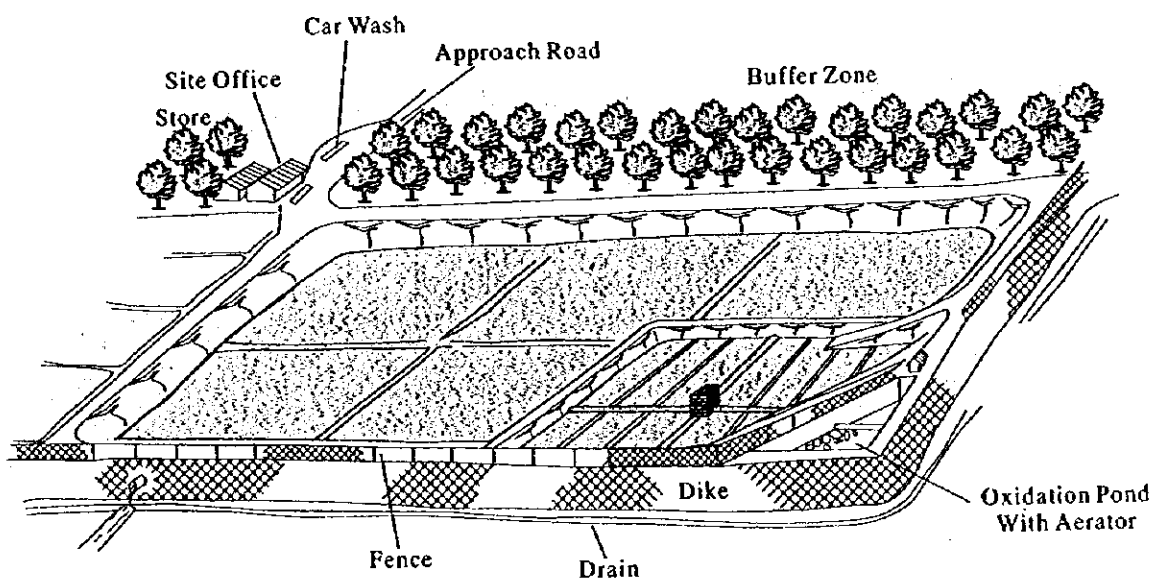


Figure 5-2: Illustration of Prospective Sanitary Landfill Development and Operation Levels 2, 3 and 4

Table 5-3: Outline of Sanitary Landfill Developments and Operation

Items	Level of Sanitary Landfill				Remarks
	1	2	3	4	
1 Site Development					
1.1 Main Facilities					
a. Enclosing Structures					
• Enclosing dikes		A	A	A	B requires a dike made of waste and soil
• Dividers		B	A	A	
b. Drainage System					
• Surrounding drains		A	A	A	If necessary
• On-site drains (surface water)		A	A	A	
• On-site drains (spring)		A	A	A	
• Drains for reclaimed areas		A	A	A	
c. Access					
• Approach roads	A	A	A	A	Improvement of existing road network to access the sites
• On-site roads	A	A	A	A	
• Others	A	A	A	A	
1.2 Environmental Protection Facilities					
Buffer zones		A	A	A	Movable fences, etc.
Litter control facilities		B	A	A	
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 Building and accessories					
Site office	B	A	A	A	Gate, fence, lights, etc. Water tank, extinguisher, etc. Monitoring well, etc.
Weighbridge	A	A	A	A	
Store			A	A	
Safety facilities		A	A	A	
Fire prevention facilities		B	A	A	
Monitoring facilities			A	A	
Car wash			A	A	
2 Equipment					
Landfill Equipment	A	A	A	A	Water tanker, inspection vehicles, etc.
Others			A	A	
3 Operation and Maintenance					
3.1 Operation					
a. Personnel					B means insufficient soil cover.
b. Cover material	B	A	A	A	
c. Utility					
• Fuel tank	A	A	A	A	
• Water		A	A	A	Divider, drain for reclaimed area, leachate collection pipes, etc.
• Electricity	B	A	A	A	
d. Chemicals					
• Insecticide	A	A	A	A	
• Monitoring chemicals			A	A	
e. Others		A	A	A	
3.2 Maintenance					
• Main facilities		A	A	A	
• Environmental protection facilities		A	A	A	
• Building and accessories	A	A	A	A	
• Equipment	A	A	A	A	

A: necessary

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

5.4.8 Maintenance of Vehicles and Equipment

There are basically two possible alternatives for the maintenance of vehicles and equipment. The first alternative would be the allocation of preventive services to the AMDC workshop and large-scale maintenance services to private garages. The second alternative would be the allocation of all maintenance and repair works to the AMDC workshop.

Since preventive services are basic and essential for the maintenance of vehicles, the first alternative would be inexpensive as it would only require basic facilities and a minimum number of mechanics and workers. The private workshops must have sufficiently skilled personnel, to properly provide the AMDC's fleet with the required technical services. Since many private workshops in the Central District were assessed to have skilled mechanics to provide these services, the first alternative would be appropriate for the Central District.

The second alternative demands a large number of skilled mechanics, a large workshop, as well as sophisticated machinery. It is capital intensive and requires a lot of money for operation and maintenance, as well as management of technical difficulties that may arise, with a degree of uncertainty and risks.

Governmental organizations tend to inefficiently conduct operations due to inflexibility, political interference, lack of motivation among staff, slow decision-making processes, etc. Therefore, the services to be conducted by the AMDC should be minimized; the first alternative is concluded to be more appropriate for the Central District.

5.5 Selection of the Best Technical System

Following the examination of various SWM technical sub-systems, the selection of the best SWM technical systems for the Central District are proposed.

Table 5-4: The Best SWM Technical System

Category	Proposed Technical System
Discharge and Storage	<ol style="list-style-type: none"> 1) Source separation <ul style="list-style-type: none"> • Separating recyclable and non recyclable wastes 2) Type of storage <ul style="list-style-type: none"> • Plastic sacks and plastic containers for common areas • Communal containers for marginal areas 3) Collection frequency <ul style="list-style-type: none"> • More than twice a week 4) Collection method <ul style="list-style-type: none"> • To introduce the separate collection for wastes 5) Type of collection method <ul style="list-style-type: none"> • Most areas: Curb collection • Marginal areas: Point collection with communal containers 6) Collection time <ul style="list-style-type: none"> • Most areas: Day collection • Traffic congested areas: Night collection 7) Type of collection vehicles <ul style="list-style-type: none"> • Most areas: Compactor trucks • Marginal areas: Detachable container trucks 8) Haulage system <ul style="list-style-type: none"> • Direct transport by motor vehicles
Primary Collection	Primary collection is required only in marginal areas. Hand cart and pedal cart systems will be used.
Secondary Collection and Haulage	<p>Common areas</p> <ul style="list-style-type: none"> • 15 m³ compactor trucks • 8 m³ compactor trucks <p>Marginal areas</p> <ul style="list-style-type: none"> • 5.5 m³ hoist trucks <p>Street sweeping waste</p> <ul style="list-style-type: none"> • 10 m³ armroll and 5 m³ hoist truck
Street Sweeping	<ul style="list-style-type: none"> • Manual sweeping
Processing and Treatment	<ul style="list-style-type: none"> • Only on-site/community based composting is encouraged.
Recycling	<ul style="list-style-type: none"> • Recycling activities are encouraged through educational programs.
Final Disposal	<ol style="list-style-type: none"> 1) Existing disposal site <ul style="list-style-type: none"> Level 2: Sanitary landfill with a surrounding dike and daily soil coverage 2) New disposal site <ul style="list-style-type: none"> Level 3: Sanitary landfill with a liner to prevent leachate from seeping into the ground
Maintenance of Vehicles and Equipment	<ul style="list-style-type: none"> • Preventive services are allocated to the AMDC workshop and large-scale maintenance services private garages.

Chapter 6

Projection until 2010

6 Projection until 2010

6.1 Economic Conditions

a. Economic Growth Rate

In this study, the GDP growth rate is projected taking into account the past economic growth rates of Honduras and Latin American countries, and the target economic growth rate under the new Central Government of Honduras. Table 6-1 shows the overview of the GDP increase until 2010.

- The economic growth rate is assumed to exceed a minimum of 4 % per annum taking into account the population growth rate.
- Assuming the target economic growth advocated by the new government is achieved, the economic growth rate until 2000 is projected to be 6 % per annum.
- The projected mean value for the period between 2000 and 2005 is 5% per annum.

Table 6-1: Overview of the GDP until 2010

	1997	2000	2005	2010
Rate of increase (%)	4.9	6.0	5.0	4.0
GDP (million Lps*)	53,330	63,517	81,066	98,629

* Lempiras using 1997 constant prices

b. GRDP

The Central District is the focal point of financial and commercial activities as well as the hotel industry. It is also the seat of the central government. In this study, the GRDP for the Central District was estimated by using the 1997 data by economic activity and the number of employees according to their income level. It is assumed that the high economic growth rate will continue in the future, so therefore the economic growth rate for the Central District is projected as being 1% higher than the national GDP figure (Table 6-2, Table 6-3).

Table 6-2: GRDP of the Central District by Economic Activity in 1997

(Unit: million Lempiras)

	GRDP	Share of GRDP (%)	Reference	
			Number of Employees	Share of the Whole Country
Agriculture, Forestry, Fishing	62	0.5	1,479	0.2
Mining	94	10.2	538	12.5
Manufacturing	2,100	22.0	68,713	19.4
Construction	783	28.9	23,613	27.1
Public Utilities	1,454	44.6	2,793	44.3
Transportation	725	31.8	14,270	30.0
Trade, Catering & Hotel	1,487	23.7	81,606	22.2
Finance, Insurance, Real Estate	2,680	52.2	20,601	48.6
Home-Ownership*	1,101	37.4	-	-
Government*	1,140	37.4	-	-
Services	1,983	37.4	107,609	30.1
Total	13,609	22.5	321,222	15.6

*Note: The GRDP of Home-ownership and Government were estimated using the share of Services to the whole country.

Table 6-3: Overview of GRDP until 2010

	1997	2000	2005	2010
Rate of increase (%)	5.9	7.0	6.0	5.0
GRDP (million Lps*)	13,609	16,516	21,893	27,942

* Lempiras using 1997 constant prices

c. Municipal Tax Revenues in the Central District

Currently, the public finances of the Central District are running a deficit, leading to the accumulation of debts. Regarding the potential increase in municipal tax revenue, it is understood that GRDP increase rate is a determinant. However, for the purpose of this study, the rise in the number of tax payers, i.e., population increase, is also taken into account. These assumptions give the estimation shown in Table 6-4.

Table 6-4: Potential and Actual Municipal Tax Revenue of the Central District and the Determinant of Potential Revenue Increase

(Unit: 1,000 Lempiras)

	1997			2010			Determinant of Potential Increase
	Potential Revenue	Collection Rate (%)	Actual Revenue	Potential Revenue	Collection Rate (%)	Actual Revenue	
Fixed Assets	50,550	39	19,715	83,562	100	83,562	Population
Other Direct Taxes	85,815	74	63,503	176,196	100	176,196	GRDP
Indirect Tax	53,250	42	22,365	88,026	100	88,026	Population
Service Tax	10,500	100	10,500	21,559	100	21,559	GRDP
Rental Fees	18,750	100	18,750	30,995	100	30,995	Population
Total	218,865	(61.6)	134,833	400,338	100	400,338	

The revenue plan for the Central District is shown in Table 6-5 below.

Table 6-5: Future Revenue Plan for the Central District

	1997	2000	2005	2010	Average Growth Rate (%/Year)
Fixed Assets	19,715	30,130	52,715	83,562	11.8
Other Direct Taxes	63,503	83,316	124,249	176,196	8.2
Indirect Tax	22,365	33,119	56,368	88,026	11.1
Service Tax	10,500	12,743	16,892	21,559	5.7
Rental Fees	18,750	21,056	25,546	30,995	3.9
Total	134,833	180,364	275,770	400,338	8.7

6.2 Social Conditions

a. Population

By plotting the previous population data for both the Central District and for the whole country, a resulting exponential curve of population was obtained. The population for the target year 2010 was projected by an extrapolation of the curve. From these data the increase in growth rate were quantified.

The generated values are listed in Table 6-6.

Table 6-6: Projected Population of the Central District and Honduras(1989-2010)

Year	Central District (persons)	Honduras (persons)	Rate of Central District
1988 (Base)	576,661 Growth rate=3.94%	4,443,721 Growth rate=2.94%	12.98%
1998	848,859	5,935,308	14.30%
1999	882,322	6,109,602	14.44%
2000	917,104	6,289,014	14.58%
2001	953,257	6,473,695	14.73%
2002	990,835	6,663,799	14.87%
2003	1,029,895	6,859,486	15.01%
2004	1,070,495	7,060,918	15.16%
2005	1,112,695	7,268,267	15.31%
2006	1,156,558	7,481,704	15.46%
2007	1,202,151	7,701,408	15.61%
2008	1,249,541	7,927,565	15.76%
2009	1,298,799	8,160,362	15.92%
2010	1,350,000	8,400,000	16.07%

b. Population by Income Level

The present population ratio by income level was estimated to be 50% for the low income residents, 30% for the middle, and 20% for the high income residents, according to the "Programa de Encuesta de Hogares de Propósitos Múltiples, Dirección General de Estadísticas y Censos, Junio 1997" as shown in Table 6-7.

Table 6-7: Classification of Population by Income Level in the Central District

Category	Range	No. of Persons	%
Low income residents	Lps. 0-2,500	79,098	50
Middle income residents	Lps. 2,501-5,000	47,147	30
High income residents	Lps. 5,001 or more	30,328	20
Total		156,573	100

Sources: Adapted from Programa de Encuesta de Hogares de Propósitos Múltiples, Dirección General de Estadísticas y Censos, Junio 1997.

The future population ratio trends by income level was projected by taking the following factors into account.

- 1) Since the present birth rates of the low and middle income residents tend to be higher than that of the high income residents, in addition the migrant population tends to be on a lower income, it was projected that the percentage of the population earning a high income would decrease proportionally.
- 2) Various measures that are currently undertaken for the purpose of improving the economic condition of low income people will gradually materialize and the population will shift from the low income group to the middle income group.

The future population by income level group is therefore projected as shown in Figure 6-1.

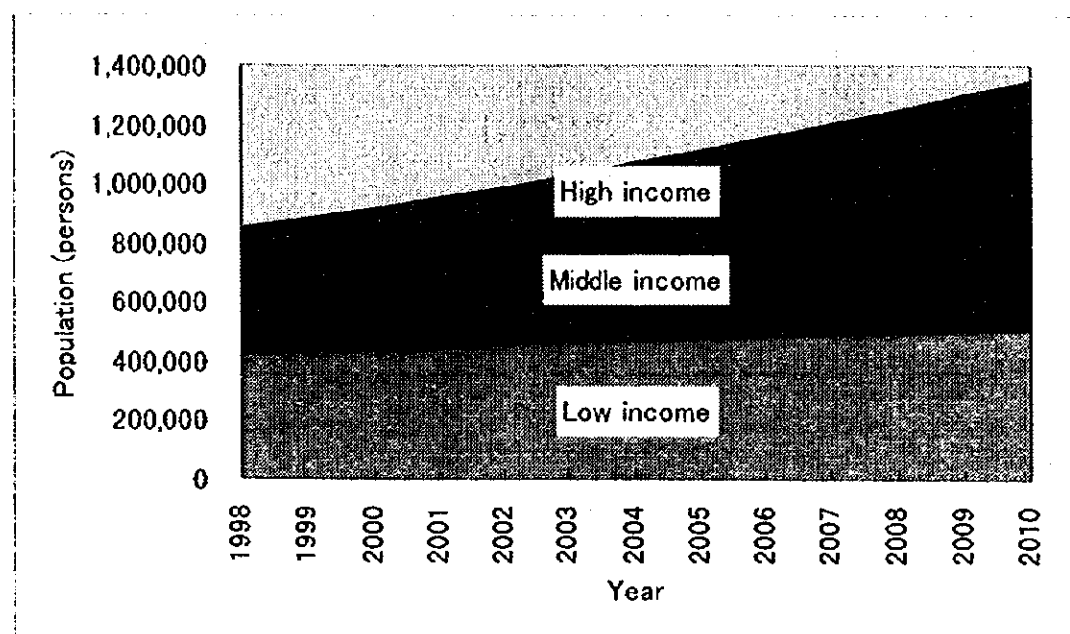


Figure 6-1: Projection of Population by Income Level Group

It was projected that the population ratio by income bracket will change from 1998 to 2010 in the following manner: high income from 20% to 14%; middle income from 30% to 48%; and low income from 50% to 38%, as shown in Table 6-8.

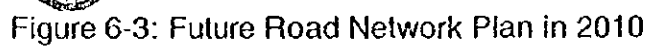
Table 6-8: Projection of Population by Income Level Group

Year	Population Ratio			Population			
	High	Middle	Low	Total	High	Middle	Low
1998	20.0%	30.0%	50.0%	848,859	169,772	254,658	424,430
1999	19.5%	31.5%	49.0%	882,322	172,053	277,931	432,338
2000	19.0%	33.0%	48.0%	917,104	174,250	302,644	440,210
2001	18.5%	34.5%	47.0%	953,257	176,353	328,874	448,031
2002	18.0%	36.0%	46.0%	990,835	178,350	356,701	455,784
2003	17.5%	37.5%	45.0%	1,029,895	180,232	386,211	463,453
2004	17.0%	39.0%	44.0%	1,070,495	181,984	417,493	471,018
2005	16.5%	40.5%	43.0%	1,112,695	183,595	450,641	478,459
2006	16.0%	42.0%	42.0%	1,156,558	185,049	485,754	485,754
2007	15.5%	43.5%	41.0%	1,202,151	186,333	522,936	492,882
2008	15.0%	45.0%	40.0%	1,249,541	187,431	562,293	499,816
2009	14.5%	46.5%	39.0%	1,298,799	188,326	603,942	506,532
2010	14.0%	48.0%	38.0%	1,350,000	189,000	648,000	513,000

c. Town Structure

Figure 6-2 shows future land use in the year 2010. Future land use is also one of the most important criteria for siting the facilities related to solid waste management.

Figure 6-3 shows the future road network plan in the year 2010. The future road network has to be taken into account for planning a haulage plan.



6.3 Waste Generation Amount

Waste is defined as materials arising from human and animal activities that are discarded as useless or unwanted items¹. All materials produced from economic activities will lose their worth sooner or later. The waste generation amount is, therefore, closely related to the population and the consumption of materials per capita. This characteristic implies that the waste generation amount increases with the increase in GRDP.

In this study, the following assumptions were set to forecast the waste generation amount.

- 1) The generation amount of all types of wastes, except street waste, will be directly proportional to the population.
- 2) The waste generation amount rates of all types of waste, except street waste, will increase by 50% of the annual GRDP growth rate.
- 3) The waste generation amount rate of street waste will remain constant until 2010.

Table 6-9 shows the relationships between the growth rate of waste generation adopted for this study and the projected growth rate of GRDP until 2010.

Table 6-9: Projected Growth Rate of Waste Generation until 2010

Year	GRDP Growth	Growth of Waste Amount Generation Rate	
		Excluding street wastes	Street waste
1998	7.0%	103.5%	0.0%
1999	7.0%	103.5%	0.0%
2000	6.0%	103.0%	0.0%
2001	6.0%	103.0%	0.0%
2002	6.0%	103.0%	0.0%
2003	6.0%	103.0%	0.0%
2004	6.0%	103.0%	0.0%
2005	5.0%	102.5%	0.0%
2006	5.0%	102.5%	0.0%
2007	5.0%	102.5%	0.0%
2008	5.0%	102.5%	0.0%
2009	5.0%	102.5%	0.0%
2010	5.0%	102.5%	0.0%

¹ Excerpt taken from: "Integrated Solid Waste Management - Engineering Principles and Management Issues"; McGraw-Hill Series in Water Resources and Environmental Engineering, 1993.

Table 6-10 shows the projected waste generation amount rates projected based on the projected growth rate shown in Table 6-9.

Table 6-10: Projected Waste Generation Amount Rates until 2010

Year	Municipal Waste								Industrial Medical Waste kg/cap/d
	Residential			Non-Residential					
	High kg/cap/d	Middle kg/cap/d	Low kg/cap/d	Commercial kg/cap/d	Restaurant kg/cap/d	Institution kg/cap/d	Market kg/cap/d	Street kg/km/d	
1998	0.541	0.343	0.328	0.067	0.053	0.015	0.022	158.300	0.012
1999	0.560	0.355	0.339	0.070	0.055	0.016	0.022	158.300	0.012
2000	0.580	0.367	0.351	0.072	0.057	0.016	0.023	158.300	0.013
2001	0.597	0.378	0.362	0.074	0.059	0.017	0.024	158.300	0.013
2002	0.615	0.390	0.373	0.077	0.060	0.018	0.025	158.300	0.013
2003	0.633	0.402	0.384	0.079	0.062	0.018	0.025	158.300	0.014
2004	0.652	0.414	0.395	0.081	0.064	0.019	0.026	158.300	0.014
2005	0.672	0.426	0.407	0.084	0.066	0.019	0.027	158.300	0.015
2006	0.689	0.437	0.418	0.086	0.068	0.020	0.027	158.300	0.015
2007	0.706	0.448	0.428	0.088	0.069	0.020	0.028	158.300	0.015
2008	0.723	0.459	0.439	0.090	0.071	0.021	0.029	158.300	0.016
2009	0.742	0.470	0.450	0.092	0.073	0.021	0.030	158.300	0.016
2010	0.760	0.482	0.461	0.095	0.075	0.022	0.030	158.300	0.017

Table 6-11 shows the projected waste generation amounts until 2010 based on the projected waste generation rates and the projected population. The waste generation amount per day is forecast to increase from 481 ton/day in 1998 to 1,055 ton/day in 2010.

Table 6-11: Projected Waste Generation Amounts until 2010

Year	Residential				Non-residential							Total
	High	Middle	Low	Sub-total	Com-mercial	Rest-aurant	Institutio-n	Market	Street	ISW, MSW	Sub-total	
1998	92	87	139	318	57	45	13	18	28	10	172	491
1999	96	99	147	342	62	48	14	20	28	11	183	525
2000	101	111	155	367	66	52	15	21	28	12	195	562
2001	105	124	162	392	71	56	16	23	28	12	207	598
2002	110	139	170	419	76	60	17	24	30	13	221	639
2003	114	155	178	447	81	64	19	26	30	14	234	681
2004	119	173	186	478	87	69	20	28	30	15	249	726
2005	123	192	195	510	93	73	21	30	32	16	266	776
2006	127	212	203	542	99	78	23	32	33	17	282	825
2007	132	234	211	576	106	83	24	34	35	19	300	877
2008	136	258	219	613	113	89	26	36	36	20	319	932
2009	140	284	228	651	120	95	27	38	38	21	339	991
2010	144	312	236	692	128	101	29	41	40	22	361	1,053

6.4 Waste Composition

Table 6-12 compares the household waste composition (weighted average basis) of the Central District during this study with other countries. The composition of waste appears to be similar to that of industrialized countries, however the contents of paper, metal, etc., that are categorized as recyclable materials are less than the trend observed in industrialized countries.

Table 6-12: Analysis Results of Waste Composition for Residential Wastes

Items	^a Tegucigalpa (1998)	^b Managua, Nicaragua (1995)	^c Asuncion, Paraguay (1993)	^d United States (1990)	^e Industrialized Countries
unit: %					
Combustibles					
Food wastes	46.25	34.8	37.4	9.0	20-50
Paper and CB	11.65	7.4	10.2	40.0	15-50
Textiles	2.73	2.0	1.2	2.0	2-10
Plastic	7.00	4.2	4.2	7.0	2-10
Grass & Wood	12.12	26.1	19.2	20.5	-
Leather & Rubber	1.95	2.1	0.6	1.0	-
Sub-total	81.70	76.6			
Non-combustibles					
Metal	1.95	1.8	3.1	9.5	3-13
Glass	3.57	2.9	2.2	8.0	4-12
Ceramic & Dirt	12.71	7.5	0.4	--	1-20
Others	0.07	11.2	14.7	3.0	included in ceramic/dirt
Sub-total	18.29	23.4			
Total	100.00	100.0	100.0	100.0	100.0
Uncompacted Specific Weight	200 kg/m³	200 kg/m³	215 kg/m³	-	-

Note:

^a This Study.

^b "The Study on the Improvement of the Solid Waste Management System for the City of Managua"; JICA; May, 1995

^c "The Study on SWM for the Metropolitan Area of Asuncion"; JICA; Aug. 1994

^d "Integrated Resource Recovery, Recycling from Municipal Refuse: A state-of-the-art Review and Annotated Bibliography", UNDP Project Management Report Number 1, S. Cointreau, et. al. 1985

^e Integrated Solid Waste Management, Engineering Principles and Management Issues, G. Tchobanoglous, et al, McGraw-Hill, 1993

Changes in the composition of waste are mainly due to the introduction of new products in the market and a different consumption pattern. The introduction of these items have progressed significantly over the last few years. It could, therefore, be understood that the waste composition of the Central District is currently undergoing a transition phase from the trend seen in developing countries to that of industrialized countries, and it will continue to exhibit trends similar to industrialized countries.

The analysis focuses on the comparison of the data provided by the WACS and other countries, assuming that changes in waste composition would generally result in the waste characteristics of a developed economy.

- Less kitchen waste and more paper and plastic.
- Less grass and wood and more metal and glass.
- Lower uncompacted specific weight.

The waste composition forecasts for 2004 and 2010 are as shown in Table 6-13

Table 6-13: Waste Composition Forecast of Residential Waste

Items	1998		2004		2010	
	Rate	Amount (tons/day)	Rate	Amount (tons/day)	Rate	Amount (tons/day)
Combustibles						
Kitchen wastes	46%	220	42%	304	40%	422
Paper and CB	12%	58	13%	94	15%	158
Textiles	3%	14	3%	22	3%	32
Plastic	7%	34	8%	58	8%	84
Grass & Wood	12%	58	12%	87	12%	127
Leather & Rubber	2%	10	2%	14	2%	21
Sub-total	82%	394	80%	579	80%	844
Non-combustibles						
Metal	2%	10	3%	22	4%	42
Glass	3%	14	4%	29	5%	53
Ceramic & Dirt	13%	63	12%	87	10%	105
Others	0%	0	1%	7	1%	11
Sub-total	18%	87	20%	145	20%	211
Total	100%	481	100%	724	100%	1,055
Lower Calorific Value by Karisato's Formula	1,667 cal/g		1,723 cal/g		1,761 cal/g	
by Dulong's Formula	1,615 cal/g		1,734 cal/g		1,778 cal/g	

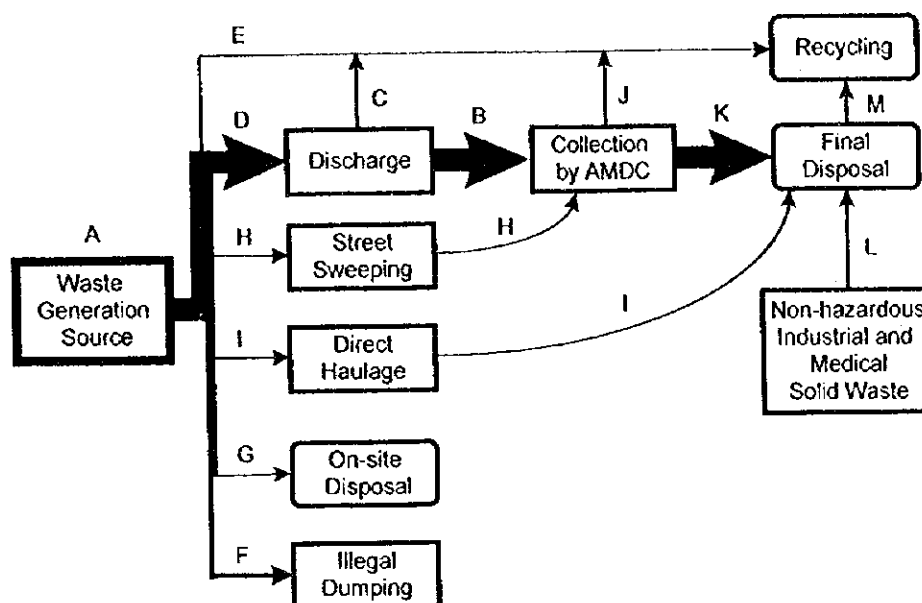
- 1) The ratio of **kitchen waste** is forecast to decrease from 46% to 40% mainly due to the increase in consumption of processed food.
- 2) The ratio of **paper waste** is forecast to increase from 12% to 15% mainly due to the increase in use of wrapping paper and in business activities.
- 3) The ratio of **textile waste** will remain at 3% until 2010.
- 4) The ratio of **plastic waste** will increase slightly from 7% to 8% mainly due to increase in the import of plastic goods.
- 5) The ratio of **grass and wood wastes, leather and rubber wastes** will remain constant until 2010.
- 6) The ratio of **metal waste** will increase slightly from 2% to 4% mainly due to the increase in use of home electric appliances.
- 7) The ratio of **glass waste** will increase slightly from 3% to 5% mainly due to the decrease in the use of reusable bottles, as the type of bottles used becomes diverse.
- 8) The ratio of **ceramics and stone waste** will decrease from 13% to 10%.

6.5 Waste Stream

The main factors that will affect the changes in the waste stream in the Central District are:

- changes in waste generation amount.
- changes in waste collection system.
- changes in the recycling system.

The waste stream model below illustrates the flow of waste in the Central District and shall also be used as a basis to forecast future waste flow.



A: Waste Generation

The waste generation amount is as stipulated in Table 6-11.

B: Waste Collection (I)

The waste collection amount will increase according to the planned waste collection ratio in the master plan.

$$B_n = A_n \times \text{planned waste collection rate}$$

C: Recycling of Discharged Waste

The ratio of the amount of waste discharged for recycling to the total waste generation amount in 1998, which is 1%, will remain constant until 2010.

$$C_n = A_n \times C_{1998} / A_{1998}$$

D: Discharge

The waste discharge amount shall be the sum of the waste collection amount and the amount of waste discharged for recycling.

$$D_n = B_n + C_n$$

E: Recycling at Generation Sources

The ratio of the recycling amount to the total waste generation amount will increase from 1% to 2 % in 2004 as recycling activities gain momentum.

$$E_n = A_n \times \text{planned recycling rate}$$

F: Illegal Dumping at Generation Sources

The amount of illegally dumped waste is calculated as follows.

$$F_n = A_n - D_n - E_n - H_n - I_n - G_n$$

G: On-site Disposal

The ratio of self disposed waste amount to the total waste generation amount in 1998 will remain constant until 2010.

$$G_n = G_n \times C_{1998} / A_{1998}$$

H: Street Waste Collection

The amount of street waste amount will vary according to the master plan.

I: Direct Haulage

The ratio of direct haulage amount to the total waste generation amount in 1998 will be maintained until 2010.

$$I_n = A_n \times I_{1998} / A_{1998}$$

J: Recycling at Collection

The ratio of recycling amount at collection to the total waste generation amount in 1998 will remain constant until 2010.

$$J_n = A_n \times J_{1998} / A_{1998}$$

K: Waste Collection (2)

The waste collection amount (2) (where collection is undertaken by the AMDC) will increase according to the planned waste collection ratio in the master plan.

$$K_n = B_n + H_n - J_n$$

L: Non-hazardous Industrial Medical Waste

The waste generation amount is as stipulated in Table 6-11.

M: Recycling of Wastes Discharged at the Final Disposal Site

The ratio of wastes at the final disposal site for recycling to the total waste generation amount, which is 1%, will remain the same until 2010.

$$M_n = A_n \times M_{1998} / A_{1998}$$