

REPUBLIC OF GUATEMALA
MUNICIPALITY OF GUATEMALA
THE STUDY ON SOLID WASTE MANAGEMENT
IN METROPOLITAN AREA OF GUATEMALA CITY

FINAL REPORT
VOLUME II MAIN REPORT

SEPTEMBER 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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国際協力事業団

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PREFACE

In response to a request from the Government of the Republic of Guatemala, the Government of Japan decided to conduct a study on Solid Waste Management in Metropolitan Area of Guatemala City and entrusted the study to the Japan International Cooperation Agency (JICA).

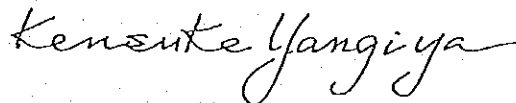
JICA sent to Guatemala a study team headed by Mr. Michio Sakamoto, CRC Research Institute, Inc. and composed of members from CRC Research Institute, Inc. and Environmental Technologic Consultant Co., Ltd., three times between June, 1990 and July 1991.

The team held discussions with the officials concerned of the Government of Guatemala, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Guatemala for their close cooperation extended to the team.

September, 1991



Kensuke Yanagiya

President

Japan International Cooperation Agency

Mr. Kensuke Yanagiya
President,
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Dear Sir:

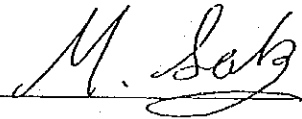
We have the pleasure of submitting to you the final report on the solid waste Management in Metropolitan Area of Guatemala City. This report has been prepared with a view to contributing toward the solid waste management to solve the growing problem of waste in the Metropolitan Area.

The purpose of the survey was to improve public health and preserve the local environment through establishing the Solid Waste Management in the Metropolitan Area of Guatemala City, (which covers the entire city of Guatemala and portions of five adjacent cities). Toward this objective, the Study Team conducted various surveys between June 1990 and September 1991, and gathered the results together in a four-volume report.

Through the surveys, it was concluded that organizational improvement of Guatemala City's public cleansing department, substitution of equipment, and training and guidance for private collectors would be indispensable to the solution of the Solid Waste problem in the Metropolitan Area of Guatemala City. Through these steps, Solid Waste collecting service would be improved as would the state of environmental sanitation in the landfill site. In this connection it is recommended that cooperation and assistance should be extended to the Solid Waste Management from the high ranking officers of the Municipality and related organizations, and a cooperative system should be established among the residents.

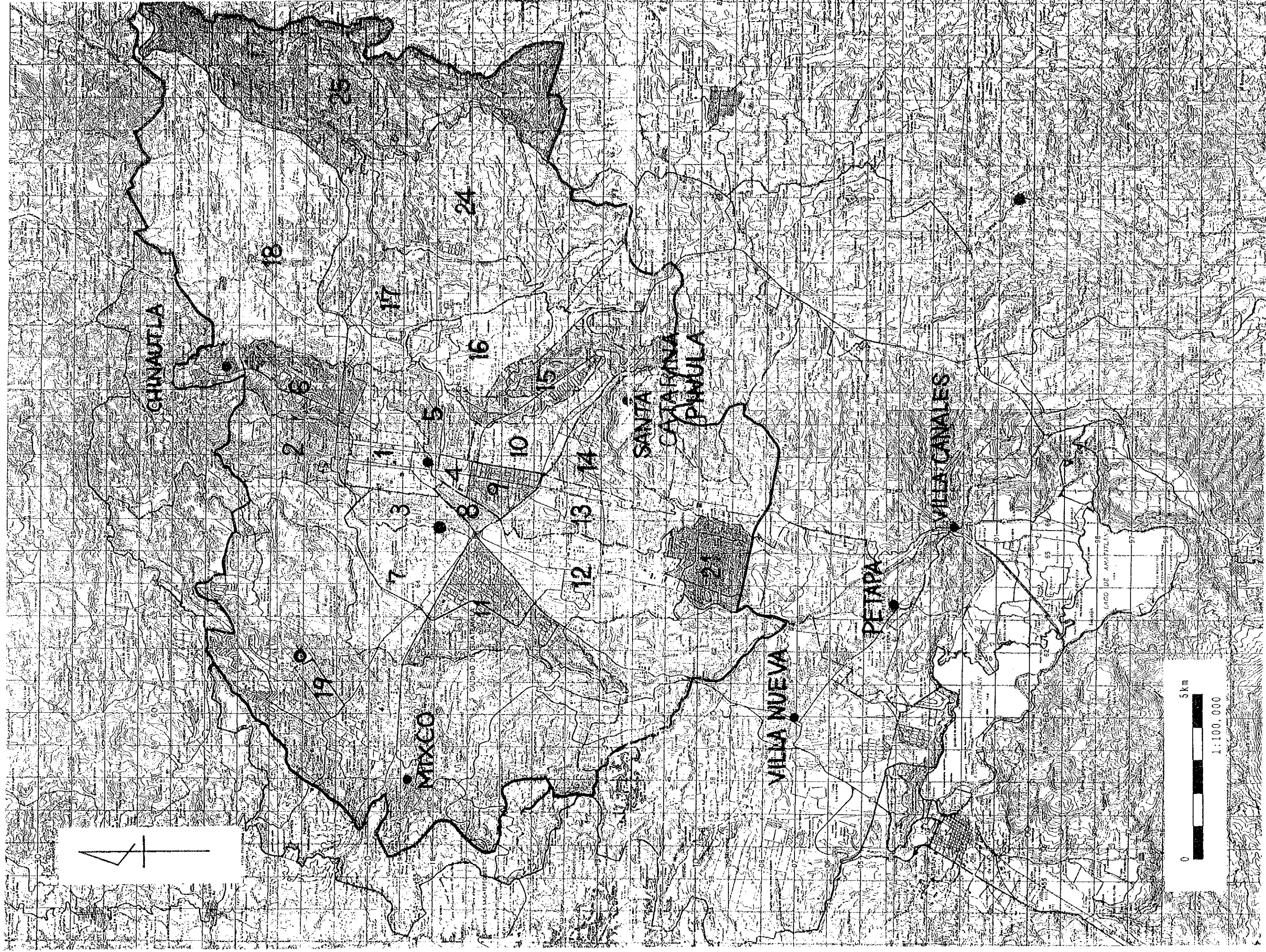
In submitting this report, all members of the Study Team would like to thank the personnel at your Agency, the Advisory Committee, Ministry of Foreign Affairs, and the Japanese Embassy in Guatemala as well as officials and individuals of the Municipality of Guatemala for their assistance and cooperation.

September 1991



NORIO SAKAMOTO

Team Leader



Study area



Present condition of "El Trebol" disposal site in 1990



Present condition of "El Trebol" disposal site in 1990



Pilot test "Video Program"
(Filming)



Pilot test "Video Program"
(Presentation)



Pilot test "Container experiment"



Pilot test "Container experiment"

PRINCIPAL FEATURES OF THE PLAN

1. Master Plan

1.1 Planning Conditions

(1) Planning period

Until the year 2000

(2) Population

In 1990, 1,532,000, and 2,047,000 in the year 2000

(3) Types of solid waste

Solid waste not including hazardous materials

(4) Annual increase of real GDP

From 1990 to 1995 4%, and 3% from 1996 to 2000

(5) Dual collection system

Maintain and promote the dual collection system of municipal and private collectors during the period until the year 2000.

(6) Recycling and resource recovery

Continue and promote the sanitary recovery of certain parts of the collected solid waste during the period until the year 2000.

(7) Community participation

It is indispensable to count on the support of the community.

1.2 Target

The targets of the Master Plan are set as follows:

- (1) Increase the actual service coverage rate for collection of domestic solid waste from the actual 53% to 86% by the year 2000.
- (2) Immediately improve the sanitary and environmental conditions of the "El Trebol" disposal site, converting it into a controlled landfill.
- (3) Augment the existing landfilling capacity by initiating the construction of a new sanitary landfill.
- (4) Carry out the concession program for private collectors in 100% of easy collection area, and complete this process by the year 2000.
- (5) Establish a preventive maintenance and repair program for collection vehicles and other equipments, and maintain their constant operation rate of 90% to improve the collection productivity, sweeping efficiency and final disposal operation.
- (6) Reduce the number of clandestine open dumping sites through the above-mentioned 5 measures.

1.3 Recommended Implementation Schedule

<u>Program number</u>	<u>Program (What)</u>	<u>Responsibility (Who)</u>	<u>Schedule When)</u>
1.	Expansion of collection service	DLP/Private collectors/ MAM	1992-2000
2.	Improvement of the "El Trebol" disposal site	DLP	1991-1992
3.	Construction of a new sanitary landfill	DLP	1994-2000
4.	Concession of collection service to private collectors	DLP	1992-2000
5.	Preventive Maintenance Program	DLP	1991-1992
6.	Educational and community participation program	DLP	1991-2000
7.	Personnel training program	Municipality	1991-2000
8.	Recycling and resource recovery programs	DLP	1992-2000
9.	DLP Institutional development	Municipality	1992-1993
10.	Initiation of CMDS Activities	Municipality/ MAM	1992

DLP = Public Cleansing Bureau;

MAM = Municipalities of the metropolitan area;

CMDS = Metropolitan committee in charge of solid waste

1.4 Benefits

As a result of the implementation of the proposed Program, the following benefits will be secured, i.e.,

- (1) Institutional and organizational support-systems necessary for the promotion of SWM (Solid Waste Management) will be properly established.

- (2) Collection services will be extended to currently non-served areas, including marginal areas, through zone concessions to private collectors and exchanges between ECA (Easy Collection Area) and PCA (Possible Collection Area), and through the increase of operational efficiency.
- (3) The existing final disposal site, "El Trebol", will be transformed into a controlled landfill within a short time. Through the observation of the improvement process of "El Trebol", consensus among residents to open a new additional sanitary landfill will mature.
- (4) Environmental and sanitary conditions in the metropolitan area will be preserved at a satisfactory level by the desirable promotion of public health and environmental protection.
- (5) Participation of residents in the Solid Waste Management (SWM) program will be implemented through community education and campaign about SWM.

2. Priority Projects

2.1 Identification of Priority Projects

Among the proposed programs in the Master Plan, the following 3 projects are recommended as the projects with high priority in view of possibility to generate great benefit.

- (1) Expansion of collection services particularly in marginal areas
- (2) Sanitary final disposal of solid waste through the immediate improvement of the "El Trebol" landfill, and the initiation, as soon as possible, of a new sanitary landfill.
- (3) Institutional development of municipal public cleaning services through reorganization and systematization of the dual collection services to effectively plan the management, operation, organization and financial aspects.

2.2 Proposed Programs

The programs proposed in the Master Plan are detailed as follows.

(1) Collection service

- 1) Program number 1: Expansion of collection services

Increase the coverage of collection services in the marginal areas by generally increasing collection efficiency throughout the entire city.

Gradually extend private collection services to all ECA and PCA and begin to withdraw municipal

collection services, in a coordinated manner, from currently covered areas in order to extend services to marginal areas.

Under municipal guidance and supervision, implement appropriate systems to manage solid waste in isolated areas.

(2) Improvement of final disposal

1) Program number 2: Improvement of the "El Trebol" disposal site

Immediate improvement of the El Trebol disposal site to convert it into a controlled landfill. Within a period of four months after obtaining of the bulldozers, it would be possible to construct a slope that would allow access to the bottom of the gullies to be reached, and to initiate the technical construction of the landfill. Only in this way could the Municipality demonstrate to the residents, over the short term, the advantages of a sanitary landfill, and bring real awareness to the community. Furthermore, through this work the Municipality could ensure the confidence and trust of the residents, which is so important in works of this kind.

2) Program number 3: Construction of a new sanitary landfill

Given the above-mentioned facts, construction of the indispensable and absolutely necessary second Sanitary Landfill could begin in 1994. The best site for new sanitary landfill would be "Las Guacamayas".

(3) Institutional development

- 1) Program number 4: Concessions of collection service to private collectors

Beginning in 1992, gradually initiate the granting of concession zones to private collectors, and attempt to complete this concession process of 26 zones by the year 2000. The fundamental criteria for this process are: that the private collectors shall collect all the solid waste, which is generated within their area; that only currently existing private collectors shall be eligible to receive concessions; that municipal services shall be halted to avoid competing with private collectors in the areas granted by concession; and that the DLP shall supervise and control the process.

- 2) Program number 5: Preventive maintenance and repair program

Operate maintenance services under the direct administration of the DLP with all its equipment and begin a preventive maintenance program for the equipment.

- 3) Program number 6: Education and community participation programs

The strategy behind this fundamental program includes:

Dialogue with the public; community motivation via the proper means of communication, such as the video prepared through the Study and the effective presentation of the DLP's programs to the public. Initiate programs in schools and in marginal areas, such as those that have already been started

successfully by the DLPM.

4) Program number 7: Personnel training program

It will be necessary to implement a permanent training program on three levels for DLPM personnel and some other personnel transferred from other municipal departments.

The training for managerial levels requiring participation in service entities outside the country and the middle level requiring training through short local courses and the operative level requiring training through actual work sessions.

5) Program number 8: Recycling and resource recovery program

Promote recycling and resource recovery of the various material sanitarily in the solid waste, passing from the present recovery rate 5% to 8% by the year 2000, with the following measures: increase the recovery before collection by the private collectors and the recovery which the private collectors execute: and discourage the recovery in "El Trebol", orientating so that the actual scavengers may formalize their work through the previously mentioned methods.

6) Program number 9: Institutional organization of the DLP

The executing agency proposed to administer and execute all the programs previously indicated shall be the Public Cleansing Bureau (DLP), a municipal department into which the current DLPM shall be transformed. The operational efficiency is improved without increase of personnel; and it is

recommended to establish a Working Group to facilitate this process of transition.

7) Program number 10: Initiate CMDS Activities

Regulate, supervise and coordinate the planning and finance of metropolitan sanitary landfills, and other matters related to municipal services via the CMDS.

CMDS = Metropolitan Committee in charge of solid waste

(4) Strengthening of finance

Capital costs, which will be required for the purchase of equipments and machines, and civil construction at the landfill sites, will depend on foreign assistance, such as donations and soft loans. Additional operating costs, which will be required for the maintenance of equipments and machines and the procurement of covering soil will be provided by an increase of the SWM budget. The municipality will be able to increase the SWM budget through new revenues to be obtained by charging some fees on the cleansing services implemented by the DLP.

2.3 Feasibility

(1) Socio-economic aspects

- 1) The proposed programs will be financially feasible as a result of the increase of municipal revenues and the SWM budget, and acquisition of international donations.

- 2) The concession process can stabilize the business of private collectors by eliminating excessive competition among them resulting in the increase of their collection amounts.

(2) Institutional aspects

- 1) The institutional organization will be realized without increase of bureaucracy.
- 2) The proposed organizational restructuring is realistic and will be possible to be implemented immediately since the change is required only within the same municipality.
- 3) It will ensure the continuity, improvement and extension of the coverage of collection services, especially in marginal areas after relations with private collectors have been formalized.
- 4) It will improve the efficiency of services once an evaluation and planning system has been established.
- 5) The long-term strategy established by the Master Plan will facilitate a study of possible sites for future sanitary landfills.
- 6) The implementation of education and community participation program with high priority will lead to permanent benefits, including the reduction in the cost of services.
- 7) Economies of scale at the metropolitan level will be achieved in final disposal and private collection services.

- 8) The proposed institutional re-organization can be carried out without causing social problems.

(3) Technical aspects

- 1) Solid waste management plan up until the year 2000 is established based on the use of two landfills including the opening of a new landfill.
- 2) The plan will increase the efficiency of waste collection and transport by use of the two landfill sites decreasing of clandestine open dumping.
- 3) "El Trebol" disposal site will be improved by converting it to a controlled landfill.
- 4) Las Guacamayas new landfill will be opened using sanitary landfill system.
- 5) Promotion of community participation will facilitate the improvement of collection process.

(4) Environmental aspects

- 1) Urban environment will be improved by the decrease of clandestine open dumping and the community participation.
- 2) The opening of "Las Guacamayas" new landfill will improve traffic conditions around "El Trebol" area.
- 3) Environmental improvement will be achieved by converting "El Trebol" disposal site to a controlled landfill.
- 4) Erosion problem and present clandestine open dumping at "Las Guacamayas" gully will be prevented by opening a new sanitary landfill site at "Las

Guacamayas".

(5) Overall evaluation

Improvement of collection service coverage in marginal areas is feasible if private collectors are granted concessions in areas where collection is comparatively easy, and if the city organization and equipment in areas where collection is possible are improved. A new sanitary landfill site can be acquired if residents notice a quick improvement of the "El Trebol" disposal site, and if the government can obtain their understanding necessary for the opening of a new sanitary landfill site.

Moreover, a systematic improvement of the city's cleansing services can also be realized with the cooperation of residents, private collectors and the central government as long as the highest authorities of the city make necessary decisions on the organizational and financial strengthening of solid waste management system.

Through these measures, the sanitary conditions of Guatemala City will certainly be improved and a healthy living environment will be assured.

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ABBREVIATION

APT	Food for Work
BANVI	The National Housing Bank
BOD	Biochemical Oxygen Demand
CACM	Central American Common Market
CMDS	Metropolitan Solid Waste Committee
COITRAMBA	Integral Cooperative for Special Services of Motorized Transportation of Solid Wastes
CPI	Consumer Price Index
DLP	Public Cleansing Bureau
DLPM	Municipal Public Cleansing Department
ECA	Easy Collection Area
EDOM	Study on Metropolitan Regulations
EMPAGUA	Municipal Water Supply Corporation of Guatemala City
GDP	Gross Domestic Product
GNP	Gross National Product
GT	Working Group
IA	Isolated Area
INE	Institution of National Statistics
JICA	Japan International Cooperation Agency
JST	JICA Study Team
MP	Master Plan
PAHO	Panamerican Health Organization
PCA	Possible Collection Area
PLAMABAG	Master Plan on Water Supply of Guatemala City
SEGEPLAN	National Economic Planning Agency
SW	Solid Waste
SWM	Solid Waste Management
F/S	Feasibility Study

I. INTRODUCTION

This study was conducted during the period from June 1990 to Sept. 1991, and the Master Plan was prepared for the Solid Waste Management in Metropolitan area of Guatemala City. At the same time, the feasibility of priority projects was confirmed.

The background, objective, and methodology of this study are explained below.

1. Background

The Constitution of Guatemala stipulates that the national and municipal governments must establish policies to improve health and preserve the living environment and that municipalities must be responsible for cleansing services.

In accordance with the above, there exist regulations concerning cleansing services including penal provisions for clandestine open dumping. However, they are not enforced because the administration of cleansing services is presently being carried out as an accepted custom.

The cleansing service of the Municipality of Guatemala is presently not keeping pace with dramatic population increase in recent years. As a result, unsanitary conditions, an increasing decline in the natural beauty of Guatemala City, and environmental problems both inside and outside landfill site have arisen. Priority projects to improve these conditions are necessary. In addition to road-sweeping services, collection of market waste, and landfill supervision, the Public Cleansing Department (DLPM) of the Public Service Bureau is implementing policies focusing on the collection of waste in areas in which private collectors do not operate and in low income areas. Sufficient results have not been obtained, however, due to technical and financial limitations.

On the other hand, the authorities concerned of governmental planning, the Economic Planning Agency (SEGEPLAN), are making efforts to prepare a National Plan of Urban Solid Waste Management with a joint cooperation of the Municipalities of the Country.

Under these conditions, the preparation of a Master Plan regarding SWM in the metropolitan area of Guatemala City and the implementation of priority projects are of the utmost importance.

2. Objective

To contribute to the development of the systematic management of the solid waste in the Metropolitan Area of Guatemala City with an object of improving and safeguarding the public health as well as protecting the environmental quality by the year 2000. At the same time, to effect the technical transfer to the counterpart of the municipality of Guatemala through studies.

3. Methodology

(1) Compilation and selection of basic materials

The basic materials are geographical and geological information, socio-economic data, legislation, waste quantity and quality, environmental surveys, etc.

During the study period, we tried to obtain as much material as possible. We could not, however, expect to immediately prepare and obtain from our counterpart the compiled data and materials deemed necessary by the study team; most materials were obtained from the related government authorities and private sectors related, as well as data from the study team's actual field surveys.

Furthermore, since the study period was limited, most of the data was organized after returning to Japan. Therefore, systematic and efficient data collection were required.

(2) Joint study

A joint study with our Guatemalan counterpart was indispensable to the preparation of a plan suitable for the present conditions of Guatemala, including a clear understanding of the geographical conditions, sociological features, and cultural background of the study area. Furthermore, the presence of a counterpart capable of taking responsibility for implementing the plan and, at the same time, transferring the technology necessary for that implementation were significant factors.

(3) Collection and transport operations

Private collectors collect most of the domestic waste in Guatemala City. It is believed that in addition to the social conflicts that would result from completely switching over to direct municipal collection operations, it would be financially unfeasible for the municipality. Therefore, the basic thinking behind the study is that, as a rule, domestic waste should be collected by private collectors as is presently the case, and that the municipality should try to increase service areas by trying to improve operation efficiency and cooperation through the closer supervision of collectors. Moreover, collection by private collectors is, as a rule, based on profit-seeking which is supported by those who use the service. We decided to investigate possible collection fees and collection systems from institutional, organizational, and financial points of view.

Besides present road sweeping services and the collection of market waste, the Municipality has to extend its collection services to the poor marginal areas where it is difficult for the private collectors to obtain income.

(4) Final disposal

Although there exist environmental problems caused by an inadequate final disposal of solid waste in the area near "El Trebol" disposal site located in the center district of the city, it is essential that this site continues to operate as long as possible. Therefore, in addition to strengthening the strict enforcement of soil covering, necessary measures for the prevention of stench, insects, smoke and gas generated as well as countermeasures to prevent an environmental deterioration and to solve problems resulting from leachate outflow were also taken into consideration. Furthermore, in order to improve measures directed at the future development of the metropolitan area and to make collection and transportation more efficient, establishing a new landfill site is necessary. Thus, the selection of this site and the basic construction plan for the landfill were also considered.

(5) Institution and organization

The Public Cleansing Department (DLPM) within the Public Service Bureau, a large institution employing some 700 workers, is presently in charge of SWM for Guatemala City. This institution has finally reached a point where it can manage activities on a day-to-day basis. Nevertheless, DLPM lacks sufficient staff to revise its management methods, prepare future plans, sufficiently maintain its collection vehicles, supervise private collectors, train personnel, and educate the community concerning SWM. Were this

situation to continue the appropriate implementation and realization of the MP, for example, would prove to be difficult, and corresponding future revisions of the MP would be indispensable according to future changes. Therefore, the development of an entity responsible for SWM and the redistribution of personnel within the municipality is considered to be essential. Hopefully, such an organizational redevelopment will require no increase in the number of personnel.

Furthermore, improvements in residential services and enlargement of service areas cannot be expected in the previously mentioned domestic waste collection by private collectors, under the present uncontrolled conditions of inefficient and unstable operations resulting from excessive competition. Therefore, measures were investigated to expand the population to be served and service areas in an organized way though granting zone concessions to private collectors currently under municipal supervision.

(6) Finances

In order to implement the MP, in addition to personnel costs of the Municipality, and the operation and maintenance costs, it is necessary to cover the investment costs to execute the sanitary landfills and the costs of acquiring new vehicles. It is necessary, therefore, to rely on bigger budget than present. Though the financial conditions of the Municipality of Guatemala and the cost control by more efficient internal operations were considered, it was also investigated how to realize budget increase with revenues to be obtained applying charges to users such as fee for sweeping service of public roads which is actually free.

Also it was considered to improve the efficiency of private collection through gradual concessions to the private collectors.

4. Study Area

This study covers all of Guatemala City and part of the surrounding developing areas geographically and economically linked to Guatemala City, namely, Mixco City, Villa Nueva City, Chinautla City, Villa Canales City, and Sta. Catarina Pinula City. This area includes a total of six municipalities in all, encompassing a total area of 350 km².

The marginal areas in the study area lack the collection service and are the areas especially targeted for future improvement. These areas must be considered as an integral part of entire study area.

5. Target Waste

In this study, the target waste is urban solid waste. This is specifically, domestic waste, market waste, street waste, and garden waste. Obviously, the management of hazardous solid waste is not the target of this study.

6. The Organizational Structure for the Study

On Guatemalan side, the Municipality of Guatemala is the responsible agency of this study, and the Steering Committee consisting of the authorities concerned was formed.

JICA established the Advisory Committee for the technical assistance to JST. The members of JST, the Counterpart, the Steering Committee of the Republic of Guatemala and the JICA Advisory Committee are shown in the appendix.

7. Report

The reports of this study consist of the four parts.

- Part 1 Summary Report
- Part 2 Main Report
- Part 3 Supporting Report
- Part 4 Data File

II. MASTER PLAN

1. Present Macro-Frame Situation in the Study Area

1.1 Natural Conditions

1.1.1 Topography

The study area is located in the central plateau formed by the Sierra Madre mountain range running northwest to southeast along the shores of the Pacific Ocean from Mexico.

The Central portion of Guatemala City is at an elevation of 1,500 m, and forms a basin-like prairie jammed amongst the hilly plateaus of the east and west. A continental divide cuts east and west across the central area of the plateau, and the later is divided into two water sheds in the north and the south. The continental divide runs parallel to the Central American International Highway CA-1 and forms the Las Vacas River water shed in the north and the Los Villalobos River water shed in the south. The tributaries of Las Vacas River into the Motagua River and pour into Amatique Bay on the Caribbean Sea. The rivers of the Las Vacas water shed are the Las Vacas, El Zapote, Chinautla, El Naranjo, La Barranca, and El Marrullero Rivers. On the south side of the continental divide, the Las Minas, Pinula, and Molino Rivers join the Villa Lobos River and pour into Lake Amatitlan, and, through the Michatoya River, into the pacific Ocean. Lake Amatitlan is located at an elevation of 1,188 m.

The western area where Mixco City is located is a hilly area slanting west to east at an elevation of 1,600 to 2,000 m. The Agua Volcano rises to 3,766 m near Lake Amatitlan to the southwest.

Hills stretch to the north from the hills of the southeast portion of the metropolitan area on the eastern side of the central plateau. In the areas on the eastern

side of Guatemala City (Zones 17, 18, 24, and 25), the rivers belonging to the Las Vacas water system run northwest, and numerous gullies form a complicated topography.

1.1.2 Geology

Complex igneous tuff, estite, and limestone rock formations form the geological basis of the study area. The upper stratum is covered by deposits of volcanic ash and volcanic clastic rock or alluvium. Bed depths average 100 m. In these layers of volcanic deposits, deep V-shaped gullies have been formed by water erosion, dissecting the earth into a sort of branch formation. Many of these gullies reach depths of 50 to 100 m.

Due to local movements in the earth's crust, numerous faults have been formed, creating trough-ground-trough structures. The river system is determined by each of these faults.

1.1.3 Climate

The Republic of Guatemala is located in the tropics at a northern latitude of 14° 30" to 14° 45". The environs of Guatemala City, situated in mountainous zones, have mild average annual temperatures of 19° to 22° C.

The dry and rainy seasons are distinct, the dry season being from November to April and the rainy season from May to October. The annual high in the planned area reaches approximately 25° C and the annual low around 15° C. Annual rainfall averages 1,000 to 1,200 mm.

1.2 Population

According to the estimation of population by the INE, the Republic of Guatemala has about 9.2 million people, of

which Guatemala department has about 1.96 million and Guatemala City about 1.08 million as of 1990. The annual growth rate of population in the Republic of Guatemala from 1981 to 1990 is estimated at 4.8% - same as that of the Metropolitan area. Growth rates in Mixco and Villa Nueva, which stand at 6.5% and 7.9% respectively, are estimated to be much higher than that of Guatemala City at 4.0% (Refer to Table II-1.2-1).

Table II-1.2-1 Population in Areas Studied

Area	1981 ¹⁾		1985 ²⁾		1990 ²⁾	
	Population	Share	Population	Share	Population	Share
Republic	6,054,227	-	7,963,355	-	9,197,345	-
Guatemala department	1,311,192	100.0	1,696,391	100.0	1,962,953	100.0
Guatemala City	754,243	57.5	976,205	57.5	1,076,725	54.9
Mixco	197,741	15.1	267,737	15.8	346,445	17.6
Villa Nueva	71,069	5.4	101,817	6.0	140,888	7.2
Villa Canales	39,309	3.0	47,588	2.8	54,005	2.8
Santa Catarina Pinula	17,387	1.3	22,005	1.3	26,295	1.3
Chinautla	41,682	3.2	51,216	3.0	59,131	3.0
Subtotal	1,121,431	85.5	1,466,568	86.5	1,703,489	86.8
Metropolitan area	1,134,700	86.5	-	-	1,711,000	87.2
Area studied	-	-	-	-	1,532,000	78.0

Source: 1) INE, 1985, Censos nacionales de 1981.

2) INE, 1989, Guatemala: poblacion urbana y rural estimada por departamento y municipios 1985-90.

Note: The census in 1981 has some omissions.
Unit of share is percent.

1.3 Land Use

Gullies are estimated to occupy some 36% of the total land area of Guatemala City, limiting, the level areas in which urbanization is possible. Consequently, in the Metropolitan area of Guatemala City, urbanization and residential development have sprung up around the central plateau running along the divide where gullies are few.

Trunk roads centered around the heart of the Metropolitan area of Guatemala City are configured radially, with residential areas distributed along them. In recent years, the rate of annual population increase has been decreasing. The present rate continues at just under 3% expanding in search of level suburban areas. This tendency for expansion to level ground has resulted in a gradual diminution of farmland, mountains, forest, and fields.

As for land use in the central urban areas, government and municipal offices and commercial enterprises are concentrated in the central area of Guatemala City (Zones 1 and 4). Since the streets of these areas are lines with shops and residences, new commercial business areas in recent years have begun to center in Zones 9 and 10 in the south along Avenida Petapa. Most factories are light industry, few are heavy industries.

Residential development in the Metropolitan area of Guatemala City stretches to the west, south, and northeast, with the highest concentration in the central area (Zones 1 and 4) comprising the commercial business area. This advance has constituted the primary development of the city.

Such residential development has been spurred for the most part by private development banks and the BANVI (Banco Nacional de Vivienda), the National Bank of Housing. Upper class residential areas are located in the southern and southeastern areas of Guatemala City (Zones 10, 13, and 14). Residential areas developed in recent years are middle and lower class areas compared to the hilly portions of the central area and outskirts of the Metropolitan area. Slums are situated in areas facing the gullies at the upper reaches of rivers and also at gullies surrounding new residences.

1.4 Economics

1.4.1 GNP and its components

GNP is one of the most useful indices reflecting the economic situation of a country. The trend in Guatemala's real GNP from 1976 to 1988 is summarized below. Real GNP is measured by the constant price in 1958.

1976-1980	5.0% per year
1980-1985	-1.3%
1985-1988	3.2%
1989	4.0%
1990	4.0% (estimated)

Guatemala's economy has surely been steadily recovering in recent years.

1.4.2 Price

Compared to El Salvador and Mexico, the consumer price index (CPI) has changed slowly as shown below:

	(%)							
Year	83	84	85	86	87	88	89	89/83
Guatemala	81.5	84.3	100.0	136.9	153.8	170.5	189.9	18.4
El Salvador	73.3	81.7	100.0	131.9	164.7	197.3	232.1	21.2
Mexico	38.3	63.4	100.0	186.2	431.7	924.6	1,109.6	75.3

Note: 1985 = 100

89/83: annual growth rate

1.4.3 Employment

Demand and supply conditions in labor have not changed because industrialization has been delayed. Therefore, improvement of social conditions, for example security, education, etc. will be necessary to improve this situation.

The unemployment rate is as shown below.

1985	36.4%
1986	37.8%
1987	37.3%
1988	36.7%
1989	36.0%

1.4.4 Fiscal situation

Guatemala's public sector is relatively small, and the country's tax burden is light by international standards. Central government expenditures in 1987 amounted to 11.2% of the GDP, and tax revenues have risen rapidly since 1986. In order to further reduce the budget deficit, the government has set a goal of increasing tax revenues by 1% of the GDP.

Guatemala's fiscal deficit stood at only 1.4% of the GDP in 1987, but rose to 3% in 1988 because of increased government spending and the shift of the Central Bank's losses on foreign exchange operations to the central government's account.

In 1987, against private sector objections, the Central Government adopted a tax reform package that included new rules and rates for income and property taxes, a 4% surcharge on imports, and other tax changes. The full effect of the new measures on government revenues and investment is unclear. The implementation of regulations is not yet in place, and some sections of the new tax laws, are being challenged in courts. Tariff on exports, adopted in 1986, is being phased out at the rate of 3% per month until it reaches zero in 1990.

The export tax is currently assessed on a sliding scale, ranging from 2.7 to about 25%, depending on the

product and its international price. Nontraditional exports are taxed the lowest rates, while drawback industries are fully exempt.

1.4.5 Industrial structure

Agriculture accounts for 26% of the GDP. Growth of farm output in 1988 was 4.3%, with rises concentrated on nontraditional crops such as winter vegetables and fruit. The value of Guatemala's coffee crop declined in 1987 due to lower international prices.

Manufacturing, which accounts for some 15% of the GDP, grew by 2.3%. Since most Guatemalan industries have traditionally serviced the protected trade area of the Central American Common Market (CACM), the CACM's decline since 1980 seriously pinched the Guatemalan industry. But manufacturing is now recovering with emphasis on assembly and reexport (drawback) operations.

Construction contributes only about 2% to GDP, but a mini-boom in Guatemala City precipitated to 11.9% increase in construction activity in 1988.

The commercial sector accounts for 24.6% of GDP, which ranks second to agriculture.

The mining sector, including a crude oil contribute less than 1% to GDP. The crude oil, all of whose products are exported declined from \$27 million in 1986 to \$16 million in 1987, because of its lower price.

Electric power is abundant in Guatemala since the start-up of the Chixoy project has been plagued by a variety of problems.

It is understood that agriculture and commercial sectors followed by the manufacturing sector have been large production sectors. Guatemala fully depends on agricultural production and marketing, not industrialization.

1.4.6 Trade

(1) Exports

Agricultural goods, such as coffee, sugar, banana, cotton, and cardamom, are Guatemala's exports.

These goods are easily influenced by demand and supply conditions of the international commodity market and by natural conditions (climate). This means that Guatemala cannot control their prices and production volumes. Also these goods cannot be stocked in warehouses. Therefore, it is clear that exports are extremely unstable. Yet Guatemala's whole economy depends only on such exports.

(2) Imports

Guatemala's main imports are consumer goods, primarily industrial materials and capital goods. Recently, imports of primary materials for industry have increased rapidly. This means that basic industries, such as iron, steel, pulp, refineries, chemical and cement are insufficient.

(3) Exchange Rate

In general, the exchange rate is determined by demand for and supply of currency, Quetzal and US dollar. In recent years imports have always exceeded exports, implying that demand for US dollar for payment of imports in Guatemala has been increasing. With this background, the Quetzal has slightly depreciated

against the US dollar (see below), and the exchange rate stood at 5.0 Q/US\$ at the end of February 1990.

Trend in Exchange Rate

Year	85	86	87	88	89
Depreciation	29%	28%	26%	26%	28%

Note: depreciation rate is over that of previous year.

2. Present Situation of Solid Waste Management in the Study Area

2.1 Solid Waste Generation

(1) Solid Waste Generation Amount

A sampling of solid waste generation was conducted twice during the rainy season from July to October 1990, and during the dry season from January to March 1991.

The list of sampling areas is shown in Table II-2.1-1. Solid waste was sampled from 4 social strata: high class, middle class, low class and slum. The classifying standards are shown in Table II-2.1-2.

The sample number included 892 families total: 405 families in 1990, and 487 families in 1991. Solid waste was collected from several families at a time and was stored for 2-3 days. It was then analyzed and thus generation unit (kg/cap.day), composition and chemical content have been ascertained. The results of the above analysis are shown in DATA FILE.

Generation units by social strata are as follows:

High class	0.767 kg/cap. day
Middle class	0.564 kg/cap. day
Lower class	0.549 kg/cap. day
Slum	0.296 kg/cap. day

Classified specific weights are as follows:

High class	0.212 kg/l
Middle class	0.252 kg/l
Lower class	0.254 kg/l
Slum	0.248 kg/l

Using the above results, weight and volume of waste generated were calculated zone by zone, as shown in Table II-2.1-3 and Table II-2.1-4.

Solid waste generation amount is calculated as shown in Table II-2.1-5.

Table II-2.1-1 List of Sampling Area

Class	Name	Zone	Sample No.	
			Houses 1990	Houses 1991
High 1	Tecum Uman	15	60	78
High 2	Aeropuerto	13	48	61
Middle 1	Las Victorias	1	49	52
Middle 2	Mirador II	11	44	48
Lower 1	La Parroquia	6	47	52
Lower 2	Roosevelt	11	44	52
Slum 1	Lourdes	5	51	78
Slum 2	Trinidad	1	62	66
Commercial	Centro Com. Montufae	9	-	-
Market	Mercado Sur 2	4	-	-
Building	Centro Empresarial	10	-	-

Table II-2.1-2 Classifying Living Standards

Code	Code description	Characteristics of the family
H	High Income Class Family	<ol style="list-style-type: none"> 1. House area is larger. 2. Road in front of the house is paved. 3. Big, well cared gardens. 4. Several cars. 5. Several employees working there. 6. Income level about Q.10,000/month.
M	Middle Income Class Family	<ol style="list-style-type: none"> 1. They have dust boxes. 2. They have small gardens. 3. Road in front of the house is paved. 4. Income level about Q.2,500/month.
L	Low Income Class Family	<ol style="list-style-type: none"> 1. They don't have dust boxes. Instead they use vinyl bags or paper cases. 2. Road in front of the house is not paved. 3. They have no garden. 4. Income level about Q.300/month.
S	Slum Area	<ol style="list-style-type: none"> 1. It is not a collection served area. (They cannot pay collection fee.) 2. They don't have a constant income. 3. They live near a railway and/or street. 4. Income level about Q.30/week.

Table II-2.1-3 Classified Solid Waste Generation (1990)

Unit: Ton/Cal.day

Zone	High × 0.767kg/C.D	Middle × 0.564kg/C.D	Low × 0.549kg/C.D	Slum × 0.296kg/C.D	Total
1	1.95	15.74	5.57	3.00	26.26
2	0.00	9.69	4.04	0.00	13.73
3	0.00	16.50	5.35	2.89	24.74
4	0.00	2.16	0.23	0.00	2.39
5	0.00	21.25	20.68	2.48	44.40
6	0.00	25.61	14.96	5.38	45.95
7	0.00	71.26	19.82	5.34	96.41
8	0.00	5.83	5.68	0.00	11.51
9	1.99	0.79	0.00	0.00	2.78
10	9.89	1.28	0.00	0.00	11.17
11	5.09	33.66	0.00	0.00	38.75
12	9.63	17.00	4.14	0.00	30.77
13	8.25	10.11	3.94	0.00	22.30
14	16.19	1.40	0.68	0.00	18.27
15	14.04	1.29	1.26	0.00	16.59
16	0.00	3.65	3.55	0.00	7.21
17	0.00	5.84	3.79	0.00	9.64
18	0.00	63.67	33.81	9.11	106.59
19	0.00	10.44	10.16	0.00	20.61
21	0.00	25.47	10.62	0.00	36.09
24	0.00	3.50	1.46	0.00	4.96
25	0.00	2.13	2.08	0.00	4.21
Mixco	12.61	64.92	63.19	24.34	165.05
Villa Nueva	0.00	13.15	12.80	0.00	25.96
Villa Canales	0.00	6.97	6.79	0.00	13.76
S.C. Pinula	0.00	7.87	2.55	0.00	10.42
Chinautla	0.00	8.18	11.94	0.00	20.11
Total	79.64	449.37	249.10	52.54	830.64

Table II-2.1-3 is calculated based on the following formula:

Classified population of each zone x Generation unit of the corresponding class (kg/cap.day) and sum up all results and exchange Unit to Ton/Calender Day.

Table II-2.1-4 Classified Solid Waste Generation (1990)

Unit: m³/Cal.day

Zone	High ÷ 0.212kg/l	Middle ÷ 0.252kg/l	Low ÷ 0.254kg/l	Slum ÷ 0.248kg/l	Total
1	9.18	62.45	21.93	12.11	105.68
2	0.00	38.45	15.92	0.00	54.37
3	0.00	65.47	21.08	11.64	98.19
4	0.00	8.57	0.92	0.00	9.49
5	0.00	84.31	81.42	9.99	175.72
6	0.00	101.64	58.90	21.68	182.22
7	0.00	282.76	78.02	21.54	382.32
8	0.00	23.15	22.36	0.00	45.51
9	9.38	3.12	0.00	0.00	12.50
10	46.64	5.09	0.00	0.00	51.73
11	23.99	133.57	0.00	0.00	157.56
12	45.44	67.46	16.29	0.00	129.18
13	38.92	40.13	15.50	0.00	94.55
14	76.36	5.56	2.68	0.00	84.61
15	66.24	5.12	4.95	0.00	76.31
16	0.00	14.49	13.99	0.00	28.48
17	0.00	23.19	14.93	0.00	38.12
18	0.00	252.66	133.09	36.75	422.49
19	0.00	41.44	40.02	0.00	81.45
21	0.00	101.07	41.83	0.00	142.90
24	0.00	13.89	5.75	0.00	19.65
25	0.00	8.46	8.17	0.00	16.64
Hixco	59.49	257.60	248.78	98.13	664.00
Villa Nueva	0.00	52.19	50.41	0.00	102.60
Villa Canales	0.00	27.68	26.73	0.00	54.40
S.C.Pinula	0.00	31.22	10.05	0.00	41.27
Chinautla	0.00	32.44	47.00	0.00	79.44
Total	375.65	1,783.20	980.71	211.84	3,351.39

Table II-2.1-4 is calculated by using Table II-2.1-3 result changing the unit from Ton to m³.

Table II-2.1-5 Solid Waste Generation Amount
in the Study Area (1990)

Class	ton/Cal.day	m ³ /Cal.day
High class	79.6	375.7
Middle class	449.4	1,783.2
Low class	249.1	980.7
Slum	52.5	211.8
Total	830.6	3,351.4

Domestic waste generation in 1990 in the study area is about 830.6 ton/Cal.day or 3,351.4 m³/Cal.day.

Other general solid waste generated in the study area includes waste from street sweeping, market and parks, furthermore, the solid waste from factories, and debris and materials from excavation.

Daily solid waste generation are calculated as follows:

High class generation (kg/Cap.day) x High Class
Population of Study Area

Middle Class generation (kg/Cap.day) x Middle Class
Population of Study Area

Low Class generation (kg/Cap.day) x Low Class
Population of Study Area

Slum people generation (kg/Cap.day) x Slum Population
of Study Area

Refer to Table II-2.1-3, II-2.1-4.

(2) Solid Waste Composition

After obtaining the fundamental quantity, the solid waste was treated to obtain specific weight and then classified into ten kinds of composition.

Table II-2.1-6 Solid Waste Composition (1990, 1991)

Unit: %

Item	Class	High	Middle	Low	Slum	Commercial	Market	Building	Super Market
Apparent Specific Weight (kg/l)		0.212	0.252	0.254	0.248	0.132	0.255	0.066	0.063
Garbage		59.7	62.4	63.8	67.4	32.7	82.9	8.3	1.7
Paper		15.4	14.6	14.2	11.7	38.7	10.3	74.1	73.9
Textile		4.9	1.8	2.4	5.4	5.8	0.5	0.4	1.3
Plastic		7.6	9.0	8.4	7.5	9.1	4.2	9.8	20.7
Glass		4.4	4.3	2.8	1.3	4.1	0.3	3.3	1.1
Wood, Coco, Leaves		0.1	0.9	2.1	0.5	1.7	0.3	2.2	0.3
Leather, Rubber		0.3	0.5	1.1	1.4	1.2	0.5	0.0	0.0
Metal		2.1	1.4	2.4	1.5	3.0	0.7	1.6	1.0
Stone, Ceramic		3.1	1.0	1.0	0.5	1.9	0.2	0.0	0.0
Others (Ash, Soil)		2.7	4.3	2.0	3.0	2.1	0.3	0.5	0.0

(3) Chemical Analysis of Solid Waste

To obtain the combustion and composting conditions, chemical analysis was practiced as follow items:

- 1) Moisture content
- 2) Chemical analysis
 - a) Combustible matters
 - b) Carbon content
 - c) Nitrogen content