

## 8. Operational Planning

### 8.1 Collection and Transport Operation

#### 8.1.1 Fundamental Framework

Collection and transport plans in the ECA, and PCA are to be formulated on a long-term basis by the year 2000, target year of this study. These plans must be compatible with other implementation programs, such as the institutional improvement program, the concession program, the preventive maintenance program, etc., which are discussed in other part of the Master Plan. Furthermore, these collection and transport plans must conform to the number of collection vehicles financially available, both in municipal and private sectors.

The following basic concepts, therefore, come to form themselves into a strategic framework of service operation in the areas in question:

- (1) Prerequisite is a systematic and gradual interchange of operation areas between easy and possible collection areas.

These easy collection areas (ECA) are to be extended continually through an ever-growing concession of zones, resulting thus in a considerable reduction of the PCA. The population to be served and the waste amount to be collected in the PCA will be restricted within such a scale that the municipal sector may carry out its own operations with available resources.

- (2) Gradual and intentional concessions of zones to the private sector will be imperative.

To produce the intended effect of the above mentioned area interchange, these concessions become indispensable. Items and mechanism of concession processes have been discussed in 7.2.

- (3) The above plans in question will be formulated in accordance with actually available resources, without counting upon a drastic increase in manpower and in vehicle number, except the replacement of collection vehicles.
- (4) An institutional development prospect is to be examined as an important support system for collection and transport operations in the ECA and the PCA. Master Plan I - 7 refers to this point.
- (5) To make the collection and transport plans practical and feasible, the financial viability will be examined in 9, for a technical feasibility has to take root firmly in a sound financial viability.

#### 8.1.2 Recommendable Collection and Transport Systems

Each suitable and recommendable system differs from others according to area divisions, zone specifications and operation assignments, but there will be in short three major types of systems: Door to door system, Station system, and Block collection system. Table II-2.2-1 shows collection and transport systems by area division and by responsible collectors.

(1) Collection and transport systems in the ECA (Easy collection areas)

The collection service in the ECA will be exclusively entrusted, by 1996 at the latest, to the private sectors.

1) Door to door backyard collection system in the regular service areas

This system will be selected as the most reasonable one because private collectors are sufficiently accustomed to this system and material recovering operations at sources will be easier by means of the system above.

2) Combination system of "Door to door" and "Station" for low-income - people in marginal areas

Actually, no collection service is carried out where low-income residents live, unwilling to pay for collection service and access is possible (marginal areas in ECA in a broad sense). Suitable collection system for these areas will be "Door to door" and/or "Station" collection.

3) Station collection system in marginal areas in a narrow sense (marginal and non-accessible areas)

No collection service is rendered, due to impossibility of access. In this area, station collection system will have to be introduced. A container system will also be a topic worth to be studied.

With respect to the experiment of container collection effected as a pilot project, it proved that the community cooperation to this method can be expected,

and also its effectiveness is recognized.

This method can be considered as one of the effective methods for collection in the marginal areas. However, for its materialization, it is necessary to study more in details regarding the size, the number, the distribution site, and also the specifications of collection vehicles. Accordingly, it is not included in the collection system of the Master Plan.

Relating to the areas specified in 1), 2) and 3) above, the problem of partial coverage is striking and obvious. This causes clandestine open dumping sites even in the ECA. As to cope with this difficult situation, the door to door system alone cannot be deemed sufficient, other systems need to be applied. The final selection of the most appropriate collection system, however, should be made by each collector who is responsible for the conceded zone. Furthermore, because residents' cooperation becomes indispensable in the case of the station system, an effective education program has to be elaborated and implemented by the municipal authorities.

## (2) Collection and transport systems in the PCA

The collection service in the PCA will be entrusted mainly to the municipal sector and partially to the private sector. The collection service will be of "Mixed type" in said zones.

### 1) Regular Services areas in the PCA

In these areas, the municipal and the private sectors will carry out collection service. The suitable system will be as follows:

- a. Door to door and/or station system for the private sector.
- b. Station and Block (including bell collection) system for the municipal sector.

In these "mixed collection areas", waste storage yards made of R.C. occupy a prominent position in the service operation to improve collection efficiency, but a success or failure of the station system depends totally on the behaviour and cooperation of residents. Besides, special attention should be paid to problems inherent in the dual collection practice peculiar to the Metropolitan Area of Guatemala City. To cope with any difficulty in these areas, it is necessary to settle the following points in a reasonable manner;

- c. Coordination of zonings between the private collectors and the Municipality.
  - d. Concession granting to the private collectors on condition that they should agree on a mixed collection system and observe all regulations to be imposed prior to concession approval.
- 2) Station and Block system in the marginal areas in the PCA

The collection service will be assigned solely to the municipal sector, and the suitable collection system will be Station and Block collection.

### 8.1.3 Collection Operation in Each Area

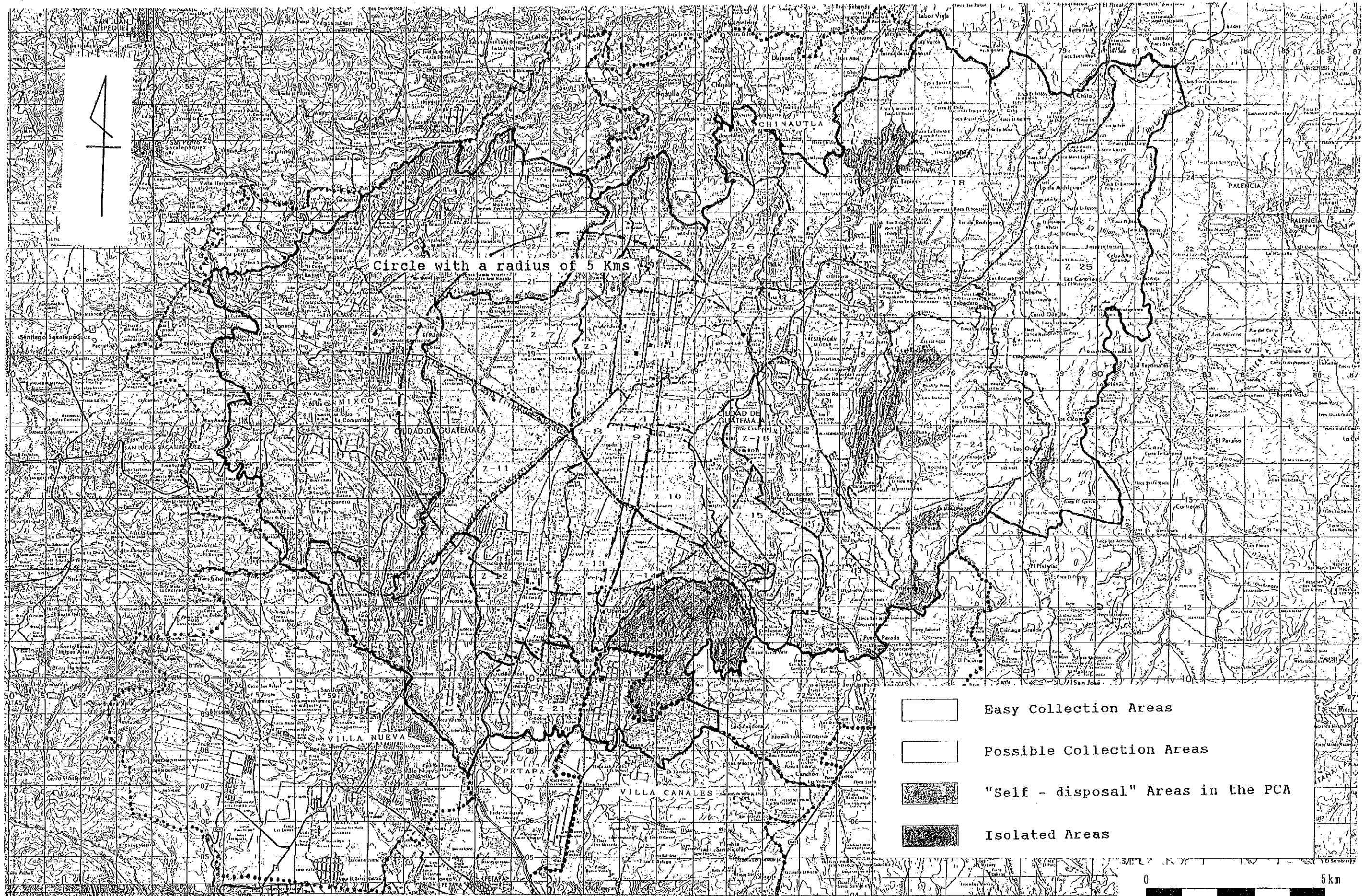
To facilitate the understanding of the explanations of the collection operation in each area, Table II-8.1-1 shows a summary of characteristics of the collection operation in each area. (Confer also Table II-2.2-1.)

Table II-8.1-1 Classified Collection Area

Area Division	Sub-division	Collectors	Systems
ECA	1) Regular Service areas (Service covered)	Private	Door to Door
	2) Marginal areas in a broad sense - Topographically accessible - Mainly low-income class - Fees collectable	Private	Door to Door Station
	3) Marginal areas in a narrow sense - Topographically not accessible - Slum colonies predominantly - Fees non-collectable	Private	Station (Container)
	2) + 3) marginal areas For a transitorial period only	Municipal	Block (Bell)
PCA	1) Regular Service areas (Mixed collection areas)	Private	Door to Door Station
	2) Marginal areas	Municipal	Station Block (Bell) (Container)
	3) Self-disposal areas (Rural & fringe areas) - Farms and scattered hamlets		
IA	Self-disposed areas For a transitorial period only	-	

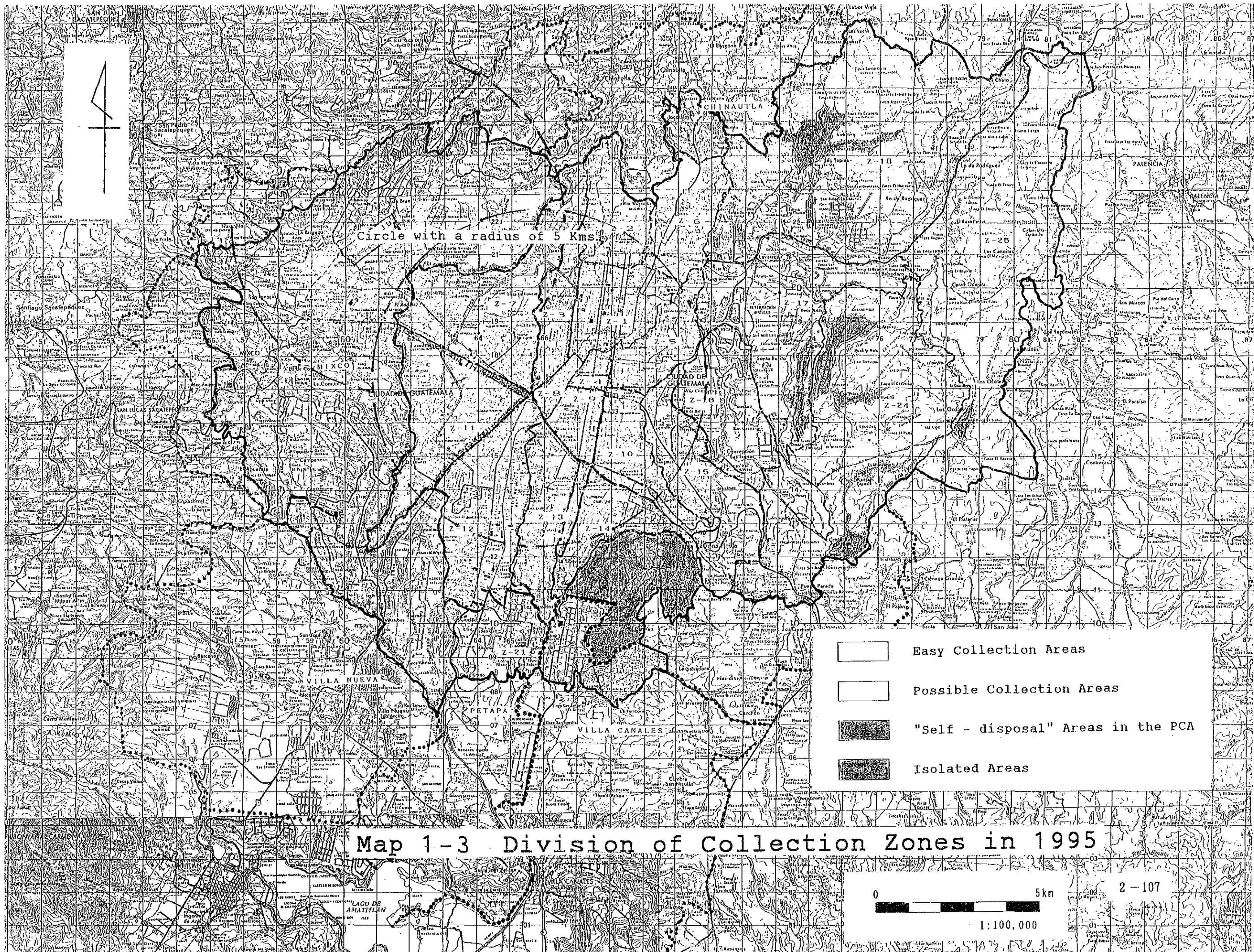
The most important criterion of area assortment between marginal areas in a broad and a narrow sense in the ECA is "accessibility" according to topographical conditions.





Map 1-2. Division of Collection Zones in 1990



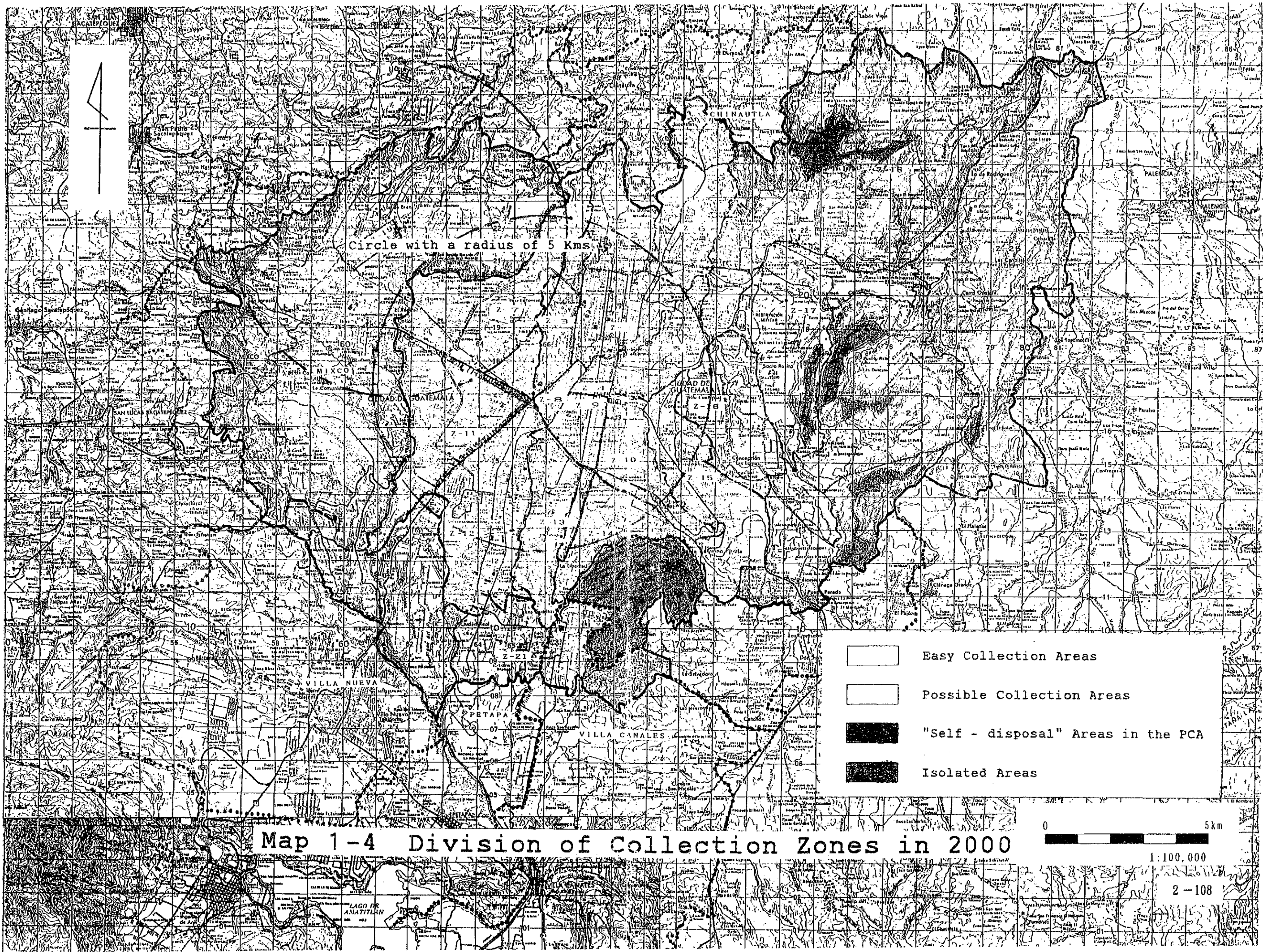


Circle with a radius of 5 Kms.

- Easy Collection Areas
- Possible Collection Areas
- "Self - disposal" Areas in the PCA
- Isolated Areas

Map 1-3 Division of Collection Zones in 1995

0 5 km  
1:100,000



Circle with a radius of 5 kms.

- Easy Collection Areas
- Possible Collection Areas
- "Self - disposal" Areas in the PCA
- Isolated Areas

Map 1-4 Division of Collection Zones in 2000

0 5 km

1:100,000



(1) Collection and transport for low-income residents in marginal areas (in a broad sense) of the ECA

1) Collectors to be assigned

- a. Private collectors
- b. Municipal (Transitorial period only)

2) Recommendable collection system:

- a. Door to door and/or Station system
- b. Block system for the municipal sector

3) Materialization of collection plan

a. General policy

The entire ECA will be entrusted exclusively to the private sectors by 1996. The concession of collection zones, however, will be made stepwise and gradually in order to avoid confusion among private collectors and disorder in the existing collection system. Improvement in service coverage of collection, therefore, will become practicable by a deliberate and gradual concession of zones to the private collectors. During a transition period, collection service for the low-income residents is to be partially supported by the municipal sector.

b. Measures for implementing the general policy

Such measures will be as follows:

- Gradual and stepwise concession with a full responsibility of covering all population in

conceded areas, regardless of paying or not paying collection fees.

- Municipal support operations to the best of their ability (here, municipalities concerned are Guatemala, Mixco and Chinautla in particular).
- Establishment and completion of competent municipal authorities in charge, especially for Mixco and Chinautla.
- Education on awareness of the SWM

c. Collection points

Private collectors: Backyard or front-door  
Fixed storage bins

Municipal service: Appointed places for bell collection

d. Service level and number of trips

Collection frequency will be planned at a level of 2 to 3 times a week. In any case, collection frequency must not be lower than two times a week.

The long-term collection plan will be based on 1.5 trips/vehicle/day, a reasonable and realistic value.

e. Capacity of waste storage yard (station)

As a general rule, these areas are densely populated and it is often difficult to find out or ensure construction sites of storage yards. In addition, the placement of storage yards

often leads to environmental deterioration problems. Special attention, therefore, should be paid to the selection of the storage type. It is preferable to use small-sized refuse yards or containers with lids. In some cases, it will be necessary to practice a kind of bell collection service similar to the municipal one.

f. Cost bearing

The necessary expenses of station yards or containers should be covered by the private collectors, who will receive the concession. Service users should pay due rates in accordance to the beneficiaries pay principle.

(2) Collection and transport in marginal areas (in a narrow sense) of the ECA

1) Collectors to be assigned

- a. Private collectors
- b. Municipal (Transition period only)

2) Recommendable collection system

- a. Station system (Container system)
- b. Block system for the municipal sector

3) Materialization of collection plan

a. General policy

Collection operation in these areas will be carried out solely by private collectors in principle. In some situations as in (1), being valid also in this case, municipal support

operation will be required as well. As most of the marginal areas of the ECA are situated in inaccessible parts, such as steep hillsides, bottom of gullies and hill tops without appropriate road networks, a special consideration will be applied to cope with the difficulty of the collection service.

b. Means for implementing the general policy

- Gradual and step-by-step concession, as mentioned above.
- Municipal support operations, as in (1).
- Prior and exhaustive talks with community leaders and residents to overcome topographical handicaps and to get communal cooperation.
- Appropriate site selection and construction of refuse storage stations on collection routes both for private and municipal sectors.
- Health education.

c. Collection points

Private collectors: Fixed storage yards  
(stations)

d. Service level and number of trips

Collection frequency in these areas is scheduled to be on a twice a week level, and this frequency should be strictly maintained. The number of trips will be 1.5/vehicle/day.

e. Capacity of waste storage-yard (station)

The size of waste storage yard is hampered by a lot of restrictions such as geographical features, road conditions, limited site area, etc. Generalization is, therefore, impossible.

Collection points and storage capacity should be decided case by case, in consideration of proper and characteristic restriction for each colony.

Also, an expedient use of the container needs to be examined in case of a limited site area condition.

f. Cost bearing

Private collectors will pay necessary costs for managing waste stations or containers with the view of zone concession to be assigned. Here, cross-subsidiary tariff system will be applicable in principle, but service users or colonies concerned need to bear at least a part of necessary expenses according to their means based upon the benefit principle.

(3) Collection and transport in regular service areas of the PCA

1) Collectors to be assigned

a. Private collectors

b. Municipal



2) Recommendable collection system

- a. For private collectors, door to door and/or station system
- b. For the municipal sector, station and block system

3) Materialization of collection plan

- a. Collection operations will cover the whole regular service areas of the PCA by the target year 2000. In these areas, collection service will be of "a mixed character"; the private collectors will slowly enter into these areas through a systematic concession to alleviate the heavy burden of the municipal operation. On the other hand, the municipal sectors will carry out their service in zones reserved to them. In case of Mixco, Villa Nueva and Villa Canales, the role of municipal operations will be so important that they should either create fleets of task forces enough to meet requirements of the areas or concert with the DLP of Guatemala City in order to solve difficulties relating to the collection service.

b. Means for implementing the general policy

- Expansion of the ECA and reduction of the PCA to make collection services easier and more feasible.
- Gradual and step-by-step concession of zones to the private collectors.
- Coordination and operational arrangement between the private and the municipal sectors

in connection with a reasonable service level, a convincing territorial sharing, an appropriate collection system, etc.

- Reinforcement of operational sub-system of surrounding municipalities or intermunicipal agreement on collection operations.
- Education on awareness of the SWM and health education.

c. Collection points

Private collectors: Backyard or front door  
Fixed storage yards

Municipal service: Fixed storage yards  
Appointed places for bell collection

d. Service level and number of trips

A reasonable collection frequency will be 2 to 3 times a week for door to door system. In case of another system, twice a week collection will be required.

The planned number of trips is 1.5/vehicle/day.

e. Capacity of waste storage yard (station)

In consideration of a gradual zone concession to the private sector, storage bins should be designed based on the average loading rate of private collection vehicles.

f. Cost bearing for fixed stations

As a rule, user charges in accordance with the beneficiaries pay principle will be imposed to all service users for the construction of fixed stations, if possible. Otherwise, a "cross-subsidiary" charge system should be introduced in the zone conceded to the private sector in order to recover the cost of fixed stations.

(4) Collection and transport in marginal areas of the PCA

- 1) Collectors to be assigned: municipal sector
- 2) Recommendable collection system

Station and block system

3) Materialization of collection plan

a. General policy

The collection operation in marginal areas of the PCA will be totally assigned to the municipal sector. Population in low-income, squatter and scattered colonies will be included. Almost all of the waste generated within these areas should be collected by the end of the target year 2000. These areas are scattered in peripheries around the study area; to be exact, specially in zone 16, 17 and 18 of Guatemala City, in the west and south-west parts of Mixco City and in the northern part of Villa Nueva. Although characteristic features differ a great deal from colony to colony, a fundamental policy is to carry out a service operation which is able to cope with sanitation problem and environmental deterioration.

b. Means for implementing the general policy

To allot collection capacity of the municipal sector which will become available with gradual concessions to the private collectors.

c. Collection points

Municipal service only: Fixed storage yards  
Appointed places for  
bell collection

d. Service level and number of trips

A collection plan will be prepared on the basis of twice a week frequency and with 1.5/vehicle/day trip number.

e. Capacity of waste storage yard

This will depend on the population to be served, the waste generation per capita in that zone, and frequency of collection.

f. Cost bearing

The necessary cost for constructing storage yards will be paid by the municipality concerned, without excluding, however, residents' labour and/or cash contribution in accordance with the beneficiaries pay principle.

(5) Collection in the self-disposal areas in the PCA and the isolated areas

1) Solid waste management in the self-disposal areas in the PCA

As denote the terminology "self-disposal areas", any kind of collection service does not and will not take place in these areas, because of

- a. Impossibility of a regular collection service due to a lower population density,
- b. Impracticability of operation originating from geographical conditions, and extreme difficult access problems,
- c. High operation costs to be caused by long distance and small settlements scattered in vast rural zones.

A regular collection service does not fit the case; a proper principle for these areas, therefore, will be "self-disposal" by residents themselves under a properly planned municipal guidance. The municipal role is essential in this aspect; municipalities ought to take the following countermeasures such as:

- d. Residents education program on the SWM
- e. Technical instruction of how to dispose of solid waste sanitarly and in a proper manner (e.g. small scale individual composting, reduction of waste volume, household level incineration method etc.)
- f. Preparation of a plain and simple guide for the environmental protection,
- g. Periodical and proper on site instructions, including video projection on sanitation problem and demonstration of waste disposal.

- h. Practical guidance on waste disposal method which is likely to be selected in the future, etc.

2) Collection of waste in the isolated area

Principle is the on-site collection and disposal. This means a full participation of resident; whether as an individual or as a community member. Alternatives for collection method can be divided into three types.

- a. Waste collection by each resident, where each individual habitant will discharge his own waste to a designated place of disposal.
- b. Communal collection system; in which collection operation will be carried out by collectors appointed or elected from among the community members at the cost of working funds of community.
- c. Contracting-out of collection service or zone concession to the private. In this case, the study on "concessions to Private Collectors" will be applicable with some necessary restrictions. One of main restrictions will be related to a payable consignment fee.

## 8.2 Final Disposal

### 8.2.1 Construction Method and Improvement Planning of EL Trebol Landfill

#### (1) Basis of improvement planning of the EL Trebol

##### a. Method of solid waste landfilling:

Controlled landfilling from the gully bottom

##### b. Approximate quantity of solid waste to be hauled to the site from 1990 to 2000:

1990	-----	133,400	tons/year
'91	-----	136,600	
'92	-----	139,800	
'93	-----	142,800	
'94	-----	145,940	
'95	-----	149,700	
'96	-----	152,700	
'97	-----	155,640	
'98	-----	158,520	
'99	-----	161,350	
2000	-----	164,000	

##### c. Targeted period of the landfill - up to the year 2000

##### d. Scavengers operation has to be allowed

#### (2) Construction method

The selection of the most suitable construction method in accordance with such complicated topography in EL Trebol will be definitely the decisive factor for the success of its improvement.

A comparative study on the three alternatives has been conducted for the selection of the most suitable one.

Three alternatives are as follows and its comparison in detail is shown in the attached Table III-3.2-1 of the F/S:

- 1) Truck access to bottom method
- 2) Platform method
- 3) Slope method

As the most appropriate construction method, "slope method", has been selected.

(3) Improvement planning

The improvement planning of EL Trebol landfill will consist of four categories; construction of common facility, administration facility, operational equipment and environmental protection facility.

- 1) Construction of common facility is detailed as follows: (Refer to Fig. III-3.2-1 - Fig. III-3.2-5.)

- a. Improvement of main existing road

The existing main road will be paved with asphalt.

- b. Slope

A slope will be constructed to facilitate the transport of waste and covering materials such as construction and demolition wastes from the waste unloading area to the gully bottom.



c. Ground preparation

Present ground at top level will be improved and prepared for safe operation by site workers and scavengers.

d. Internal road construction

The internal roads and areas for unloading solid waste, covering material will be constructed in order to facilitate the safe unloading.

2) Construction of administration facility

The facility is as follows:

a. Fence with gates

The existing fence will be partially reconstructed with new gates and extended to enclose the site completely in order to separate the site from the surrounding residential areas. Gates will function to control the movement of vehicles, people and animals.

b. Shed for operators

c. Oil tank yard

Fuel oil tanks (ordinary oil containers) will be placed at the yard.

d. Work shop

Usually maintenance of operational equipments such as bulldozers and shovel loaders will be repaired in the work shop.

e. Parking lot

3) Operational equipment

To carry out the landfill operation the following equipments should be acquired in accordance with the amount of the waste to be landfilled and other conditions such as topography for instance.

a. Bulldozers

Bulldozers which have the capacity to operate at a soft ground condition, with a specific mechanism to avoid any clogging with the wastes at the sprocket and wheels, should be required. The existing old bulldozers will be incorporated with the said bulldozers.

b. Shovel loaders

To obtain the soil as covering material the shovel loaders are needed, which will work together with the dump trucks.

c. Truck scale

To grasp the total weight of the waste hauled to the site for controlling of the landfill schedule, the truck scale will be installed at the entrance of the site.

4) Environmental protection facility

To improve and protect the present environmental conditions at EL Trebol, the followings facilities are required:

a. Submerged pumps

The pump will be used for leachate circulation to spray it over the waste with an expectation of natural evaporation and oxidation.

b. Leachate reserve pond with dams

The pond consisting of a concrete and wire-mat dams will be constructed to reserve the leachate, on which leachate recirculation pumps will be located.

c. Aerators

Before coming to use the leachate circulation system, tentatively the aerator will be used for treating leachate by aeration at a small pond.

d. Rain water drainage system

To minimize the quantity of leachate, rain water at the top level ground will be drained to the outside of landfilling area.

(4) Landfill operation

1) Basic policy for landfill at EL Trebol

Basically landfill operation to improve EL Trebol landfill has to be performed in the way of controlled landfilling.

2) Transportation

Basically all waste collection vehicles will be weighed and then come to the specified lanes for unloading.

3) Controlled landfill

The waste unloaded, after the recovery of some valuables items by scavengers, will be pushed down on the slope to the gully bottom.

Construction and demolition wastes, soil and etc. will be also pushed down on the slope to be used as covering materials.

On the slope the waste and covering materials have to be forwarded to the gully bottom by heavy duty type bulldozers.

From the gully bottom the waste has to be pushed to the working face, and then spread, compacted, and covered with the covering material by the same type bulldozer.

(4) Waste covering

At the gully bottom the waste spreading and compacting will be performed through 6 days from Monday to Saturday morning, and soil covering will

be done during Saturday afternoon.

(5) Environmental protection

The following measures will be taken at El Trebol to protect the environment:

a. Air pollution

By means of covering the compacted waste with covering materials, air pollution to the neighboring residential areas, caused by spontaneous combustion, dusts and bad smell will be prevented.

b. Ground water pollution

By means of tentative aeration of leachate with an aerator in a small pond, and leachate circulation system reduction of ground water contamination can be expected.

c. Sanitary condition

With the facilities such as fence, gates and improved access roads, sanitary condition of the people living or working inside or outside of the site will be greatly improved.

(6) Recommendation

Special attention must be paid to the importance of constant acquisition of cover material such as soil and construction and demolition wastes as much as possible realizing its necessity at any cost for environmental protection.

For that purpose the Guatemala City government should be responsible and take a concrete action to obtain such materials.

To facilitate the acquisition of cover material, an establishment of a rule putting the governmental agencies and/or private constructors under obligation to bring such materials to the landfill site as the first priority would be recommendable.

### 8.2.2 Construction Method and Planning of Las Guacamayas Landfill Site

#### (1) Basis of construction planning of Las Guacamayas

##### a. Method of solid waste landfilling:

Sanitary landfilling from the gully bottom

##### b. Volume of solid waste to be hauled to the site from 1990 to 2000:

1990	-----	0 tons/year
'91	-----	0
'92	-----	0
'93	-----	150,907
'94	-----	165,305
'95	-----	180,285
'96	-----	191,243
'97	-----	202,267
'98	-----	213,366
'99	-----	224,537
2000	-----	235,783

##### c. Targeted period of the landfill - up to the year 2000

##### d. Sanitary landfill from the beginning

(2) Construction method

The selection of the most suitable construction method in accordance with such complicated topography in Las Guacamayas will be a decisive factor for success of landfill.

A comparative study on the three alternatives has been conducted for selection of the most suitable one. Three alternatives are as follows and its comparison in detail is shown in the attached Table III-3.2-1.

- a. Truck access to bottom method
- b. Platform method
- c. Slope method

As the most appropriate construction method "slope method" was selected. (Refer to Fig. III-3.3-1 - Fig. III-3.3-8.)

(3) Construction planning

Construction planning consists of four categories; construction of common facility, administration facility, operational equipment and environmental protection facility.

1) Construction of common facility is detailed below.

- a. Internal access roads

These roads will be used for waste collection vehicles to access to the waste unloading area. They will also be used by other trucks for construction work.

b. Slope

The slope will be constructed for waste, and construction and demolition waste transportation from the waste unloading area to the gully bottom.

c. Ground preparation

Present ground at top level will be prepared not only for landfill operation, but also for location of the administration facility.

2) Construction of administration facility

The following facility will be constructed:

a. Fence with gates

The fence will be constructed to enclose the site completely in order to separate the site from the surrounding residential areas. Gates will function to control the movement of vehicles, people and animals.

b. Shed for operators

c. Oil tank yard

Fuel oil tanks (ordinary oil containers) will be placed at the yard.

d. Work shop

Usually maintenance of operational equipments such as bulldozers and back hoes will be repaired in the work shop.



e. Parking lot

3) Operational equipment

To carry out the landfilling operation the following equipments will be needed in accordance with the amount of the waste to be landfilled and other condition such as topography for instance.

a. Bulldozers

Bulldozers which have the capacity to operate at a soft ground, with a specific mechanism to avoid any clogging by the wastes at sprockets and wheels, will be required.

b. Back hoe

In case of Las Guacamayas a lot of soil produced from the landfill site construction can be used for covering of waste.

For this purpose the back hoe will be used to remove the soil and load into the dump trucks.

c. Truck scale

To grasp the total weight of the waste hauled to the site for controlling of the landfill schedule, a truck scale will be installed at the entrance part of the site.

4) Environmental protection facility

To protect the present environmental condition the following equipments will be needed:

a. Submerged pumps

The pump will be used for leachate circulation to spray it over the waste with an expectation of natural evaporation and oxidation.

b. Leachate reserve pond with dams

The pond consisting of concrete and wire-mat dams will be constructed to reserve the leachate, on which leachate recirculation submerged pumps will be located.

c. Aerators

Before coming to use the leachate circulation system, tentatively the aerator will be used for treating leachate by aeration at the small pond.

d. Rain water drainage system

To minimize the quantity of leachate, rain water at the top level ground will be drained to the outside of landfilling area.

(4) Landfill operation

1) Basic policy for landfill at Las Guacamayas

Basically a landfill has to be performed in the way of sanitary landfilling.

2) Transportation

Basically all waste collection vehicles will be weighed and then come to the specified area for unloading.

### 3) Sanitary landfilling

The waste unloaded will be pushed down on the slope by the bulldozers to the gully bottom.

Construction and demolition wastes, soil and etc. will also be pushed down on the slope as cover material.

On the slope the waste and cover material have to be forwarded to the gully bottom by heavy duty type bulldozers.

From the gully bottom the waste has to be pushed to the working face, and then spread, compacted and covered with the cover material by the same type bulldozers.

At the gully bottom, leachate collecting ditches consisting of clay, cobble stones, synthetic rubber sheets and soil will be constructed in order to prevent the ground water from contamination due to leachate permeation, before starting of landfill.

### 4) Waste covering

The waste at the gully bottom will be covered with the covering materials every day.

### (5) Environmental protection

The following measures will be taken at Las Guacamayas to protect the environment:

a. Protection of gully erosion

Dangerous situation due to undergoing gully erosion which is nearing to the residential area of Guacamayas would be overcome by landfilling.

b. Air pollution

By means of covering of the compacted waste with covering materials, air pollution to the neighboring residential areas caused by spontaneous combustion, dusts and bad smell will be prevented.

c. Ground water pollution

By means of tentative aeration of leachate with an aerator in the small pond, and leachate circulation system, reduction of ground water contamination can be expected in association with the construction of leachate collection ditches at the gully bottom.

d. Countermeasure against the spring water at the gully bottom

Spring water which is likely to cause the erosion of gully and increase leachate volume will be piped to the downstream of the landfill area.

e. Sanitary condition

With the facilities such as fence, gates and access roads, sanitary condition of the people living or working inside or outside of the site will be maintained.

(6) Recommendation

Special attention must be paid to the importance of constant acquisition of cover material such as soil, and construction and demolition wastes as much as possible, realizing its necessity at any cost for environmental protection.

For that purpose Guatemala City Government should be responsible and take a concrete action to obtain such materials. To facilitate the acquisition of cover material, an establishment of a rule putting the governmental agencies such as public service department, planning department, civil construction department and EMPAGUA etc. and/or private constructors under obligation to bring such materials to the landfill site as the first priority, would be recommendable.

Meanwhile, Guatemala City Government should also consider and investigate continuously about the erosion problem due to the spring water at the bottom of the gully.

Guatemala City Government shall obtain the right of utilization of Las Guacamayas Gully from the relative land owner.

## 9. Financial Planning

### 9.1 Costs

The new organization replacing the DLPM will incur the following costs to improve the solid waste situation described in Chapter 8.

- (1) Capital costs: For the purchase of vehicles, the preparation of maintenance facilities, the improvement of "El Trebol" and the construction of a new landfill.
- (2) Operational costs: For fuel and maintenance of vehicles and landfilling at El Trebol and Las Guacamayas. Furthermore, additional operation costs will be considered for improvements in collection services and the final disposal of waste.

#### 9.1.1 Capital Costs

##### (1) Collection and transport

Compactor truck: to be purchased

1992: 18 vehicles

1995: 19 vehicles

Price US\$55,000 in 1991

Open truck (dump-type): to be purchased

1992: 4 vehicles

1995: 2 vehicles

Price US\$35,000 in 1991

Maintenance facilities: shall consist of a building, furniture, and tools

1992: US\$20,000 (1991 price)

(2) Final disposal

El Trebol: controlled landfill

1992: Q. 7,073,400 (price in 1991)

1995: Q. 2,674,000 ( " )

1997: Q. 714,000 ( " )

1998: Q. 2,674,000 ( " )

Las Guacamayas: Sanitary landfill

1992: Q. 15,298,000 (price in 1991)

1995: Q. 954,000 ( " )

1996: Q. 2,229,500 ( " )

1998: Q. 2,474,000 ( " )

A summary of the capital costs is provided in Table II-9.1-1.

Table II-9.1-1 SUMMARY OF NEW CAPITAL COSTS

(1000Q)

YEAR	COLLECTION			TOTAL	FINAL DISPOSAL		TOTAL	CAPITAL TOTAL
	CMPCT	OPEN	FCLTS		TREBOL	GUACA.		
1991	0	0	0	0	0	0	0	0
1992	4950	700	100	5750	7073	15298	22371	28121
1993	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0
1995	5225	350	0	5575	2674	954	3628	9203
1996	0	0	0	0	0	2230	2230	2230
1997	0	0	0	0	714	0	714	714
1998	0	0	0	0	2674	2474	5148	5148
1999	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
<b>TOTAL</b>	<b>10175</b>	<b>1050</b>	<b>100</b>	<b>11325</b>	<b>13135</b>	<b>20956</b>	<b>34091</b>	<b>45416</b>

FOOTNOTE :

(1) COLLECTION EQUIPMENTS

COMPACTOR TRUCK PRICE 275 1000Q/truck  
NUMBER 18 at 1992, 19 at 1995

DUMP TRUCK PRICE 175 1000Q/truck  
NUMBER 4 at 1992, 2 at 1995

FACILITY, TOOLS etc 100 1000Q at 1992

(2) FINAL DISPOSAL

TREBOL(controlled) 7073 1000Q at 1992  
5348 1000Q for 4 BULLDOZERS  
396 1000Q for 2 SHOVEL LOADERS  
2674 1000Q at 1995  
2674 1000Q for 2 BULLDOZERS  
714 1000Q at 1997  
2674 1000Q at 1998  
2674 1000Q for 2 BULLDOZERS  
GUACAMAYAS(sanitary) 15298 1000Q at 1992  
8022 1000Q for 6 BULLDOZERS  
1785 1000Q for 2 BACK HOE LOADERS  
954 1000Q at 1995  
2230 1000Q at 1996  
1337 1000Q for 1 BULLDOZER  
893 1000Q for 1 BACK HOE LOADER  
2474 1000Q at 1998



### 9.1.2 Additional Operating Costs

#### (1) Personnel

Director	from 1992	Q3,500/month (Price in 1991)
Sanitary Engineer	from 1992	Q2,700/month (Price in 1991)

#### (2) Collection and transport

1992-1994:	US\$84,000/year (price in 1991)
1995-2000:	US\$41,000/year ( " )

#### (3) Final disposal

##### El Trebol:

1992-1994:	Q. 2,361,140/year (price in 1991)
1995-1996:	Q. 2,879,090/year ( " )
1997 :	Q. 2,971,690/year ( " )
1998-2000:	Q. 3,450,480/year ( " )

##### Las Guacamayas:

1993-1995:	Q. 1,049,940/year (price in 1991)
1996-1997:	Q. 2,636,960/year ( " )
1998-2000:	Q. 2,729,560/year ( " )

A summary of additional operating costs is shown in Table II-9.1-2.

Table II-9.1-2 SUMMARY OF ADDITIONAL OPERATION COSTS

(1000Q)

YEAR	PROFESSIONAL PERSON. COST	COLLECTION & TRANSPORT	LAND FILL		TOTAL	TOTAL
			TREBOL	GUACA.		
1991	0	0	0	0	0	0
1992	74	420	2361	0	2361	2856
1993	74	420	2361	1050	3411	3905
1994	74	420	2361	1050	3411	3905
1995	74	205	2879	1050	3929	4208
1996	74	205	2879	2637	5516	5795
1997	74	205	2972	2637	5609	5888
1998	74	205	3450	2730	6180	6459
1999	74	205	3450	2730	6180	6459
2000	74	205	3450	2730	6180	6459
TOTAL	670	2490	26165	16612	42777	45937

FOOTNOTE :

(1) PROFESSIONAL PERSONNEL COST

DIRECTOR 3500 Q/month

SANI. ENG. 2700 Q/month

(2) COLLECTION & TRANSPORT COST (FUEL, MAINTENANCE & REPAIR)

1992--1994 84 1000US\$/yr

1995--2000 41 1000US\$/yr

EXCHANGE RATE 5.0 Q/\$ at beginning of 1991

(3) FINAL DISPOSAL COST (FUEL, MAINTENANCE, ELEC., SOIL & ETC)

EL TREBOL 2361 1000Q/year 1992 to 1994

2879 1000Q/year 1995 to 1996

2972 1000Q/year 1997

3450 1000Q/year 1998 to 2000

LAS GUACAMAYAS 1050 1000Q/year 1993 to 1995

2637 1000Q/year 1996 to 1997

2730 1000Q/year 1998 to 2000

## 9.2 Case Study

Two cases were examined to evaluate the financial performance of DLP:

An interest rate of 8% corresponds to a normal loan, while a rate of 4% corresponds to a soft loan, which the Municipality can obtain from foreign governments or international credit organizations.

The SWM's budget ratio for each case is shown in Table II-9.2-1 to II-9.2-2. Their averages are summarized below:

Interest rate		
8%	4%	Difference
21.38%	20.47%	0.91%
(24.14%)	(23.19%)	(0.95%)

Note: ( ) indicates the maximum ratio.

As a result, it can be concluded that:

- (1) It is necessary for the Municipality to increase the SWM budget about 70-80% over the next decade, if the Municipality wants to improve the actual SWM situation.
- (2) The necessary budget for the sanitary landfill will be noticeably large. The operational unit cost of sanitary landfill in Las Guacamayas is estimated to be about \$2.00 per ton, compared with its present value \$0.40/ton at the El Trebol site. This cost, however, is necessary, if the Municipality wants to implement sanitary landfills. As a reference, landfill costs in the USA and Japan are reported to be about \$20 - 30/ton, generally.

- (3) The difference between the two interest rates is large, totalling about Q8.1 million.

$$45,421 - 37,328 = 8,093 \text{ (Q1,000)}$$

Therefore, the Municipality should study the possibility of obtaining a long-term soft loan to manage solid waste from an international credit organization. To do so, it is first necessary for SEGEPLAN to list this as a national project with high priority.

Table II-9.2-1 ESTIMATION OF DLPM'S BUDGET TO BE NEEDED  
(CASE-1, ANNUAL INTEREST RATE OF 8%)  
(1000Q)

YEAR	EXISTING BUDGET	ADD.OPE.	DEBT SERVICE PAYMENT	TOTAL DLPM BUDGET	MUNICIPAL BUDGET	RATIO (%)
1990	5818	0	0	5818	55283	10.52
1991	6674	0	0	6674	68563	9.73
1992	6674	2856	0	9530	71419	13.34
1993	6674	3905	5062	15642	77530	20.17
1994	6674	3905	4837	15417	77305	19.94
1995	6674	4208	4612	15495	77383	20.02
1996	6674	5795	6043	18513	80402	23.03
1997	6674	5888	6146	18709	80597	23.21
1998	6674	6459	5958	19092	80981	23.58
1999	6674	6459	6563	19697	81585	24.14
2000	6674	6459	6199	19333	81222	23.80
TOTAL	60069	45937	45421	151427	708425	21.38

FOOTNOTE :

(1) CAPITAL COSTS

COLLECTION	VEHICLES	:	11225	1000Q
	FACILITIES	:	100	1000Q
	TOTAL	:	11325	1000Q
F. DISPOSAL	TREBOL	:	13135	1000Q
	GUACAMAYA	:	20956	1000Q
	TOTAL	:	34091	1000Q

(2) LOAN CONDITIONS

REPAYMENT PERIOD	:	10 years
GRACE PERIOD	:	0 years
INTEREST RATE	:	8.00 %/year

(3) AFTER 1992, MUNICIPAL BUDGET IS DEFINED AS FOLLOWS:  
MUNICIPAL BUDGET OF 1991 + OPEARTION COSTS  
+ DEBT SERVICE PAYMENT

(4) OTHERS

SUBSIDY OF URBAN TRANSPORT IS DELETED FROM MUNICIPAL BUDGET

Table II-9.2-2 ESTIMATION OF DLPM'S BUDGET TO BE NEEDED  
(CASE-2, ANNUAL INTEREST RATE OF 4%)  
(1000Q)

YEAR	EXISTING BUDGET	ADD.OPE.	DEBT SERVICE PAYMENT	TOTAL DLPM BUDGET	MUNICIPAL BUDGET	RATIO (%)
1990	5818	0	0	5818	55283	10.52
1991	6674	0	0	6674	68563	9.73
1992	6674	2856	0	9530	71419	13.34
1993	6674	3905	3937	14517	76405	19.00
1994	6674	3905	3825	14404	76293	18.88
1995	6674	4208	3712	14595	76483	19.08
1996	6674	5795	4888	17358	79246	21.90
1997	6674	5888	5051	17613	79502	22.15
1998	6674	6459	4993	18126	80015	22.65
1999	6674	6459	5552	18686	80575	23.19
2000	6674	6459	5371	18504	80393	23.02
TOTAL	60069	45937	37328	143333	700331	20.47

FOOTNOTE :

(1) CAPITAL COSTS

COLLECTION	VEHICLES :	11225	1000Q
	FACILITIES :	100	1000Q
	TOTAL :	11325	1000Q
F. DISPOSAL	TREBOL :	13135	1000Q
	GUACAMAYA :	20956	1000Q
	TOTAL :	34091	1000Q

(2) LOAN CONDITIONS

REPAYMENT PERIOD	:	10 years
GRACE PERIOD	:	0 years
INTEREST RATE	:	4.00 %/year

(3) AFTER 1992, MUNICIPAL BUDGET IS DEFINED AS FOLLOWS:

MUNICIPAL BUDGET OF 1991 + OPEARTION COSTS  
+ DEBT SERVICE PAYMENT

(4) OTHERS

SUBSIDY OF URBAN TRANSPORT IS DELETED FROM MUNICIPAL BUDGET

### 9.3 Projection of Budget

The SWM budget required until year 2000, will be as follows:

#### Operational costs

1991	Q6.7 million/year
1992-2000	Q11.8 million/year (average) an increase of 100%

Debt service payment, in case of interest rate of 4%

1992-2000	Q4.1 million/year (average)
-----------	-----------------------------

As a result, it is necessary to increase the existing DLPM's budget from Q6.7 in 1991 to 11.8 million/year as operational cost and about Q4.1 million/year as debt service payment. (Refer to Figure II-9.3-1.)

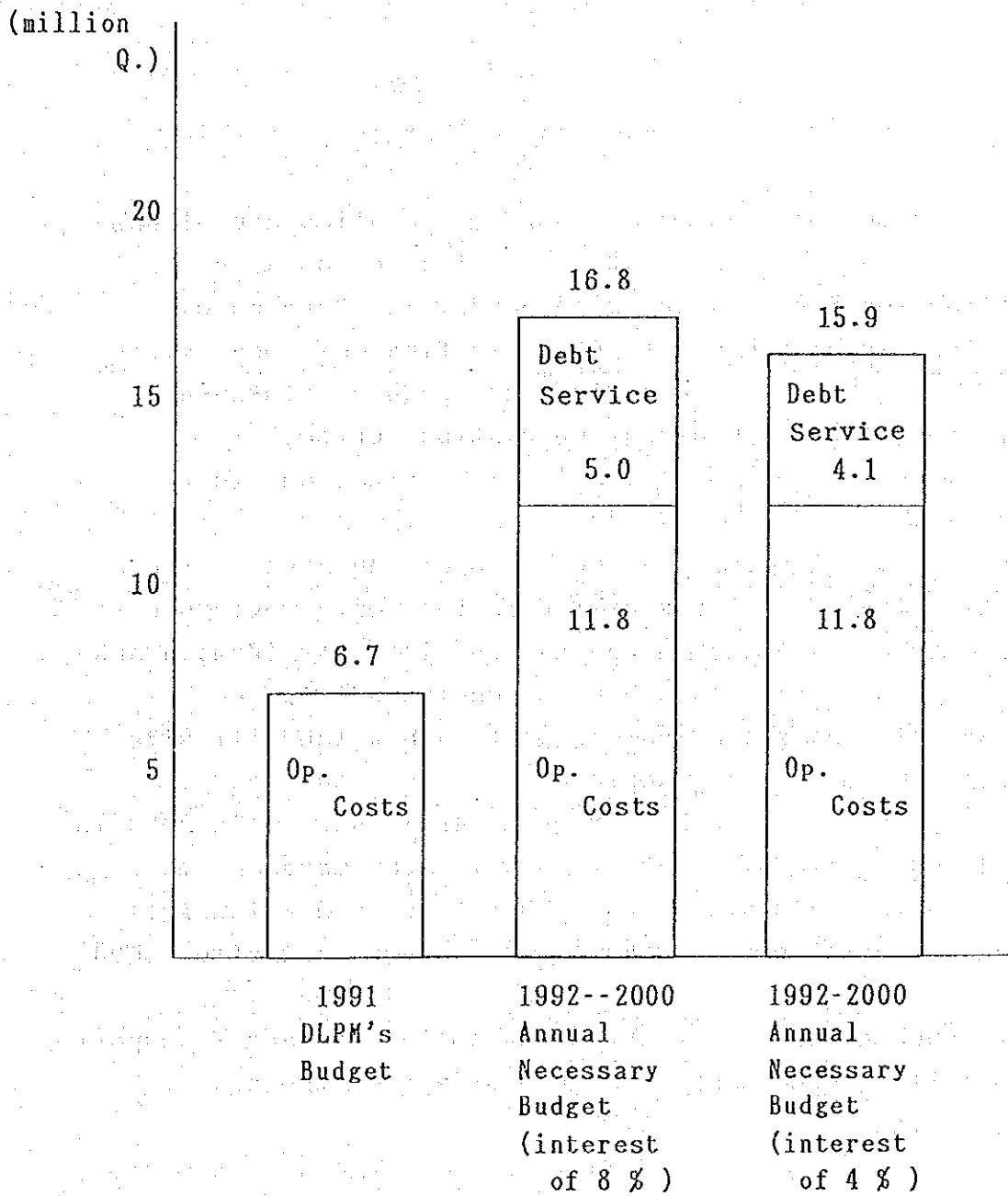


Figure II-9.3-1 Necessary budget for improvment of SWM



## 10. Items to be Studied after Year 2000

### 10.1 Collection and Transport

#### 10.1.1 New Landfill Site and New Collection System

Collection service and transport operation are planned and carried out in consideration of final disposal sites and collection services areas. In addition, design of collection routes and access roads to final disposal sites is hampered by a lot of restrictions, such as distance, traffic conditions, number of population served, distribution of population density, urbanization etc.

Population increase in the Metropolitan Area of the Guatemala City is really striking in the south-western part (Mixco City) and in the north-eastern districts (Zona 6 and especially Zona 18). As urbanization is and will be remarkable in the south-western part, a new landfill site has been decided at Las Gacamayas. On the other hand, population forecast in the north-eastern district in 2000 is over 386,000. Traffic congestion will grow more and more intense in the said districts. Therefore, a new landfill site should be planned in the north-eastern part after 2000.

In such a case, a study on new collection and transport system will be necessary to make best use of the new landfill site.

#### 10.1.2 Waste Treatment and New Collection System

Also, after 2000, it will be necessary to examine a feasible and appropriate system of waste treatment (gas recovery from landfills, composting, incineration, etc.) to cope with a waste problem. Should such a system be introduced, collection and transport system must be revised and implemented to meet new conditions of the SWM.

## 10.2 Transfer Station

After 2000, one to three transfer stations will be indispensable, specifically in the south, south-western and south-eastern parts of the Study Area, on condition that no new landfill site would be opened there. Because transfer station(s) cut the hauling distance considerably, eliminating the non-productive time spent by the collection crews going to and coming from the landfill. It will reduce manpower and equipment requirements as well as fuel and maintenance costs. On the other hand, it will require special transport equipments suitable to haul a large quantity of waste to landfill sites. In addition, a specially designed facility is also indispensable in order to keep environmental conditions clean and to facilitate transshipment from collection trucks to hauling equipments.

## 10.3 Final Disposal

With the essential reasons of financial difficulty and fundamental policy of Guatemala City to avoid location of landfill sites in the southern basin of Guatemala Valley for environmental reasons, Las Guacamayas has been selected as the new landfill site which has already been clearly mentioned previously.

It may be convenient to remind that the Las Guacamayas site is good enough only to satisfy the landfilling requirements until the year 2000.

Meanwhile, further more landfill sites would be needed after the year 2000 in the areas far from the El Trebol, such as Villa Nueva and Santa Catarina Pinula.

However, in this case, a study on the most basic conditions, such as the efficiency of transportation, financial feasibility and environmental problems should be conducted prior to the construction of more landfills.

In particular, for the southern part such as Villa Nueva, for instance, sanitary landfilling method coupled with complete leachate treatment should be used taking into account the possible negative impact on the lake of Amatitlan.

## 11. Implementation Schedule

### 11.1 Operational Aspect

#### 11.1.1 Collection and Transport

Implementation schedule in every five years from 1990 to 2000 is shown in the following two tables.

Table II-11.1.1-1 Implementation Schedule (Service Coverage)

	Year	1990			1990			1990		
		(t/W.D.)	(%)	(%)	(t/W.D.)	(%)	(%)	(t/W.D.)	(%)	(%)
Service Coverage, Results & Forecast	Note									
1. Easy Collection Area	Service covered	456.24	76.4	-	799.44	92.2	-	1,166.11	100.0	-
	Service non-covered	141.22	23.6	-	67.66	7.8	-	-	0	-
	(Sub-total)	(597.46)	(100.0)	61.7	(867.10)	(100.0)	68.3	(1,166.11)	(100.0)	73.2
2. Possible Collection Area	Service covered	57.45	17.8	-	217.27	65.1	-	211.25	62.9	-
	Service non-covered	196.54	61.0	-	21.49	6.4	-	-	0	-
	Self-disposal	68.39	21.2	-	95.24	28.5	-	124.68	37.1	-
(Sub-total)	(322.18)	(100.0)	33.2	(334.00)	(100.0)	26.2	(335.93)	(100.0)	21.1	
3. Isolated Area	Service non-covered	49.49	100.0	-	69.37	100.0	-	91.19	100.0	-
	(Sub-total)	(49.49)	-	5.1	(69.37)	(100.0)	5.5	(91.19)	(100.0)	5.7
Total		969.13		100.0	1,270.47		100.0	1,593.28		100.0

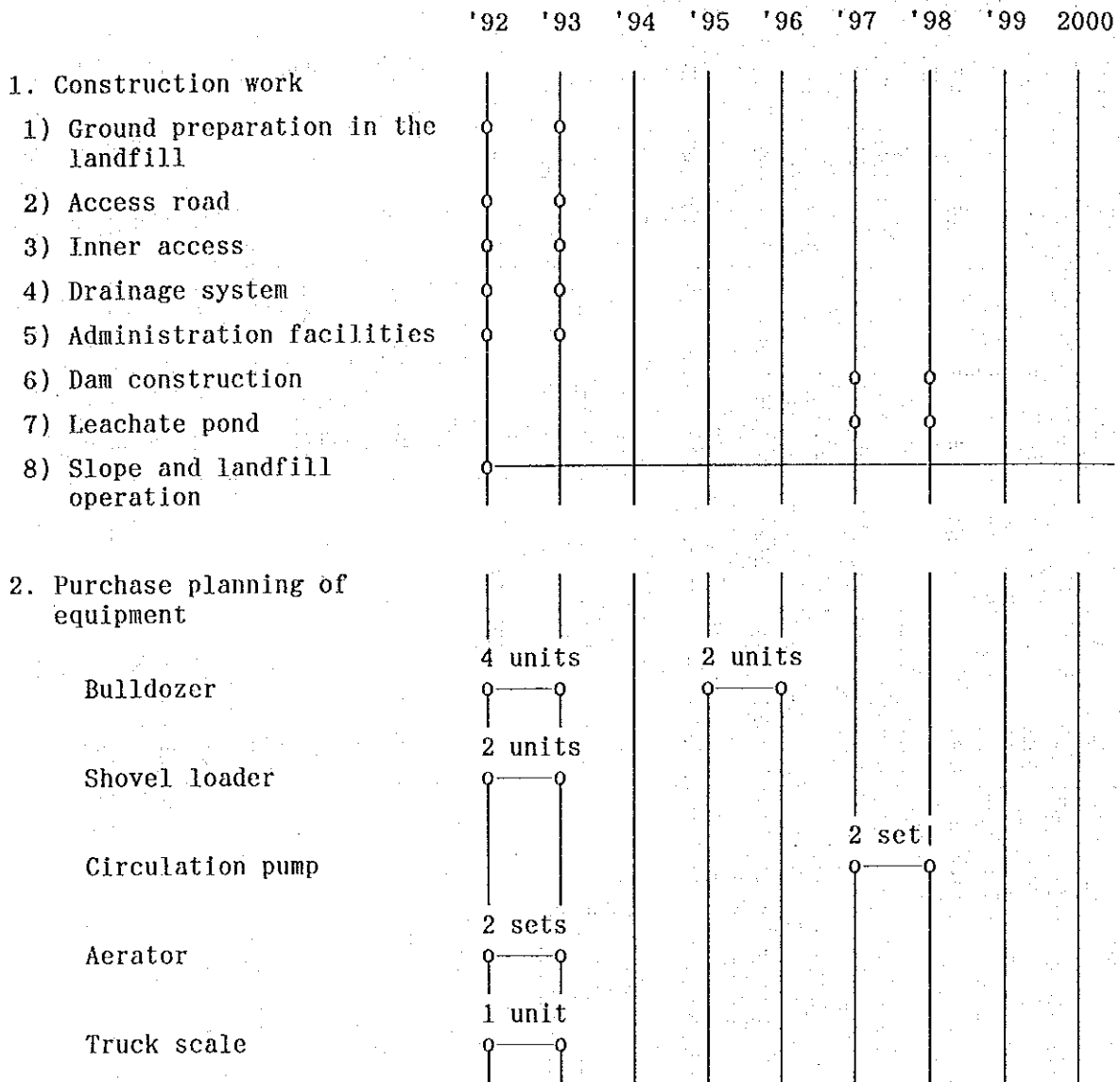
Table II-11.1.1-2 Implementation Schedule  
(Population and Waste Quantity)

Population and Waste Quantity	Year	1990			1995			2000		
		Note	(Popula- tion)	(t/W.D.)	(Popula- tion)	(t/W.D.)	(Popula- tion)	(t/W.D.)		
(1) 1. Easy										
(2) Regular Service Area	S. covered	690,894	437.12	951,347	675.49	1,163,135	905.38			
(3) Low-income Area	S. covered	30,216	19.12	91,577	65.02	174,107	135.53			
(4) Marginal	S. non-covered	116,745	73.56	69,079	49.06	-	-			
(5) Marginal	S. covered	-	-	82,996	58.93	160,839	125.20			
(6) (Sub-total)	S. non-covered	106,475	67.36	26,207	18.60	-	-			
(7) 2. Possible		(944,330)	(597.46)	(1,221,206)	(867.10)	(1,498,081)	(1,166.11)			
(8) Regular Service Area	S. covered	19,200	12.15	219,005	155.50	235,388	183.23			
(9) Marginal Area	S. covered	71,230	45.10	87,000	61.77	36,003	28.02			
(10) Self-disposal Area	S. non-covered	310,648	196.54	30,267	21.49	-	-			
(11) (Sub-total)	S. non-covered	108,097	68.39	134,135	95.24	160,172	124.68			
(12) 3. Isolated		(509,235)	(322.18)	(470,407)	(344.00)	(431,563)	(335.93)			
(13) Self-disposal Area	S. non-covered	78,225	49.49	97,693	69.37	117,161	91.19			
(14) (Sub-total)		(78,125)	(49.49)	(97,693)	(69.37)	(117,161)	(91.19)			
(15) Total		1,531,790	969.13	1,789,306	1,270.47	2,046,805	1,593.28			
Waste amount, Results & Forecast										
15) 1. Recovered amount (t/W.D.)			30.17		74.60		110.19			6.9(%)
16) 2. Collected amount (t/W.D.)	Municipal Private (Total)		45.12 438.19 (483.31)		(942.11)		(1,267.22)			79.6(%)
17) 3. Waste amount non-collected			337.77		89.15		0			0
18) 4. Amount self-disposed	10) + 12)		117.88		164.61		215.87			13.5(%)
19) Total	19)=15)+16)+ 17)+18)		969.13		1,270.47		1,593.28			
20) Waste amount (to be) hauled to landfill site(s)	Equivalent to (6)		483.31		942.11		1,267.22			

11.1.2 Implementation schedule of the EL TREBOL landfill site

The schedule is shown in Table II-11.1-3.

Table II-11.1-3 Implementation Schedule of the El Trebol Landfill Site



11.1.3 The implementation schedule of the sanitary landfill in Las Guacamaya

The schedule is shown in Table II-11.1-4.

Table II-11.1-4 Implementation Schedule of the New Sanitary Landfill in Las Guacamaya

	'92	'93	'94	'95	'96	'97	'98	'99	2000
(1) Construction work									
1) Ground preparation	○—○								
2) Access roads	○—○								
3) Drainage system	○—○								
4) Administration facilities	○—○								
5) Dam construction							○—○		
6) Leachate pond							○—○		
7) Leachate collection ditch	○—○			○—○			○—○		
(2) Purchase planning of equipment									
1) Bulldozers	6 units			1 unit					
2) Barkhoe	2 units			1 unit					
3) Circulation pump	2 sets								
4) Aerator	2 sets								
5) Track scale	1 unit								

The construction of Las Guacamayas landfill site will be executed during 1992, however, leachate collection ditch and leachate pond and dam construction are to be executed according to the above table.



## 11.2 Institutional Aspects

### 11.2.1 Institutional Organization

- (1) Approval of the new organizational structure of the Public Cleansing Service (DLP) by the Municipal Corporation OCT. 1991
- (2) Formation of a Work Group (GT), to facilitate the transition of the present DLPM to a new organization OCT.-DEC. 1991
- (3) Preparation of the draft of budget of the Public Cleansing Service for 1992 AUG.-OCT. 1991
- (4) Implement the new Public Cleansing Service organization, making changes and transfers of municipal personnel required and putting into operation of the new Private Collection Planning Unit JAN.-DEC. 1999
- (5) Use of management indicators, commencing preparation from January 1991 1992-2000
- (6) Collection of information and setting up of a database during 1992, commencing its use 1992-2000
- (7) Organize the Metropolitan Solid Waste Committee (CMDS) and commence intermunicipal coordination activities OCT. 1991-MAR. 1992

- (8) Evaluate and carry out the necessary adjustments regarding institutional, organizational and financial aspects and others proposed in the M.P. OCT.-DEC. 1995
- (9) Preparation of the long-term plan for the selection of new sites for future sanitary fills in the Metropolitan Area 1993 - 1998
- (10) Preparation of the solid waste usable component recovery and recycling program, in an attempt to obtain 8% recovery of solid waste in the year 2000 1992-2000

#### 11.2.2 Community Education and Participation

- (1) Preparation of a program for the community education and participation in solid waste handling by the Planning Unit AUG.-DEC. 1991
- (2) Incorporation of a professional (social worker) to the DLP, to take charge of the community education and participation program AUG. 1991
- (3) Development of the community education and participation program, including the use of the video prepared by JICA 1992-2000

#### 11.2.3 Personnel Training

- (1) Establish a permanent training program of Municipal Public Cleansing personnel, monitored by the Planning and Evaluation Unit 1992-2000

- (2) Training of personnel at three levels:
- 1) Management level:  
One official per year 1991-2000
  - 2) Intermediate level:  
Fifteen persons per year 1991-2000
  - 3) Operational level: Two sessions  
for 80 persons per year 1992-2000
- (3) Obtaining of financing for this program from international and bilateral technical cooperation and credit organizations 1992-2000

#### 11.2.4 Organizational Aspects of Private Collection

- (1) Continue operating during this decade with the dual collection system, private and municipal, with the participation of the present private collectors 1991-2000
- (2) Approval of concession zoning by the Municipal Corporation Jan.-Apr. 1992
- (3) Gradual granting of concessions:
  - 1) One zone 1992
  - 2) Three zones 1993
  - 3) Three zones 1994
  - 4) Four zones 1995
  - 5) Five zones 1996
  - 6) Other concessionable zones 1997-2000

- (4) Monitoring of the entire private collection process by the corresponding department of the Municipal Service 1992-2000

#### 11.2.5 Finance

- (1) Acquisition of foreign or international soft loan
- Study the possibility of acquisition of foreign or international soft loan, for example IDB, WB, and OECF of Japan, by the Municipality: in 1991
  - Approve this project as a national project with high priority, by SEGEPLAN: Jan-Mar in 1992
  - Negotiation with foreign or international financial organization by the Municipality: 1992 - 1995
- (2) Increase of SWM's budget
- Study the possibility of creation of new revenues of the Municipality including fees and tariffs: in 1992
  - Study the possibility of increase of existing fees and tariffs: in 1992
  - Study the possibility of changing distribution of the municipal budget, that is to increase DLPM's budget: in 1992
  - Study the possibility of requesting subsidies from the Central Government: in 1992

(3) Support for private collectors

- Financial support through granting the concession. Private collectors given the concession by the Municipality will be able to borrow money from commercial banks easily, in order to replace collection vehicles: 1992-2000.

11.3 Environmental Aspects

When organizing the new SWM (Solid Waste Management) system, it will be important to introduce a system to monitor the environment.

The following items should be monitored: 1992-2000

(1) City environment

Monitoring of clandestine open-dumping sites.

(2) Final disposal

- 1) Surface water monitoring in the river basin area
- 2) Ground water monitoring via monitoring wells
- 3) Leachate monitoring at retention ponds

Implementing the above monitoring system will allow final disposal conditions to be checked and clandestine open-dumping sites to be monitored.



### **III. FEASIBILITY STUDY**







## 1. Identification of Priority Projects

The policies to be implemented in stages by the year 2000 have been set out in the above MP. Among these, there are some first priority projects requiring urgent implementation. It is believed that the implementation of these first priority projects must be achieved by 1995 at the latest. Therefore, it is essential that the possibility of their implementation be determined as soon as possible.

To make this determination, the JICA Study Team (JST) conducted a feasibility study from January to March of 1991.

The subjects of this study are as follows:

- (1) The improvement of collection in marginal areas.
- (2) The improvement of the El Trebol landfill and the opening of a new sanitary landfill in Las Guacamayas.
- (3) The institutional development of the DLPM.

Although the period for this study was limited, the JST was able to obtain the data necessary to determine the feasibility of these projects with the cooperation of their counterparts in the Municipality of Guatemala and the related authorities.

The feasibility of implementation of the above projects by the following methods was confirmed by investigating the data and records obtained.

## 2. Pilot Projects

### 2.1 Container Pilot Project

#### 2.1.1 Objective of the Pilot Program

The objective of this pilot program was to study residents' response to and cooperation for the collection system in marginal areas based on the use of containers.

#### 2.1.2 Location of Containers

Containers were set up in places where the following conditions were met:

- (1) The location should be an outlying area.
- (2) The location should be a feasible collection site, and access via collection routes should be good.
- (3) The location should be served only by the Municipality.
- (4) The location should be nearby to unauthorized open dump sites.

Containers were set up in the following colonies.

Name of colony	Number of containers
Limonada (Zone 5)	3
Paraiso (Zone 18)	7
Alameda III (Zone 18)	8
Atlantida (Zone 18)	1
Limon (Zone 18)	1
Total	20

In the colonies of Limonada and Paraiso, small handcarts with drum containers were prepared to facilitate the transport of solid waste to containers.

### 2.1.3 Procedure

#### (1) Informing the residents about the containers

Residents' willingness to cooperate in the project for hauling solid waste to containers was tested in each of the areas. Initially, the information given about the containers differed somewhat in each area. In the Limonada colony, Don Alejandro Diaz, the director of DLPM and the members of JST visited the site to ask for cooperation from the leaders of the area. In Paraiso, the same procedure was undertaken. In Alameda IV, however, containers were explained to residents, but the leaders' cooperation was not solicited.

#### (2) Containers

Containers were constructed of steel and had a capacity of 0.93 m<sup>3</sup>. The containers were manufactured to fit the collection vehicles, which were produced by Iveco in Italy.

### 2.1.4 Duration of the Experiment

The pilot program was carried out from January 1991 to March 1991 by JST and DLPM.

### 2.1.5 Results

Average fullness of containers

238.9% at the Limonada colony

75.5% at the Alameda III colony

68.6% at the Paraiso colony

22.2% at the Atlantida colony

94.7% at the Limon colony

Except at the Atlantida colony, all containers were filled to over 60% of their capacity. The data suggests that the containers would be sufficient for the residents involved provided that proper operating conditions were maintained.

#### 2.1.6 General Evaluation

The pilot study was conducted at 5 locations--4 locations in zone 18 and 1 location in zone 5. The results show that residents of these communities were willing to put their waste into the containers. This suggests that the containers will be effective as a method for solid waste collection provided that the proper operating procedures are adhered to. Requisite conditions to ensure success of the program are shown below:

##### (1) Frequency of collection by DLPM

DLPM must collect waste often enough so that the immediate vicinity of the containers does not become filthy from the accumulation of excess waste. Filthy situation would jeopardize local residents' willingness to partake in the system.

##### (2) Public relations activities

The pilot study proved that it is essential to carry out public relations activities. Because waste collection in Guatemala City is carried out through a dual collection system, socio-economic aspects of the program carry more weight than technical aspects from the standpoint of ensuring the program's success. Containers should therefore be introduced only after an understanding has been reached between municipal

authorities and private collectors.

## 2.2 Video Program

### 2.2.1 Purpose

A video program was implemented as one of the pilot projects in the feasibility study. The purpose of the video program was to educate residents on how the system works and to advise collection workers how to collect solid waste more effectively.

### 2.2.2 Items Presented by Video

#### (1) Edition for housewives

One of the videos produced was specially geared for housewives living in low-income areas, where waste management and sanitary conditions are extremely poor and the rate of illiteracy is high. For the program's success, it is essential that these housewives learn proper ways to manage and dispose of solid waste.

#### (2) Edition for teachers, students, and children

In the same way, teachers, students and children will play an important role in the success or failure of solid waste management in years to come. This video explains the hazards of solid waste and shows proper methods for solid waste discharge and collection.

#### (3) Edition for waste collection workers

This video stresses to waste collection workers the importance of their job and therefore gives them a reason to be proud of what they do.

### 2.2.3 Presentation of Videos

Activities geared to residents of low-income areas should be carried out with the cooperation of community leaders, volunteer groups, or other active members of the community. The cooperation of these people is essential for arranging a place and time for video presentation.

### 2.2.4 Conclusion

We concluded that the videos were viewed favorably by residents who watched them. The video portrayed the waste management issue realistically, indicating the relationship between safe practices and people's health.

The video programs cited cholera as a disease that could result from inappropriate waste management. This proved very effective because it so happened that at the same time, cholera was running rampant through Central and South America.

### 2.2.5 Evaluation

The video presentations were a success. As of May 10, 1991, more than 20,000 people had seen the presentation. Viewers found both the contents and the way they were explained easy to understand. This project has therefore reconfirmed that audio-visual education programs employing videos are very effective in areas where the percentage of illiteracy is high.

### 2.2.6 Recommendation

A video-based educational program should be implemented to raise the public's awareness on sanitation issues. Such a program should also help to improve relations between residents and the municipal authorities.

## 2.3 Pilot Project of Preventive Maintenance

### 2.3.1 Background

At present, DLPM do not have sufficient collection vehicles for their daily work, because many of those vehicles which have been used more than 15 years are frequently submitted to a corrective maintenance and not to a preventive maintenance.

On the other hand, they do not have sufficient workshops nor tools for minor repairs or services, making the vehicles stay in the workshop more time than necessary.

In addition to above, as for the space, disused vehicles (junk) are deposited under small spaces having roof, which causes that in many cases, repairs are made in an unpaved yard causing problems, when it rains.

The shortage of reserve vehicles or "STAND-BY" makes it more difficult to carry out a preventive maintenance program, and it is practically impossible to do it in the nocturnal hours due to the difficulties of paying extra hours to the personnel.

In summary, the major problems detected in the preventive maintenance are as follows:

- (1) Lack of preventive maintenance program.
- (2) Lack of adequate installations for periodical inspections and minor repairs for the vehicles.
- (3) Lack of equipment and tools for preventive maintenance and minor corrective services.



- (4) Absence of a unit of maintenance, which, having sufficient resources, administrate, direct and control the maintenance of all the equipment of DLPM.
- (5) Lack of a maintenance unit which administer and control all the equipments of DLPM.

### 2.3.2 Object

The object of this pilot project was to evaluate the possible implementation of a preventive maintenance program of collection vehicles of DLPM, delivering the recommendation obtained as experiment results, destined to solve the problems and obstacles identified previously.

### 2.3.3 Development of Pilot Project

#### (1) Personnel training

With the object of updating the mechanical knowledge related to preventive maintenance and small repairs, the JST organized a training course for the mechanical personnel and assistants.

This course was made up of theoretical classes. Inspection sheets were prepared and explained so that attendants might cope with the present collection reality, and the current problems of the mechanical workshop of DLPM, in relation to personnel availability, tools, and equipment.

#### (2) Preventive maintenance program

A preventive maintenance program was revised and adjusted. At first, the program aimed at daily and monthly inspections. Now, quarterly, bi-annual, and annual inspections must be included. These should undoubtedly be implemented and evaluated by the DLPM.

The "Register of Repairs" and "Work Order" sheets are also to be revised and adjusted.

Regrettably, this work was detained when a unit was established which centralize the maintenance of all municipal vehicles, where the cleansing equipments have no priority and it seems that there is no preventive maintenance program for the moment.

(3) Manual for preventive maintenance

With the material that was prepared for the Preventive Maintenance Program, and with the material that was used in the training course for mechanics, a manual has been prepared with the purpose that it be used as a consultation manual, and also for the training of new personnels who join in the unit.

2.3.4 Evaluation

The conclusion is that the preventive maintenance program is feasible in its implementation by DLP, and its application will be effective to improve the operation rate of the vehicles, as well as to increase their life time.

On the other hand, JST has pointed to the high ranking Municipal officials the convenience of keeping the maintenance in the workshop of DLPM, and the recommendation has been accepted, which would mean that the proposed preventive maintenance can be carried out.