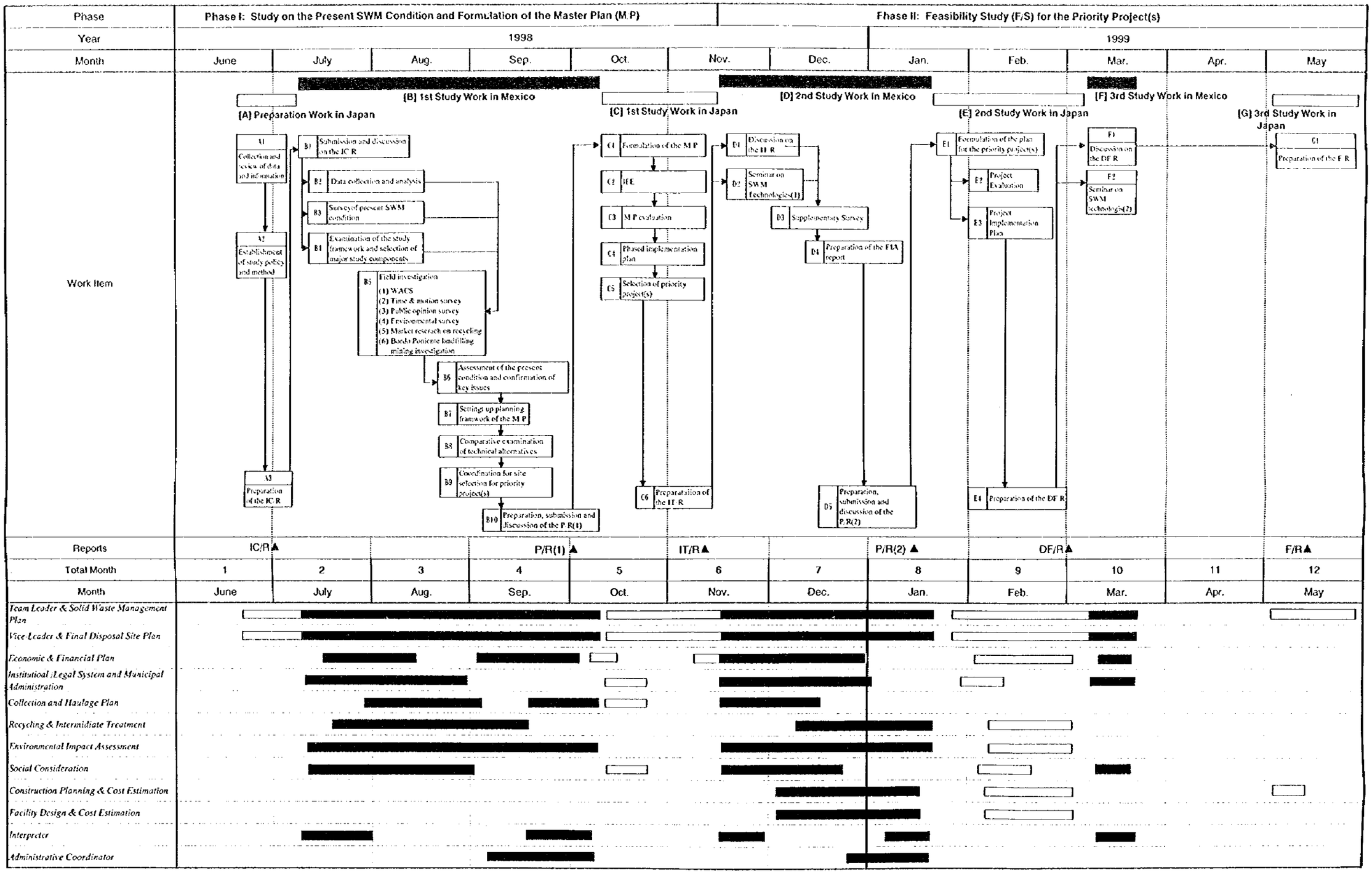


Figure 1-1: Schedule of Study Work

1.5 Study Organization and Persons Involved

The Government of the Federal District (GDF) is the counterpart agency and the coordinating body for negotiations with other governmental and nongovernmental organizations concerned. GDF organized the counterpart team consists of the appropriate number of personnel in charge of various aspects of SWM.

The Advisory Committee was organized by the JICA for the study.

1.5.1 Study Organization

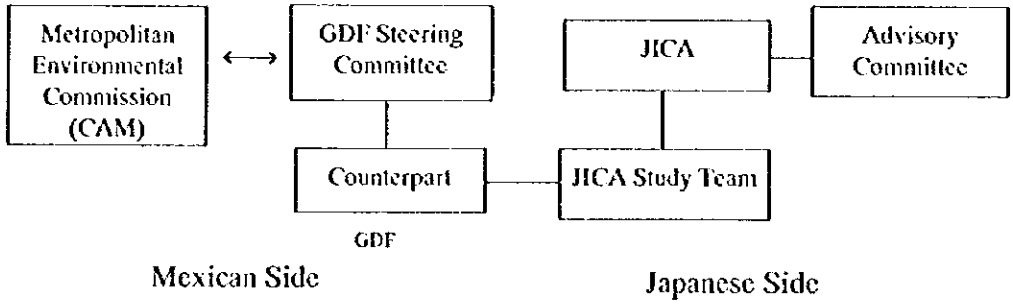


Figure 1-2: Study Organizational Structure

1.5.2 Persons Involved

a. **Members of the Study Team**

Assignment	Expert	Nationality
Team Leader & Solid Waste Management Plan	Hiroshi KATO	Japanese
Vice-Leader & Final Disposal Site Plan	Tadaya YAMAMOTO	Japanese
Economic & Financial Plan	Takao OZAKI	Japanese
Institutional/Legal System and Municipal Administration	José Felício HADDAD	Brazilian
Collection and Haulage Plan	Héctor CASTILLO B.	Mexican
Recycling & Intermediate Treatment Plan	Tamotsu SUZUKI	Japanese
Environmental Impact Assessment	Noriko OTSUKI	Japanese
Social Consideration	Guido J. ACURIO	Peruvian
Construction Planning & Cost Estimation	Ikuo MORI	Japanese
Facility Design & Cost Estimation	Andrew DORMAN	Australian
Interpreter	Fusako YAMAWAKI	Japanese
Administrative Coordinator	Noriko HIHARA	Japanese

b. Members of the JICA Advisory Committee

Chairman & Solid Waste Management Planning	Kunitoshi SAKURAI
Solid Waste Management Administration	Ryuzo HIROSE
Economics & Project Evaluation	Masahiro YAMASHITA

c. Members of the Counterpart Personnel

Assignment	Name
Leader (full-time)	Raúl Sergio Cuéllar Salinas
Collection	Ricardo Estrada Núñez
Recycle	Victor Manuel Flores Valenzuela
Treatment	Victor Manuel Flores Valenzuela
Final Disposal	Conrado Sarmiento Bleicher
Environment	Jaime Cuauhtémoc García Reyes
Sociology	Augusto E. Valenzuela López
Financial Analysis	José Luis Alvarez Pacheco - Roberto Arturo Alvarado
Institution	Gerino Guzmán Delgado
Legislation	Germán Gerardo Méndez Ruiz - Sergio Palacios Trejo
Urban Planning	Cristina Ramos Cortéz

1.5.3 Technology Transfer

During the study, the study team endeavored to transfer technology to the Mexican counterpart through the following.

- Joint study
- Explanation of reports
- Counterpart training in Japan under the Japanese technical cooperation scheme
- Seminars on SWM technologies

2 Profile of the Study Area

Mexico covers 1,958 thousand km^2, which is the 14th largest of the world. It shares a border of more than 3,100 km with the United States to the north. The other neighbors are Guatemala and Belize in the south-east with frontiers of 940 km and 250 km, respectively. The country faces Pacific Ocean on the west limited with a 7,400 km coast line, and have a 2,800 km shore on the east exposed to Mexican Gulf and Caribbean Sea.

Mexico City lies between 19°03' and 19°35' at north latitude and between 99°22' and 98°57' at west longitude in the south west corner of Mexico Valley, which is in the center of the country. It borders the State of Mexico on the west, north and east and the State of Morelos on the south.

The topography of the country of Mexico is complex: it possesses coastal plains and highlands over 1,000 meters above sea level with volcanoes which are as high as 5,000m. The Mexico Valley, on which Mexico City is located, has an area of 9,600km^2 and the altitude of its central plain ranges from 2,240 to 2,390m above sea level.

The climate of Mexico varies over the country due to its diverse topography: it has areas permanently covered with snow and areas of rain forests with abundant wild lives. The annual average temperature in the DF typically ranges from 10 to 25°C with an average of 15°C. Average annual rainfall is recorded at about 600mm, with a general trend that northwest part of the DF has less rainfall than southeast mountainous area. Most of rainfall is concentrated in a period from June to September. The GDF, an administrative body with 16 delegations, governs an area of 1,505 im^2 and 8.7 million citizens. The fiscal year of the GDF is from January to December. The GDF revenue in 1997 was 31,105 million pesos.

3 Current Situation of Solid Waste Management

3.1 Field Investigation

The following field investigations were undertaken by the study team to understand and analyze the current SWM of the DF.

- Waste Amount and Composition Survey.
- Time and Motion Survey.
- Public Opinion Survey.
- Environmental Survey.
- Market Research on Recycling.
- Bordo Poniente Landfill Mining Investigation

3.2 Current Situation of Solid Waste Management

3.2.1 Waste Stream

a. Waste Composition

The DGSU has been investigating municipal solid waste composition of wastes generated from five sectors with totally 19 sub-sectors in the DF, as shown in Figure 3-1. Wastes are classified into 35 and the obtained data are utilized for SWM control. Consequently, the present study is to follow the same waste classification as the DGSU. Table 3-1 is the result of the waste composition survey by the DGSU.

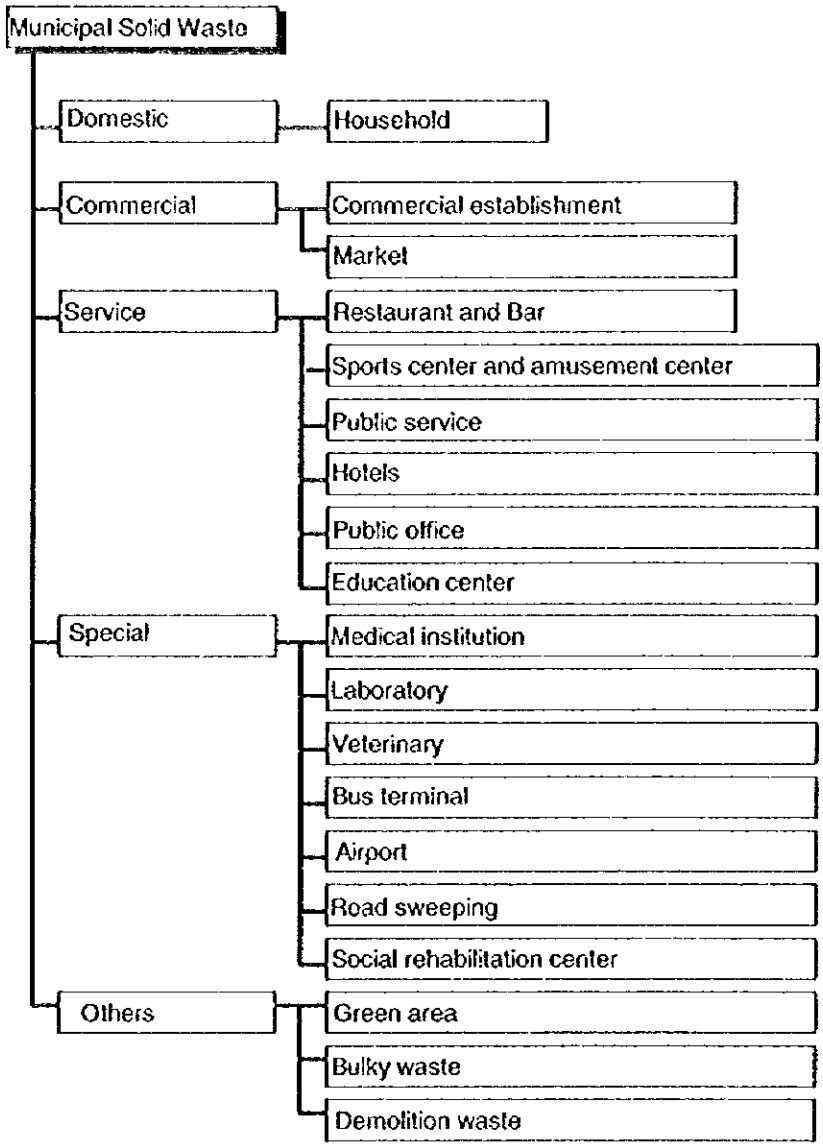


Figure 3-1: Sectors and Sub-Sectors of Waste Sources

Table 3-1: Waste Composition

(unit: %)

Composition	Domestic	Commercial		Service													Others			Total
	Household	Commercial	Market	Restaurant and Bar	Sports center and amusement	Public service	Hotels	Public office	Education center	Hospital	Laboratory	Veterinary	Bus terminal	Airport	Road	Social rehabilitation center	Green Area	Bulky waste	Demolition waste/Small repair	
1 Spatula										1.97										0.03
2 Cotton	2.15	0.07	0.83			0.38	0.03	2.99	0.17	1.97	10.38	5.57								1.30
3 Cardboard	5.36	11.51	5.29	5.97	11.04	23.18	3.77	11.20	8.98	8.30	8.01	2.56	4.34	5.31	3.66	5.06	4.00			6.68
4 Leather	0.11			0.02		3.69			0.04											0.11
5 Paper container	1.96	1.97	2.22	1.43	5.18	1.98	0.76		6.05	1.07		0.69	0.55		6.53	0.52	3.12			1.91
6 Vegetable fiber	0.06	1.79	2.63			1.13	0.08	0.01	0.78	0.20										0.69
7 Synthetic fiber	1.43	0.29	0.89	0.04			0.01	0.24		0.27	3.10				0.10					0.85
8 Gauze										3.77	5.74	5.94								0.05
9 Bone	0.08	0.44	1.11			0.21			0.67	0.07		0.38								0.27
10 Vinyl	0.20	1.07	0.16			0.36	0.18	0.83	1.33	2.07										0.37
11 Disposable syringe										2.80	1.31	1.38								0.04
12 Cans	1.58	0.31	1.47	0.25	1.23	3.10	0.52	0.28	4.89	1.73		2.31	4.53	3.17	4.77					1.24
13 Ceramics	0.37	0.12	0.09	0.45	0.29		0.18	0.08	2.01										2.09	0.30
14 Wood	0.10	1.20	1.17	0.67		6.72		0.01	3.92	0.43		4.82	0.29				5.12	20.00	1.53	1.24
15 Construction waste	0.63			0.52	0.09		2.89						1.24						95.27	2.14
16 Metal	1.39	2.59	0.07	0.92	5.65	0.71	1.79	0.15	0.40	1.90		0.69			0.41		2.86	50.00		2.56
17 Nonferrous metal	0.06	0.51				1.30		6.54		0.07	1.18	1.31					2.29			0.49
18 Paper	1.19	5.31	1.87	1.54	3.57	18.75	9.21	37.61	14.33	6.57	17.23	9.88	9.10	6.41	5.41	3.11	6.82		0.97	4.41
19 Newspaper	4.61	5.95	4.54	0.95	3.17	15.50	5.24	11.91	6.99	4.37	11.97	20.64	6.07	15.34	9.71	7.73	2.22			4.96
20 Toilet paper	8.78	1.94	4.27	3.40	9.59	4.20	8.16	1.99	10.72	11.00	9.62	7.38	15.20	8.92	9.52	4.65				5.89
21 Disposable diaper	3.37	0.14		0.08	0.09	0.32	0.89		0.30	1.43			1.94							1.62
22 X-ray film										0.30										0.00
23 Plastic film	6.24	5.38	1.50	3.08	7.13	2.14	3.58	0.16	1.95	3.27		0.44	5.34	3.91	5.38	2.00	9.29		0.14	4.53
24 Hard plastic	4.33	3.94	2.96	1.26	15.34	1.39	1.69	0.88	2.69	0.97	8.64	1.63	3.08	5.46	6.62	1.26	4.00			3.49
25 Polyurethane	0.16	0.11	0.08	0.03		2.70			0.67	0.76	2.17	2.56								0.16
26 Foamed polyurethane	0.78	0.12	0.46	0.35	0.72	1.85	0.16	0.11	0.46	1.70	2.27	1.06	1.10	1.18	1.22		1.23			0.58
27 Food waste	34.66	38.73	63.08	74.43	16.17	5.71	43.23	21.22	16.02	26.96	1.74	3.31	30.44	16.32	7.67	42.49				37.70
28 Garden waste	5.12	0.15	0.05	0.08	0.42	0.59	3.66	0.30	6.32	1.30	1.89	0.56		1.53	11.46	7.46	25.36			3.18
29 Sanitary napkin		0.17						0.04	0.63		1.61		0.01			2.00				0.04
30 Rags	0.64	0.20	0.30	0.12	1.14		1.72	0.31	1.02	0.50	1.84			4.88		3.00		30.00		1.22
31 Bandage										0.36					0.02					0.01
32 Color glass	4.00	1.77	0.30	1.53	4.67	2.81	3.09	0.26	2.44	6.70	4.86	2.00	3.45	8.07	8.64	0.42				2.62
33 Transparent glass	6.77	5.18	0.44	2.82	11.76	1.28	8.52	0.76	4.66	5.63	3.05	0.94	7.79	7.14	8.37	0.95	0.85			4.61
34 Fine fraction	1.21	0.07	3.97	0.03	2.75		0.26	0.01	0.73	0.43	0.03			3.61	4.02		26.30			1.71
35 Others	2.66	8.97	0.25	0.03			0.38	2.11	0.83	1.13	3.36	23.95	5.53	8.75	6.49	19.35	6.54			3.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.0	100.00	100.00	100.00	100.00	100.00	100.00	100.0	100.00	100.00	100.00	100.00	100.00

b. Generation Ratio

Generation ratio at each source surveyed by the DGSU is shown in Table 3-2. The present study will adopt the same generation ratio.

Table 3-2: Generation Ratio

Type of Source Generation	Classification	Generation Ratio	
Domestic	Household	0.616	kg/Person/Day
Commercial	Commercial Establishment		
	- Auto Service Shop	637.000	kg/Establishment/Day
	- Department Store	368.000	kg/Establishment/Day
	- Commercial Place	6.650	kg/Establishment/Day
	Market		
	- Meat Market	4.430	kg/Stall/Day
	- Vegetable Market	7.920	kg/Stall/Day
	- Grocery store	1.025	kg/Stall/Day
	- Food Preparation	14.960	kg/Stall/Day
	- Various	0.803	kg/Stall/Day
	- Shifting Market (Tianguis)	575.800	kg/Tianguis/Day
Service	Restaurant and Bar	25.442	kg/Establishment/Day
	Sports Center and Amusement Center		
	- Amusement Center	1.230	kg/Employee/Day
	- Sports Center	2.620	kg/Employee/Day
	- Cultural Center	0.330	kg/Employee/Day
	Public Service		
	- Services Office	3.460	kg/Establishment/Day
	- Repair and Maintenance Service	1.940	kg/Establishment/Day
	- Gas station	53.120	kg/Establishment/Day
	Hotel		
	- Five-star hotel	1,016.900	kg/Establishment/Day
	- Four-star hotel	218.500	kg/Establishment/Day
	- Three-star hotel	16.810	kg/Establishment/Day
	Education Center		
	- Kindergarten	0.040	kg/student/Day
	- Elementary School	0.055	kg/student/Day
	- Job Training Center	0.060	kg/student/Day
	- Junior High School	0.065	kg/student/Day
	- Technical School	0.060	kg/student/Day
	- Senior High School	0.060	kg/student/Day
	- University	0.070	kg/student/Day
	- Public Office	0.413	kg/Employee/Day
Special	Medical Institution		
	- 1st. Level	1.279	kg/Consultory Room/Day
	- 2nd. Level	4.730	kg/Bed/Day
	- 3rd. Level	5.390	kg/Bed/Day
	Laboratory	6.340	kg/Laboratory/Day
	Veterinary	1.700	kg/Employee/Day
	Bus Terminal	2,103.000	kg/Terminal/Day
	Airport	28,887.000	kg/Airport/Day
	Road Sweeping	125.530	kg/km/Day
	Social Rehabilitation Center	0.540	kg/Person/Day
Others	Green Area	0.00993	kg/m^2/Day
	Bulky Waste	28.850	kg/Ton-Solid Waste/Day
	Demolition Waste and Small Repair	20.850	kg/Ton-Solid waste/Day

The waste stream was calculated and summarized in Figure 3-2.

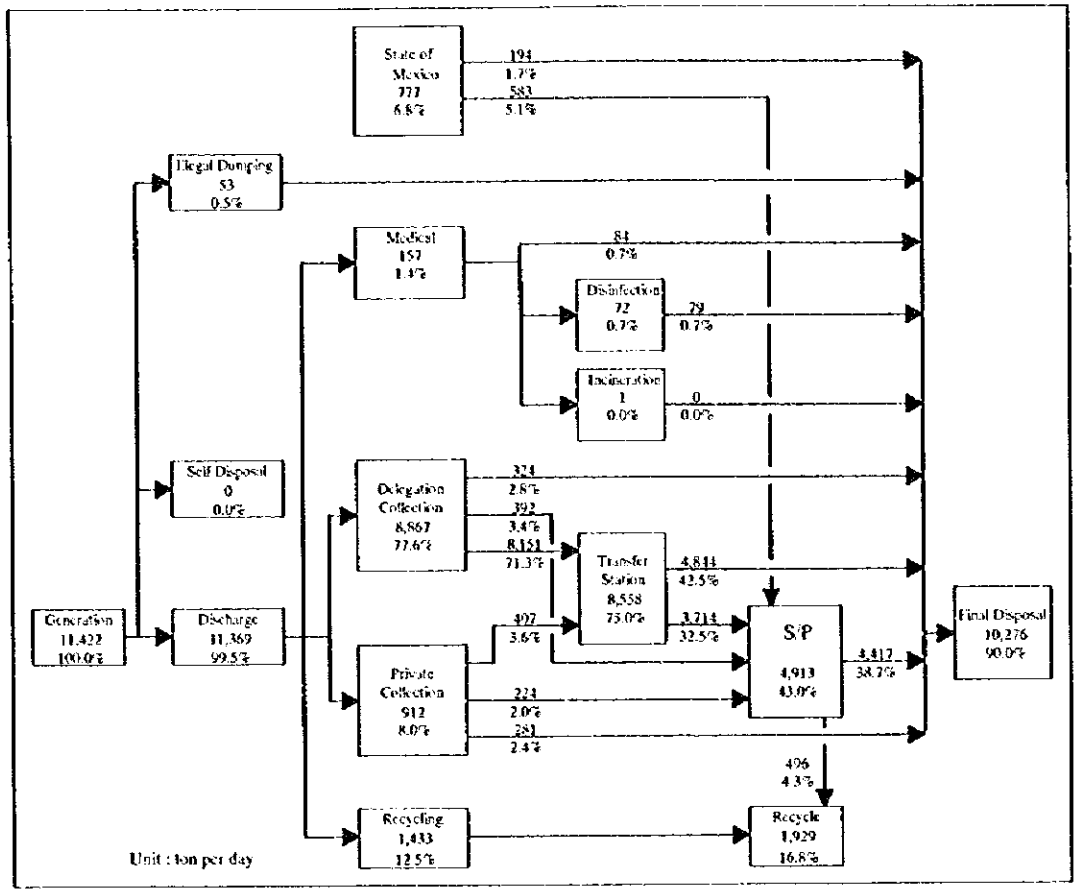


Figure 3-2: Waste Stream in 1997

3.2.2 Technical System

3.2.2.1 Collection and Haulage System

Collection of municipal wastes generated is the responsibility of respective delegations and most of them are delivered by the Section 1 to the transfer stations managed by the DGSU (Exceptions are wastes that are brought directly to the final disposal sites or the S/Ps by some delegations due to their vicinity).

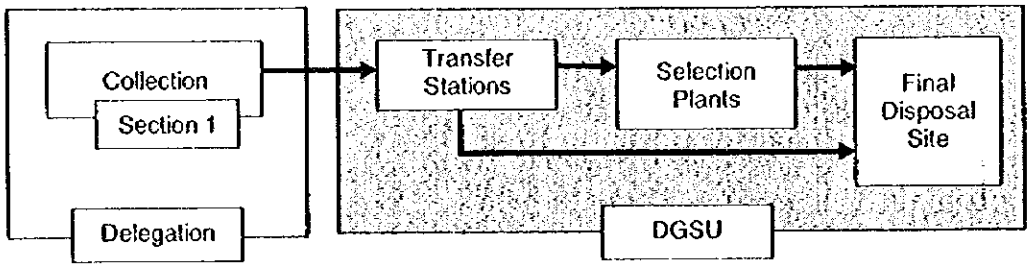


Figure 3-3: Present Collection and Haulage System

However, in July 1998, the GDF and Section 1 signed an agreement that the Section 1 would withdraw its collection service from markets, primary schools, public residence units and parks from 1999. It was decided in October 1998 that the delegations are to be in charge of employing private sectors through contracts for the wastes collection for those public institutions (or hereafter "Sub-System").

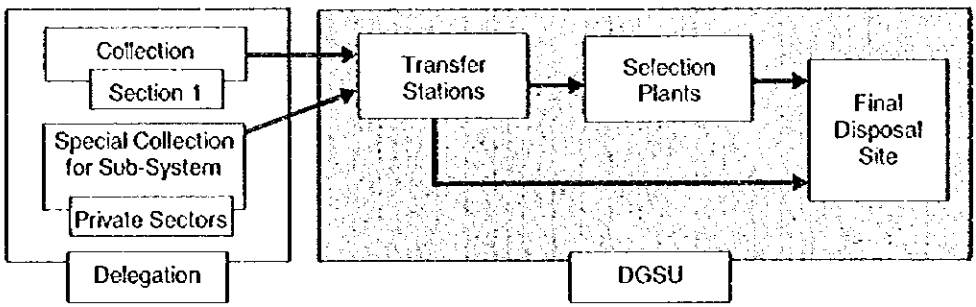


Figure 3-4: New Collection and Haulage System

Wastes brought to the transfer stations are, after visual inspection, destined to one or the other below:

- S/Ps.
- final disposal sites.

Large-size trailers ($70m^3$) are employed for the transport from the transfer station to one of the two destinations.

a. Collection Method

Regarding the collection methods, it can be said that the corner collection (with bell) is still popular, although there also exist door-to-door collection, curb collection and fixed stop collection.

b. Collection Vehicle

By 1998, the waste collection vehicles were more than 2,000 units.

It is also important to mention that, as shown in Table 3-3, 1,078 out of the 2,011 units have been used for a period of obsolescence of more than 15 years, which are supposed to have been substituted already, not only due to the high maintenance cost that are recorded, but because they technologically imply a risk of inducing inefficiency and high administrative costs.

Table 3-3: Purchase Years of Existing Collection Vehicles

	1965	1966	1967	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
Alvaro Obregon			2	3	5	4		8		38	1		16					13	1			3	13	4	4	4	6	5	7	1	138
Azcapotzalco				10	3	2		8		11	3	11	28	1				7		5		6	9	2	14		14		6		140
Benito Juarez	1			6	7	6		18	1	23	1	9	20				13					3		18	5		9		3		143
Covoacan			1	4	8	1		5		32	1		19				12		2	1		9	9	3	9		4	3	3		126
Cuajimalpa					1			1		5			5	2				4	1				2	1	1	4	15		3		45
Cuauhtemoc	3	1	1	19	18	5	1	26	1	26	2		31	3	22		34					8	12	18	2		19		3		255
Gustavo A.Madero		2	3	10	29	6	1	11	1	77	12		33		1	1	2	7	22	7		9		11	3	11	7	1	13		280
Iztacalco				4		1		5		4	3		16		5			2				4	15	10		2	11		3		85
Iztapalapa				13	4	7		12		23	1		19	7			9					5	30	65	2		7	13		8	225
M.Contreras				1		1		6		2	2		5					2				3	8	2	1		6		3		42
Miguel Hidalgo		1	1	8	20	4	1	10		37		1	17		5	1	19		8			7	4	20			1	3			168
Milpa Alta													1		3			1	1			1	6	3		6	7		3		32
Tlahuac						1	1	3	3				5			1	3	1	5			2	4	3	3	2	14		3		54
Tlalpan				1	3	2		6		9	1		17		4						2		13	6		2	2		4		72
V.Carranza				4	8	1		5		18	5	2	29	5					1			6	39	31			4		3		161
Xochimilco			1	2	1	1		2		7	1		13			1		2	2				7	2					3		45
Total	4	4	9	85	107	42	4	126	6	312	33	23	274	18	40	4	92	39	43	13	2	66	171	199	44	31	126	25	60	9	2,011
															1,087															924	2,011

Source: PARQUE VEHICULAR DE RECOLECCION ASIGNADO A LAS DELEGACIONES POLITICA, Enero, 1998, DGSU

c. Haulage System

c.1 Transfer Station

Transfer stations are a fundamental part of the infrastructure for haulage system, and 13 transfer stations are presently located in Mexico City.

Those 13 transfer stations are managed by the DGSU or by a delegation, or co-managed by both. Practical operation of the stations are all contracted out to private sectors.

However, non of them has a weighbridge, therefore the incoming and outgoing amounts are only forecast from the number of vehicles recorded and its nominal capacity (or from empirical surveys). Precisely measured transfer amounts (either incoming or outgoing amounts) do not exist to date.

c.2 Transportation

Municipal solid wastes collected by the delegations are mostly gathered in those 13 transfer stations and then transported by large-size trailers ($70m^3$) to the destinations (i.e., final disposal sites or S/Ps). A exception is direct transport by collection vehicles in view of the vicinity to the destination. Residues of the three S/Ps are loaded again to the trailers to be transported to the final disposal sites. These transport works are all contracted out to private sectors by the DGSU.

3.2.2.2 Processing, Treatment and Recycling System

As for processing, treatment and recycling facilities in Mexico City, a municipal SW incinerator and a composting facility which were used to be operated and maintained in the DGSU's premises of San Juan de Aragon are no more operated today. The facilities presently operated are the only three manual-sorting Selection Plants (S/Ps) in Bordo Poniente, San Juan de Aragon (SJA) and Santa Catarina.

a. Selection Plants (S/Ps)

Three S/Ps are currently operated for recovering recyclable materials from mixed municipal wastes. Outline of the S/Ps are shown in Table 3-4. A weighbridge is installed at the Bordo Poniente S/P and the SJA S/P respectively. The Santa Catarina S/P is not equipped with a weighbridge.

Table 3-4: Outline of S/P

	Bordo Poniente	San Juan de Aragon	Santa Catarina
Year of establishment	July/1994	July/1994	March/1996
Site area	9,500 m^2	8,000 m^2	5,600 m^2
Durability	15 years	15 years	15 years
Weighing system	Weighbridge	Weighbridge	Number of vehicles(not installed weighbridge)
Capacity	2,000 ton /day	2,000 ton/day	1,500 ton/day
Number of sorting line	4 lines	4 lines	3 lines
Capacity per line	500 ton/day	500 ton/day	500 ton/day
Working hour	24hours/3shifts, Monday to Friday	24hours/3shifts, Monday to Saturday	24hours/3shifts, Monday to Friday
Number of workers	400 persons (ex-waste picker from Prados de la Montana)	500 persons (ex-waste picker from Prados de la Montana)	400 persons
Labor organization	"Frente Unico de Pepenadores A.C."	"Asociacion de Selectores de Desechos Solidos de la Metropoli, A.C.	"Union de Pepenadores del DF Rafael Gutierrez Moreno, A.C."
Number of picking worker	42 persons/line	42 persons/line	62 persons/line
Recovered materials	Paper, Cardboard, Plastics, Glass, Steel sheet, aluminum, Copper, Iron, Tortilla, Junk, Mattress, Tire, Cloth	Paper, Cardboard, Plastics, Glass, Steel sheet, aluminum, Tortilla, Junk, Mattress, Tire, Cloth	Paper, Cardboard, Plastics, Glass, Steel sheet, aluminum, Copper, Iron, Tortilla, Junk, Mattress, Tire, Cloth

Initial objectives of installing these S/Ps were not only the promotion of recycling activities but also and mainly, the social welfare development (i.e., to improve working environment of waste-pickers by turning waste-pickers at open air dumping sites into recycling plant workers). The S/Ps today continue to hold the characteristics of social welfare installations.

Table 3-5 shows recovery ratios of respective plants, which are as low as 4% to 6%.

Table 3-5: Annual Recovery Amount and Ratios in 1997

Unit: ton/year

	Bordo Poniente	San Juan de Aragon	Santa Catarina	Total
Annual input amount	609,973.77	700,470.05	455,438.30	1,765,882.12
Annual recovery amount	32,040.05	30,646.21	30,169.24	92,855.50
Recovery ratio(%)	5.3	4.4	6.6	5.3

Table 3-6: Operation and Maintenance Cost in 1997

		Bordo Poniente	San Juan de Aragon	Santa Catarina	Average
Unit cost for recycling	pesos/ ton recovered	1,061	1,083	1,237	1,126
	pesos/ ton input	50.40	53.69	50.49	51.45

Sources : Costos de los Servicios Urbanos 1997, DGSU

3.2.2.3 Street Sweeping System

As for street sweeping in the DF, the DGSU is in charge of trunk roads sweeping, in which mechanical sweepers and manual sweeping are mainly employed. Each delegation is in charge of secondary roads, where manual sweeping is dominant.

Cleansing of public parks and green areas is mainly managed by the delegations and partly by the DGSU, where manual cleansing and sweeping are employed.

3.2.2.4 Final Disposal System

The existing final disposal sites for the DF are Santa Catarina (SC) and Bordo Poniente Etapa IV (BP IV). SC is located at about 16 km from the DGSU office on the Mexico-Puebla highway. BP IV is located about 4 km north-east of Mexico city international airport.

BP IV is located on the Texcoco ex-lake area, where an underground aquifer is highly saline and not-suited for drinking purposes. Which has a comparative advantage than any other locations that stands on a potable aquifer.

Meanwhile BP IV stands on very soft, highly compressible, clayey layers of about 60 meters thickness. It implies that if landfill is embanked in a thick layer in one operation in a short period, landslide and/or slope failure will easily take place.

SC is located on the outer slope of an ex-volcano caldera. Although major groundwater exploitation is not exercised near the SC site today, it is a disadvantage of SC site that it stands near on a water aquifer from which potable water is currently taken.

a. Landfill Structure

a.1 Bordo Poniente Etapa IV (BP IV) Site

BP IV employs the bottom impermeabilization with single high-density-polyethylene (HDPE) membrane (1.0 mm thick) sheet. The membrane is anchored in the edge of the surrounding road (see Figure 3-5).

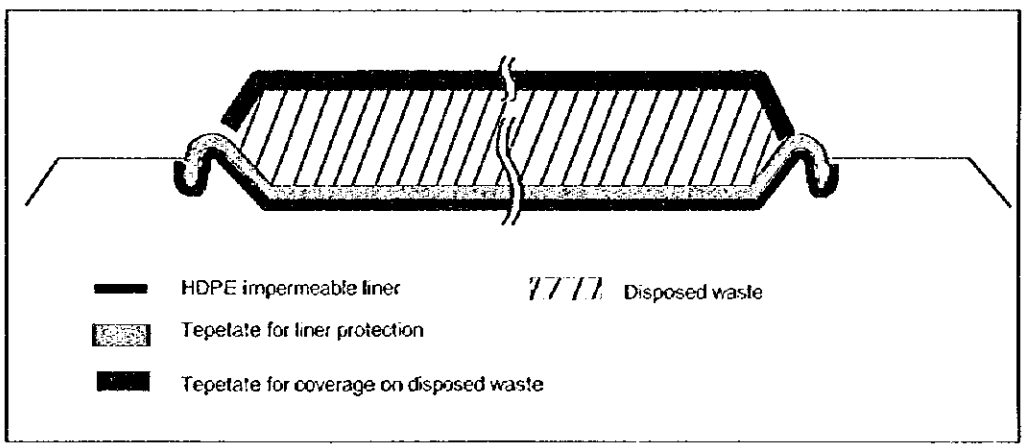


Figure 3-5: Landfill Structure of Bordo Poniente Etapa IV

BP IV does not yet employ leachate collection piping system. At present, leachate is seeping out at cells' slope bottom on to the surrounding road. **It creates a problem of operation today and the near future that the road condition is being deteriorated especially when it rains.**

a.2 Santa Catarina (SC) Site

SC initially did not employ the bottom impermeable liner. In the beginning of year 1997, when the landfill level was raised to reach to the road under which water main pipe is located, SC landfill employed the following for impermeabilization:

- mortar spray on the hill slopes and synthetic impermeable layer on the roads.
- single HDPE membrane (1.0 mm thick) sheet on the mortar-lined slope.

Figure 3-6 below (not to the scale) shows a general view of SC landfill structure.

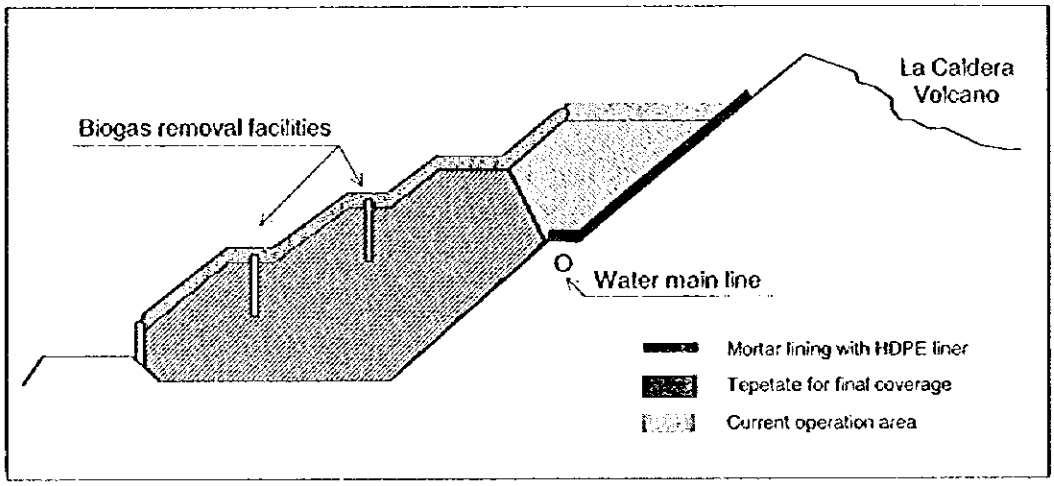


Figure 3-6: Landfill Structure of Santa Catarina Site

Table 3-7 below summarized the landfill structure of BP IV and SC.

Table 3-7: Landfill Structure of BP IV and SC

Item	BP IV	SC
Bottom impermeable liner	HDPE liner (1.0 mm thick)	Mortar lining and HDPE liner (1.0 mm thick) for upper slope only
Leachate collection system	No yet	Yes (partly)
Leachate treatment system	Transport to BP evaporation lagoon by cistern trucks	Transport to BP evaporation lagoon by cistern trucks
Biogas removal facility	No yet	Yes
Top liner	Not planned	20 cm vegetation soil layer on 30 cm tepetate layer

b. Landfilling Operation

Both BP IV and SC are currently applying bulldozers for waste accumulation and compaction. BP IV operates 24 hours continuous operation. Meanwhile SC operates from 6:30 a.m. to 6:30 p.m. from Monday to Friday and 6:30 a.m. to 2:00 p.m. on Saturdays (6 days a week).

Table 3-8: Landfilling Operation of BP IV and SC

Item	BP IV	SC
Working hours	24 hours	12 hours
Working days	7 days a week	6 days a week
Working equipment	Bulldozer 12 Nos. Vibro-Compactor 3 Nos. Backhoe 1 No. Pay Loader 3 Nos. Dump Truck 12 Nos.	Bulldozer 3 Nos. (D8N) Motorgrader 1 No. (12-G) Vibro-compactor 1 No. (CA-25) Dump truck 3 Nos. ($12m^3$)
Weighbridge control	Yes	No
Daily disposal volume	about 9,000 ton/day	about 2,000 ton/day
Working cell size	• Rainy season "80m x 750m" to "100m x 500"m • Dry season "230m x 400m" to "250m x 800"m	Basically whole area of about 5 ha
Daily soil coverage	about 1,200 m^3/day Basic practices	about 340 m^3/day Not sufficient
Items of Contract-out	all items	all items

3.2.2.5 Hospital Waste Management

The Institute of Health Services at the DF, together with the GDF, started the elaboration of a systematical program to manage adequately and appropriately the wastes.

Consequently, the collection and disposal of infectious-biological and pathological wastes were given in concession to the private sector. The infectious-biological wastes undergo a chemical treatment or sterilization in special places as autoclave and they are sent subsequently to the municipal final disposal sites. The original quantity of wastes from hospitals will increase by 10% when they are finally disposed; this is due to the chemicals that are added to the processes and treatments. On the other hand, the pathological wastes are incinerated and the remnants are hauled to the municipal final disposal sites. The costs of incineration are approximately 4 Pesos/kg (excluding collection services).

The DGSU has done some research about the generation of hospital wastes. Table 3-9 shows some of the results obtained in those investigations, regarding the generation rate of these wastes.

Table 3-10 shows the estimates of the generation of these wastes (in 1997).

Table 3-9: Hospital Waste Generation Ratio at the Medical Institutions in the GDF

Type of institution		unit	Generation rate	Remarks
Medical institution	Level 1	kg/consultation room/day	1.279	External consultation clinics .
	Level 2	kg/bed/day	4.730	Hospital with less than 50 beds.
	Level 3	kg/bed/day	5.390	Hospital with more than 50 beds.
Laboratory		kg/laboratory/day	6.343	
Veterinary		kg/employee/day	1.700	

Table 3-10: Daily Waste Generation Amount

Unit : kg/day

Institution / Delegation	Medical institutions				Other institutions			Total
	Level 1	Level 2	Level 3	Total	Laboratory	Veterinary	Total	
Alvaro Obregon	673	1,353	13,006	15,032	178	107	285	15,317
Azcapotzalco	318	1,296	7,029	8,643	57	60	117	8,759
Benito Juarez	303	6,456	12,381	19,140	501	255	756	19,896
Coyoacan	411	993	2,172	3,576	247	145	392	3,968
Cuajimalpa	463	99	0	562	44	24	68	631
Cuauhtemoc	1,086	10,141	15,507	26,734	1,414	121	1,535	28,269
Gustavo A.Madero	793	9,417	12,834	23,044	406	197	603	23,647
Iztacalco	185	4,749	458	5,392	44	75	119	5,511
Iztapalapa	510	7,327	1,692	9,529	178	211	388	9,918
M.Contreras	255	364	1,078	1,697	25	26	51	1,748
Miguel Hidalgo	1,243	3,524	9,600	14,366	514	95	609	14,975
Milpa Alta	142	52	399	593	0	5	5	598
Tlahuac	365	1,457	1,229	3,051	0	26	26	3,076
Tlalpan	752	856	12,667	14,275	152	143	295	14,570
V.Carranza	623	1,438	2,690	4,751	178	71	249	5,000
Xochimilco	549	591	0	1,140	32	39	71	1,211
Total	8,671	50,114	92,740	151,526	3,971	1,598	5,569	157,094

3.2.3 Social Aspects

3.2.3.1 Collection and Haulage System

a. Sweepers

The sweeper's initial function was sweeping streets and sidewalks of secondary streets assigned by the corresponding delegation, but due to the increase in wastes to be collected and the possibility to increase their revenues, now he/she picks solid wastes of the houses door to door.

There exist sweepers on the payroll (stably hired) and temporary sweepers (hired by periods) in this activity, who are paid by the GDF and adding up to almost 8,500 workers.

Besides, it is estimated that 3,000 or more voluntary sweepers carry out this activity; they rent the garbage carts and drums in order to work. The daily average cost of this rent is approximately 20 pesos.

The sweepers on the payroll earn 2,200 pesos per month, and temporary ones 950 pesos but the volunteers have no salary.

The income obtained by each sweeper per month depends on the socio-economic level of the population attended to and is estimated as follows:

Table 3-11: The Income of Sweepers per Month

Concept	Income per month (Pesos)		
	Formal sweeper	Temporary sweeper	Volunteer sweeper
1. Salary	2,200	950	-
2. Tip or fee	1,000	1,000	1,000
3. Trading of recovered materials	600	600	600
Total	3,800	2,550	1,600

b. Collectors

In order to carry out waste collection, the GDF by means of the delegations employs almost 2,500 formal truck drivers and 3,400 assistants, who belong to Section 1 of the Cleaning Union, which is affiliated to the Only one Workers' Union of the Federal District.

Apart from this formally paid staff, there are "volunteers", who do not earn a formal salary but join the collection teams; they are estimated to be about 4,000 people. These volunteers may not be included in the payroll until they work for as long period as 15 years. They are linked with the formal structure through truck drivers.

The union controls the infrastructure, human resources, organization and operation of the collection and transport system.

The following table shows an estimated breakdown of the monthly revenues of the collection team members by their positions. Obviously, if the team has more assistants or volunteers, their revenues will be less.

Table 3-12: Revenues of Driver, Assistant and Volunteer

Position	Income per month (Pesos)				
	Salary	*Finca*/tip	Sales of recyclable products	Payment by sweepers	Total
1. Driver (on the payroll)	2,500	3,500	3,000	750	9,750
2. Assistant (on the payroll)	2,200	1,750	1,500	375	5,825
3. Volunteer	-	1,750	1,500	375	3,625
				Total	19,200

Source: JICA study team

From this total, they pay for additional fuel to that provided by the GDF and minor repairs of the vehicle.

3.2.3.2 S/P Management System

Since 1930 in Mexico City, recyclable by-products have been recovered from the garbage due to economic, instead of ecological, reasons. For a long time, the segregation of by-products was carried out at open dumping sites in unhealthy conditions for the selecting personnel. To cope with this situation, selection plants (S/Ps) were established and have offered better working conditions, since they are roofed facilities with infrastructure required for the selection activity, and they are also furnished with the basic sanitary facilities for workers.

Currently, the DF has three S/Ps with a total installed capacity of 5,500 ton/day.

The organization and operation of the S/Ps is carried out coordinately by the DGSU and the waste-pickers groups. Maintenance of the equipment and facilities, reception of wastes and general coordination of plants are carried out by the DGSU, whereas the selection, conditioning and trading of by-products are carried out by each selecting group (formerly known as *pepenadores*).

3.2.4 Institutional and Organizational System

The competency of the **Secretariat of Works and Services** regarding the control of non-hazardous municipal solid waste is summarized in the follow table.

Table 3-13: Competencies for Municipal SWM in the DF

COMPETENCIES / ACTIVITIES	WHO NORMALIZES	WHO REGULATES	WHO AUTHORIZES	WHO OPERATES	WHO SUPERVISES
SWEEPING AND CLEANSING	SMA DGSU	SMA DGSU	DELEG. DGSU	DELEG. DGSU	SMA
COLLECTION	SMA DGSU	SMA DGSU	DELEG. DGSU	DELEG. DGSU	SMA
TRANSFER	SMA DGSU	SMA DGSU	DGSU	DGSU	SMA
TREATMENT	SMA DGSU	SMA DGSU	DGSU	DGSU	SMA
FINAL DISPOSAL	INE	SMA DGSU	SMA DGSU	DGSU	SMA PROFEPA

SMA: Environmental Secretariat of the GDF.
DGSU: General Direction for Urban Services of the Works and Services Secretariat of the GDF
INE: National Institute of Ecology, SEMARNAP.
DELEG.: Political Delegations of the DF.
PROFEPA: Office of the Federal Prosecution For the Environment Protection, SEMARNAP.

The management of municipal solid wastes in Mexico city involves, in addition to traditional sweeping, collection and final disposal stages, transfer and treatment (segregation of recyclable products) of wastes. In almost all management stages, apart from the traditional procedures applied to almost the same criteria used in the world, there exists an **informal** process that is not officially recognized by the responsible authorities, while this system is somehow accepted or although sometimes its activities are regarded as irregular.

3.3 Assessment of the Present Condition and Confirmation of Key Issues

3.3.1 Technical System

3.3.1.1 Discharge[1] and Storage System

Mixed storage and mixed discharge are the dominant practices in the present systems. However, in order to promote "recycling activities" and "final disposal amount reduction" as key elements for resource conservation, "source separation" of wastes becomes indispensable. On the other hand in the present situation, there is no specific regulation nor guideline for this purpose oriented waste containers. Waste generators (general public and institutions) are independently use their recipients such as dust bin and plastic bag.

"Source separation" requires: people's conscience and dedication; strict observance of discharge manners; changes in discharge/storage containers; and so forth. Therefore, it takes long time to popularize the "source separation" practices until it becomes as a prevalent custom.

3.3.1.2 Collection and Haulage System

a. Collection System

Mixed discharged municipal wastes are collected by the present "mixed collection" system. Collection of municipal wastes is the responsibility of respective delegations. There are many places and occasions in which collection time and frequency are far from constant.

Total collection vehicles in 16 delegations are 2,011. 1,087 vehicles out of them have been used for the service more than 15 years after their purchase (The oldest in the list was purchased in 1965). Therefore, their breakdown frequency is very high and the recurrent costs on maintenance and repairs are significant.

Average trips made by the workable collection vehicles (1,434 vehicles) are about 1.7 trip/day. 10 delegations are with figures of average trips per day lower than this figure (Table 3-1).

Such low work efficiency of vehicles will be attributable to the following:

- many vehicles are older and damaged in most parts, therefore the breakdown frequency is high.
- waste-picking (material recovery) is practiced by vehicle crews on the collection routes, therefore, much time are spent on waste-picking than waste loading or vehicle movement.

b. Transfer Station

Incoming and outgoing wastes volumes at transfer stations are not measured but only estimated from nominal capacities of vehicles/trailers and their numbers. Therefore,

[1] Discharge is the internal disposal of wastes after the generation and separation with recyclable materials. For the generator, this is known as rejected wastes.

the transfer station management in line with those estimated volumes has a serious self-limitation that is only within the reach of estimation. Therefore, as soon as possible, a **weighbridge** should be installed in every transfer station in order to manage it with realistic figures of volumes recorded.

At least from today, a **single common format for data compilation** (of incoming/outgoing amounts, O&M expenses, etc.) should be established and utilized in order to manage, review and improve the transfer station operations.

c. Transportation System

Real-time control is employed for operation of trailers through the GPS apparatus. However, since actual load weight is not measured (only estimated), management of transportation efficiency is only in a range of estimation.

3.3.1.3 Processing, Treatment and Recycling System

a. Incineration

From 1990 to 1992, a pilot incineration plant for municipal SW was operated with effluent gas treatment facilities. However, required incineration performance was not obtained from the plant. The failure was mainly attributable to the fact that the plant was not designed to suit to the waste composition in Mexico, which calorific value is in a low range of 1,200 kcal/kg.

When in future an incineration plant is installed, it is required to clear the 1997 established emission norms (NOM-ECOL/95). Consequently, significantly expensive emission treatment facilities (such as wet-type absorption and bag-filter facilities) are needed to be equipped.

b. Composting

The failure of the composting facility, which had been operated by the delegation Gustavo A. Madero since 1974 and was dismantled in 1993, might be attributable to management problems that:

- The compost was not easily commercialized because of impurities (such as glass and plastics) mixed in them.
- Low production performance of the plant was due to financial shortage of the delegation for operation and maintenance.
- Meanwhile, the technical problem of the compost product quality should be mainly because mixed municipal wastes were fed to composting processes.

Therefore, when in future a composting plant is installed, it is required to introduce and practice "**source separation**" and "**separate collection**" of organic wastes, in order not to repeat the same mistake.

c. Selection Plant (S/P)

First of all, the problem of the very low material recovery rate of the S/Ps is due to feeding **mixed municipal wastes**. In addition to that, the problem of present operation practices is very excessive waste feeding into the recovery lines:

- Waste layer thickness on sorting lines, a major determinant of selection efficiency, is as thick as 40 cm to 50 cm. Therefore, workers are unable to visually identify materials to be targeted in the initial moment, and have to stir and open the waste layer by hands. Consequently they loose more time for picking materials.
- Velocity of the sorting line conveyors is as fast as about 20 meter/min. Together with the above effect, the material recovery efficiency is lowered further.

Hence, if in the future wastes input amount in the S/Ps is decreased, working condition on sorting lines will be improved and material recovery efficiency will be raised.

Besides, the Santa Catarina S/P is not equipped with a **weighbridge**, which is the problem of not understanding the precise incoming/outgoing wastes flow.

3.3.1.4 Final Disposal System

The Bordo Poniente final disposal site employs a bottom impermeable liner (HDPE, 1.0 mm thick) and devises to minimize the landfill working face. It practically realizes a sanitary landfill and therefore, operational problems are very few.

The Santa Catarina final disposal site, although having a wider landfill working face, complies with measures of sanitary landfill such as: biogas removal, final soil cover with vegetation soil layer, and leachate collection lines (partial). In practices, technical problems are few. On the other hand, present about 5 ha working face plays a role of material recovery places of waste-pickers, which is an open air, therefore, it invites vectors of flies and mosquitoes and offensive odors.

a. Service Life of Landfill Site

The municipal SW final disposal sites presently in service in DF are Santa Catarina and Bordo Poniente "Etapa IV". The Santa Catarina site is expected to be closed soon due to the very limited remaining capacity. The Bordo Poniente "Etapa IV" is estimated to serve until January or February 2001. Therefore, sites for new final disposal need to be assured soon.

b. Leachate Management

b.1 Leachate Collection

Although the presently operated Bordo Poniente Etapa IV landfill employs HDPE impermeable bottom liners, a leachate collection facility is not yet installed. Therefore, leachate inside the buried wastes layer is not sufficiently drained but is seeping out at cells' slope bottom on to earth-excavated roadside ditches or on to roads. The roadside leachate seepage is partially collected by cistern trucks, however its majority is infiltrating into the ground as a consequence, although the landfill is provided with bottom impermeable liners.

In order to prevent this phenomenon, leachate collection lines should be installed in the landfill layers to facilitate drainage of leachate to opt its management.

b.2 Leachate Treatment and Disposal

Current limited leachate treatment by the DGSU is by: (i) physical-chemical treatment; and (ii) evaporation pond, both of which are in the Bordo Poniente area. The former requires substantially high operation and maintenance costs, and the latter sometimes suffers from overflowing of leachate from the pond.

3.3.2 Institutional System

The legislative and institutional structure targeted for SWM is well elaborated and appropriate. Some points regulated in the past by the Cleaning Code (Reglamento del Servicio de Limpia) must be reviewed in regards to the existing legal basis.

Some administrative policies and practices, such as staffing and service hiring, must be deeply reconsidered.

Contracts must be more economic and less complicated for the GDF and the contractors. Contracts will become more forcible when the GDF develops a policy of contracting out collection services and other services, which imply greater investments in equipment and labor. In this moment, not only will the contract period and contents be the appropriate; also, an **insurance** for the performance of the service to be submitted on the contract day will be convenient for both parties.

Yet the modalities allowed by the law are not changed, **labor relations** should also be reviewed, in the search of justice for both parties, with rights and obligations perfectly outlined and controlled. However, a radical change will only be feasible in the long run, for a total overcome of the informal structure that the SWM is currently bearing.

The weak points of labor legislation helped enhancing or creating the **dominant informal structure** in the SWM system, which seems to have origin in a traditional political system that helps politically well commanded groups; and economic support of "no charge" status established in the Cleaning Code (Reglamento de Limpieza); and on the other hand, the fair acknowledgment by the citizen that the service is being rendered to them.

There is no doubt that the citizen pays to the servant for the effective service rendered and at a negotiated or agreed price.

3.3.3 Social Aspects

Although the SWM service in the DF does not currently show conflictive social problems, it does present critical underlying points which block the improvements of the system. This situation could affect Master Plan implementation if these points are not solved or at least mitigated during the period until 2010.

Among those underlying critical social points, we can name the following:

- There are a large number of informal workers without being protected by the labor law.
- Social costs: subsidies for SWM granted by GDF are transferred to the society. As a result, taxes are directed to finance these subsidies instead of going to other broader social benefit projects.

- It is unknown whether there is an equitable distribution of profits among ex-waste-pickers proceeding from revenue of traded recovered materials from S/P.
- Sta. Catarina landfill still operates with waste-pickers.
- In small proportion, there are peripheral areas in the DF where there is a deficient or sporadic collection service.
- Indifference is found in the relationship between service recipients and GDF cleansing staff.
- Weak supervision to enforce labor legislation, social security, and health of workers group of the contracted enterprise.

3.3.4 Organizational System

The lack of a maintenance and control organization (with respect to supplying of spares) of the collection teams is quite remarkable, which is overcome thanks to the cooperation of informal beneficiaries. This lack is also present in regards to other equipment, but this lack is overcome by contracting operation and maintenance. Meanwhile, more attention to these aspects is recommended, because they may lead to a decrease of productivity and increasing costs, since these equipment are specialized and most of them are imported, which in turn will result in a delay to obtain spare parts or even to modify them. It is also true that service contracting or concession, including necessary equipment, can also be a good solution.

Planning and control of residential collection and street cleaning services are empirical and the informal structure is in charge of them, with the exception of specialized services.

A regulation for service execution and another for public procedure regarding urban cleaning and wastes should be created, including their corresponding sanctions. Likewise, permanent communication with neighbors is necessary such as providing them with information and paying attention to their claims, which would represent a good tool to monitor the services.

3.3.5 Ascertainment of Aggregate Unit Cost of Solid Waste Management in DF, 1998

Summary of "Aggregate Unit Cost of SWM in DF" is shown below.

1. Capital Investment	
1.1 Recycling Plant	2.7
1.2 Collection and Transfer Stations (13 units) *1	13.6
1.3 Final Disposal Site	0.5
Sub-Total	***16.8***
2. Recurrent Costs	
2.1 Collection	16.1
2.2 Transfer Station (13 units)	13.9
2.3 Selection Plants (3 units)	4.6
2.4 Final Disposal Sites (3 sites)	3.2
2.5 Disposition of Illegal Dumping	18.2
2.6 Major Road Cleaning	0.7
Sub-Total (2.1 – 2.4)	***37.8***
Sub-Total (2.1 – 2.6)	***56.7***

3. Hidden Costs (Tips)	
3.1 Household *Tips*	8.1
3.2 Entities *Fincas*	25.8
Sub-Total	*33.9*
"*AGGREGATE UNIT COST*" OF SWM, US$/ton/year/98 price	
Alternative 1: without Illegal Dumping & Major Road Cleaning	88.6
Alternative 2: including All Cost Factors	107.5

(*1 Inclusive of tracks and trailers in service)

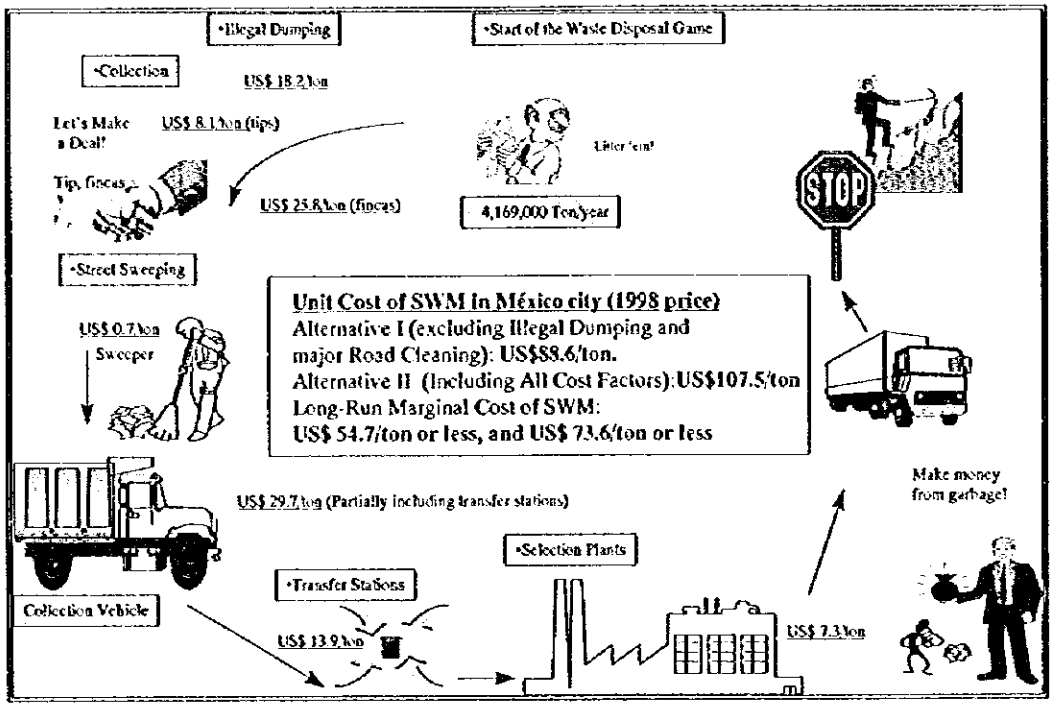
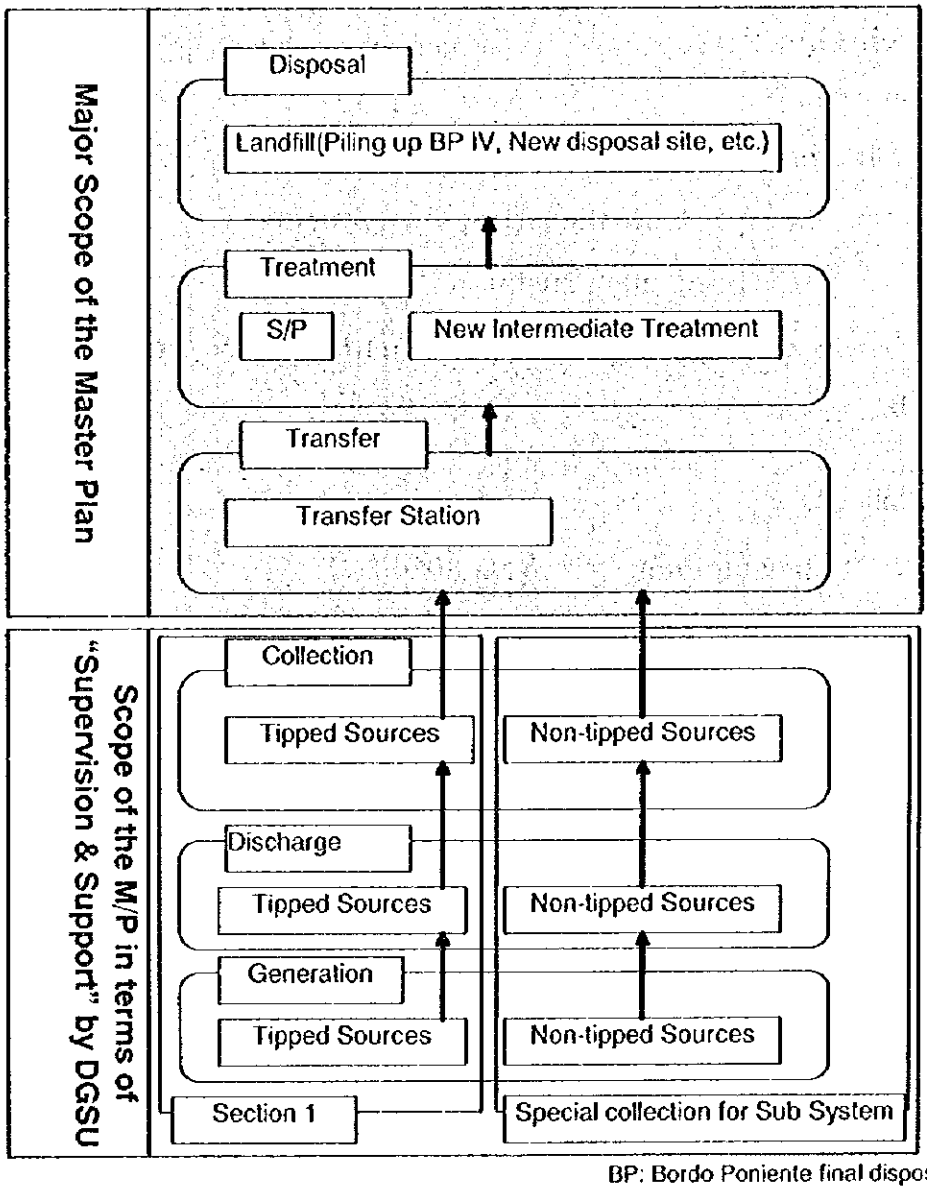


Figure 3-7: Aggregate Unit Cost of Solid Waste Management (2)

4 Setting up Planning Frameworks for the Master Plan

4.1 Scope of Planning Frameworks for the Master Plan

The major study scope field of the M/P is defined as shown in Figure 4-1.



BP: Bordo Poniente final disposal site

Figure 4-1: Scope of the M/P

4.2 Goals, Targets and Strategies

4.2.1 Goals and Targets Year

a. Goals

The principal goal of the Master Plan is to establish a sound Solid Waste Management System by the target year 2010 in Mexico City, where the population and major economic activities of the country are centered.

The Master Plan aims to:

- **promote the citizens' well-being;**
- **implement sustainable SWM; and**
- **contribute to environmental conservation.**

b. Targets

In accordance with the S/W of the Study, the target year for master plan is set up as follows:

Master Plan: Year 2010

4.2.2 Examination of the Master Plan Framework

a. Basic Alternatives

The three alternatives shown in Table 4-1 were examined in series of discussion between the team and counterpart to establish the M/P framework.

Table 4-1: Basic Alternatives for the M/P

	Purpose	Basic concept	Outline	Result
ALT 1	Social welfare for ex pepenadores	No change	No change in present situation.	No improvement
ALT 2	Financial benefit	Cost saving	Closure of the S/Ps	• DGSU will save operation and maintenance cost for the S/Ps. • Increased landfill amount.
ALT 3	Material recovery, resources conservation and reduction of disposal amount	Improvement of recovery efficiency	Improvement of waste input condition of the S/Ps. • Improvement of input waste quality (by introducing "source separation" and "separate collection" systems). • Reduced input amount Improvement of recovered material market system • Storage mechanism to adjust supply to demand in the market.	• Material recovery and resources conservation. • Reduction of disposal amount

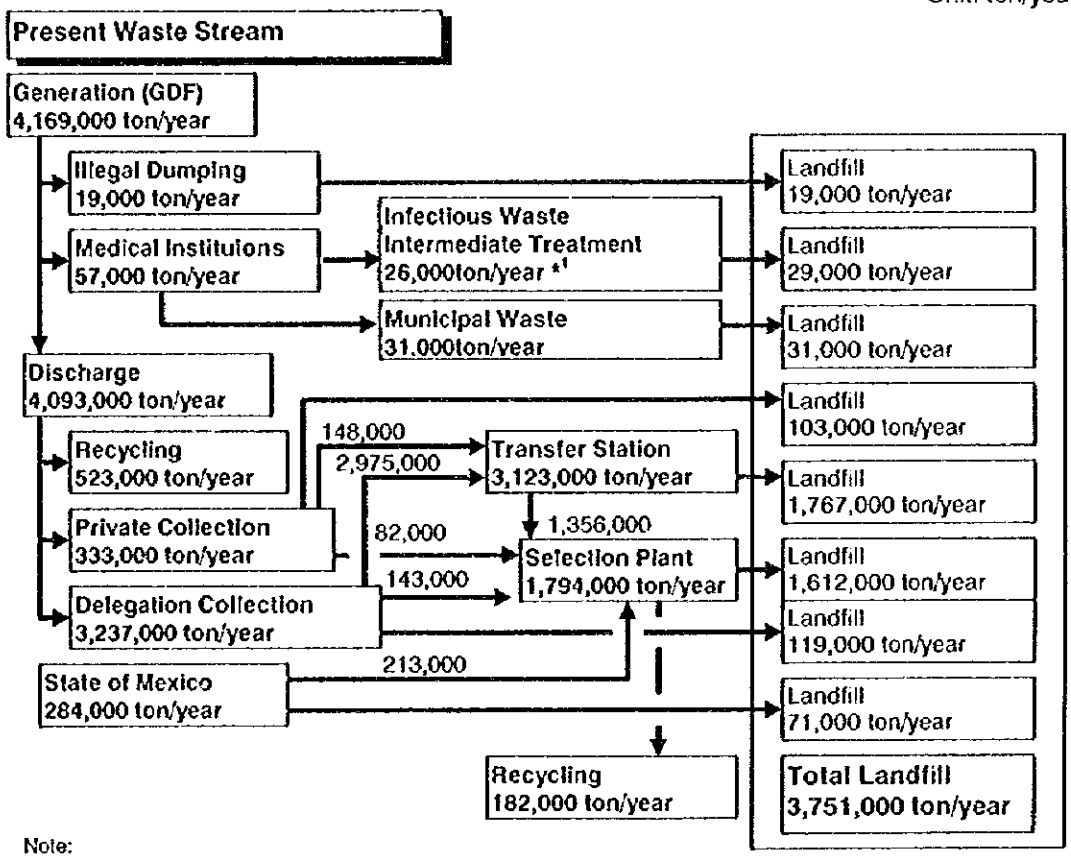
Taking the goals of the M/P described in the previous section into account, the framework of the M/P (i.e. the SWM Outline in the target year 2010) should be formulated in line with Alternative 3.

b. Basic Concept

b.1 Discharge System

Figure 4-2 illustrates the present waste stream, in which materials are recycled at the generation source, in the process of mixed waste collection and in the S/Ps. Although it is estimated that potentially recyclable materials account for 37% of the total waste generation, material recovery rates are only about 14% in the collection process and 4% in the S/Ps of the total generation.

Unit: ton/year



Note:
*1: Increase of 3,000 ton/year due to the treatment agents.

Figure 4-2: Present Waste Stream

Sustainable SWM requires the promotion of material recovery and the minimization of waste amount to be disposed of. These, in turn, inevitably necessitate separate waste discharge at source and separate collection.

Separate discharge is to be introduced step by step into the sub-system aiming at 100% separation rate in 2004 in the M/P.

On the other hand, "source separation" program is to be introduced in later years to the generators whose waste collection services are currently provided by the delegations more gradually with due attention by making use of experience gained in the sub-system aiming at 50% separation rate by 2010.

The separate discharge and collection program in the M/P is presented in Figure 4-3.

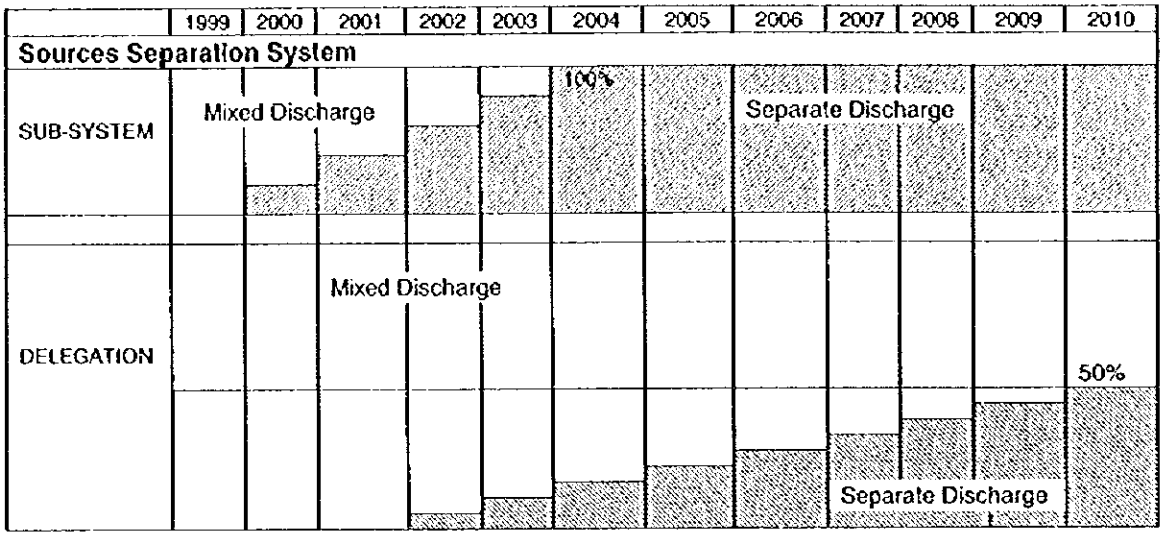


Figure 4-3: Separate Discharge and Collection Program

b.2 Treatment and Disposal System

The sub-system will involve the Central Market (*Central de Abasto*) and public markets, which generate a great amount of organic wastes. On the assumption of separate waste discharge, a practicable treatment of organic waste will have to be introduced.

Regarding the S/Ps, in order to raise the material recovery rate, measures to efficiently recover materials from mixed wastes and/or separately discharged recyclable wastes will be figured out in the M/P.

b.3 Target Year for Feasibility Study

The year 2004 is set as the target year for the F/S, when separate :discharge rate in the sub-system will reach 100%.

4.2.3 Targets and Strategies

a. Target Figures

In order to achieve the principal goals, the target figures for the major components that constitute SWM were set as indicated in the table below.

Table 4-2: Target Figures for the SWM System

		Present (1997/98)	F/S (2004)	M/P (2010)
Generation Amount (ton/year)		4,169,000	4,302,000	4,430,000
Source Separation	Sub-system	0(%)	100(%)	100(%)
	Delegation	0(%)	14.5(%)	50(%)
Separate Collection	Sub-system	0(%)	100(%)	100(%)
	Delegation	0(%)	14.5(%)	50(%)
Separated Waste S/P Input Amount	Sub-system	0	247,000 (ton/year)	253,000(ton/year)
	Delegation	0	191,000(ton/year)	591,000(ton/year)
New Intermediate Treatment	Sub-system	0(%)	100(%)	100(%)
	Delegation	-	-	-
Final Disposal Amount (ton/year)	Sub-system	0	302,000	308,000
	Delegation	3,407,000	2,738,000	2,624,000
	Medical Institution	60,000	61,000	62,000
	State of Mexico	284,000	284,000	284,000
	Total	3,751,000	3,385,000	3,278,000

b. Strategies

Strategic actions to achieve the goals and targets should be, in practice, introduced step by step toward the target year 2010. Therefore, it is recommended to divide the period up to the target year into three phases, as shown in Table 4-3, Table 4-4, Table 4-5 and Table 4-6.

Table 4-3: Recommended Alternative for the Strategies in Phase 1 for the Master Plan (1999-2001)

	Technical Aspects		Institutional Aspects	
	Sub-system	Delegation	Sub-system	Delegation
Discharge/Storage	• Promoting public awareness of separate discharge (3 items) through environmental education . • Implementation of a pilot project of source separation (3 items). • Phased introduction of source separation (3 items).	• Preparation and implementation of a pilot project of source separation (2 items).	• Preparation of the Code for the Solid Waste Management at the Sources • Implementation of the Code	
Collection	• Implementation of a pilot project of separate waste collection (3 items). • Phased introduction of separate waste collection (3 items).	• Formulation of a M/P for separate collection (2 items) in each delegation.	• Contract out to Private Sector	• Examine conditions for institutionalizing Section 1 into Private entities
TS & Tr.	• Installation of weighbridges for every station. • Utilization of a single common format for data compilation. • Establishment of a transport monitoring and control system (for 3 flows)[1] based on accurate incoming/outgoing weight measurement.		• Contract out	
S/P	• Experiment of operation modification (by reducing input amount reduction and lowering lines velocity) to incorporate an objective of quantity oriented picking, although the present objective may be sustained and more important. • Experiment of "storage system" for recovered materials to cope with market prices fluctuation.		• Examination of Concession (Examine conditions for institutionalizing Ex-pepenadores Groups into Cooperatives)	
NIT[2]	• Design and construction.		• Investment by the DGSU • Establishment of quality standards for the product **1st Priority Financing**	
Final Disposal	• Establishment of leachate collection and re-circulation system in the Bordo Poniente "Etapa IV". • Vertical expansion at the Bordo Poniente "Etapa IV". • Design and construction of a new landfill site.		• Investment by the DGSU for BP-IV and BP-V **1st Priority Financing**	

Note: This Table shows alternatives proposed by the JICA team which will be subject to further examination by the GDF.

1) 3 flows refer to waste flows from the transfer stations to the S/Ps, from the transfer stations to the final disposal sites, and from the S/Ps to the final disposal sites.

2) NIT: New Intermediate Treatment

Table 4-4: Recommended Alternative for the Strategies in Phase 2 for the Master Plan (2002-2004)

	Technical Aspects		Institutional Aspects	
	Sub-system	**Delegation**	**Sub-system**	**Delegation**
Discharge/Storage	• Promoting public awareness of separate discharge (3 items) through environmental education. • Phased introduction of source separation (3 items) aiming at 100% coverage in 2004.	• Promoting public awareness of separate discharge (2 items) through environmental education . • Phased introduction of source separation (2 items).	-------	• Implementation of the Code for the Solid Waste Management at the Source
Collection	• Establishment of separate collection methods (3 items). • Phased introduction of separate collection (3 items).	• Phased introduction of separate collection (2 items).	• Contract out to Private Sector (Preparation of Concession and Permission)	• Preparation of Concession/Permission (Formalize the Section 1 as private entities with necessary funding) **2nd Priority Financing**
			• Preparation of the criteria to fix the tariffs* and subsidies	
TS&T	• Utilization of the transport monitoring and control system (for 5 flows[1]) based on the accurate incoming/outgoing weight measuring • Efficient transport allocation by the monitoring and control system		• Contract out	
S/P	• Implementation of operation control (input amount control and lines velocity control) with 2 objectives of: (a) revenue oriented picking; and (b) quantitative picking, and (a) may be less important than (b). • Establishment of "storage system" for recovered materials to cope with market prices fluctuation, in view of experiment results.		• Preparation of Concession (Formalize the Ex-pepenadores Group as Cooperatives with necessary funding) **2nd Priority Financing** • To negotiate the implementation of improvements at the S/P conditioned at the institutionalization of ex - pepenadores as cooperatives or another appropriate juridical form	
NIT	• Starting operation of the new facility.		Examination of four options: A. Status quo (DGSU) A1. DGSU direct operation A2. Contract out operation B. Parastatal C. Concession and preparation for B or C if it is chosen.	
Final Disposal	• Starting operation of the new facility.		Examination of three options: A. Status quo (DGSU) A1. DGSU direct operation A2. Contract out operation B. Parastatal and preparation for B if it is chosen.	

Note: This table shows alternatives proposed by the JICA team which will be subject to further examination by the GDF.

* Tariff: Price of the service that the citizen pays to the concessionaire

1) 5 flows refer to additional waste flows from the transfer stations to the NIT and from the NIT to the final disposal sites, and current 3 flows.

Table 4-5: Recommended Alternative for the Strategies in Phase 3 for the Master Plan (2005-2010)

	Technical Aspects		Institutional Aspects	
	Sub-system	**Delegation**	**Sub-system**	**Delegation**
Discharge/Storage	• Continuation of promoting public awareness of separate discharge (3 items) through environmental education. • Maintaining 100% coverage on source separation (3 items)	• Promoting public awareness of separate discharge (2 items) through environmental education. • Further introduction of source separation (2 items) aiming at 50% coverage in 2010.	------	-------
Collection	• Maintenance and/or improvement of the separate collection methods (3 items).	• Further introduction of separate collection (2 items).	• Concession/Permission to Private Entities • To approve and monitor the tariffs*	• Start Concession /Permission
TS & T	• Utilization of the transport monitoring and control system (for 5 flows)[1] based on the accurate incoming/outgoing weight measurement. • Efficient transport allocation by the monitoring and control system.		• Contract out	
S/P	• Implementation of operation control (input amount control and lines velocity control) with the major objective of "quantity oriented picking". • Utilization of the optimum "storage system" for recovered materials to cope with market prices fluctuation.		• Concession	
NIT	• Operation and maintenance of the new facility.		One of the four options: A. Status quo (DGSU) A1. DGSU direct operation A2. Contract out operation B. Parastatal C. Concession and preparation for B or C if it is chosen.	
Final Disposal	• Operation and maintenance of the new facility.		Three options: A. Status quo (DGSU) A1. DGSU direct operation A2. Contract out operation B. Parastatal and preparation for B if it is chosen.	
Special Considerations: • Regional use of the future final disposal sites • Examination of wastes volume reduction technologies (such as incineration)				

Note: This table shows alternatives proposed by the JICA team which will be subject to further examination by the GDF.

* Tariff: Price of the service that the citizen pays to the concessionaire

1) 5 flows refer to additional waste flows from the transfer stations to the NIT and from the NIT to the final disposal sites, and current 3 flows.

Table 4-6: Institutionalization Alternative for the M/P

	Waste Flow	Institutionalization Flow	Phase 1	Phase 2	Phase 3	
			1999 - 2001	2002 - 2004	2005 - 2010	2011 -
Sub-system		↓	Contract out to Private Entities	(Preparation of Concession) Contract out to Private Entities	Concession to Private Entities	Concession to Private Entities
Collection	↓		Examination of Concession (Examine conditions for institutionalizing Section 1 into private entities)	Preparation of Concession/Permission (Formalize the Section 1 as private entities with necessary funding) **2nd Priority Financing**	Start Concession and Permission to Private entities	Concession and Permission
S/Ps	↓		Examination of Concession (Examine conditions for institutionalizing Ex-pepenadores Grous into Cooperatives)	Preparation of Concession (Formalize the Ex-pepenadores Groups as Cooperatives with necessary funding) **2nd Priority Financing**	Concession	Concession
T/Ss and Transport	↓	↑	Contract out	Contract out	Contract out	Contract out
NIT	↓	↑	Investment by the DGSU **1st Priority Financing**	**A1.** DGSU direct operation or **A2.** Operation contracted out by DGSU. Examination of four options: A. Status quo (DGSU) either A1. or A2., B. Parastatal, and C. Concession and preparation for B or C if it is chosen.	A1, A2, B or C.	A1, A2, B or C.
Final Disposal		↑	Investment by the DGSU **1st Priority Financing**	**A1.** DGSU direct operation or **A2.** Operation contracted out by DGSU. Examination of three options: A. Status quo (DGSU) either A1. or A2., and B. Parastatal and preparation for B if it is chosen.	A1, A2, or B	A1, A2, or B

Note: This table shows alternatives proposed by the JICA team which will be subject to further examination by the GDF.

5 The Master Plan

5.1 Outline of the Mater Plan

5.1.1 Discharge and Storage System

At present, source separation is not realized in the DF. Taking account of the future consequence of SWM in the DF, however, source separation is indispensable. The following is the plan for source separation proposed by the M/P.

a. Time Schedule

The separate discharge and collection program in the M/P is presented in Figure 5-1.

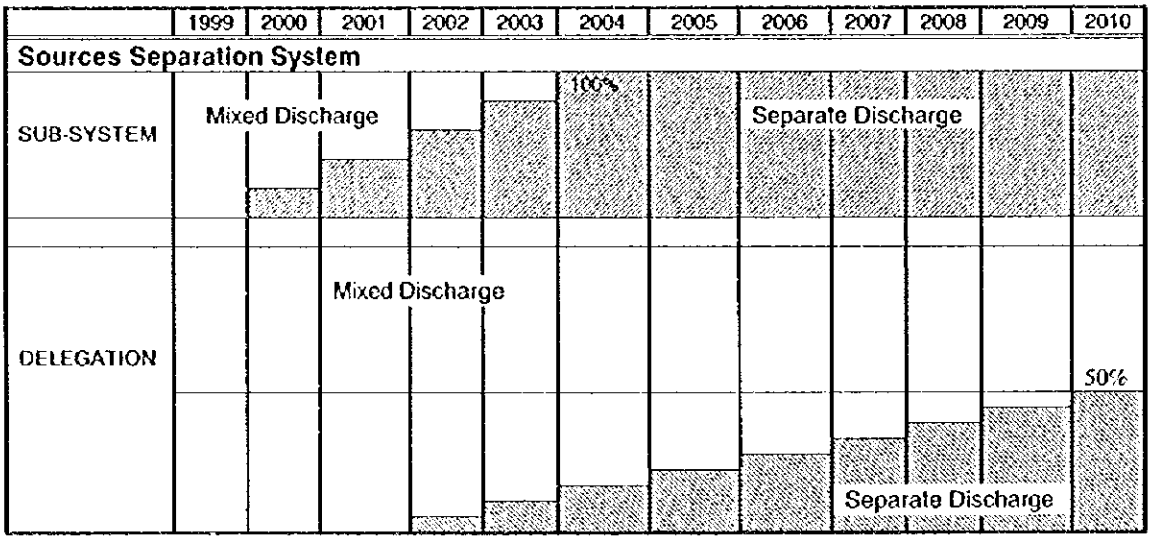


Figure 5-1: Separate Discharge and Collection Program

b. Separation Categories

The source separation categories in the sub-system are proposed to be **three** (organic, recyclable, and others).

On the other hand, the collection services by the delegations are provided for individual generators, whose laborious commitments in source separation are difficult to seek. Since it is anticipated that the same three categories source separation can not be easily achieved by generators in the delegation services, it is proposed to employ the simplest separation categories (i.e., **two categories:** recyclable, and others) for the source separation in the delegation services.

Table 5-1: Source Separation Item

System	Separation type	Waste category
Sub-system	3 categories separation	organic, recyclable, and others
Delegation	2 categories separation	recyclable, and others

5.1.2 Collection and Haulage System

a. Collection Methods

Collection methods for separately discharged wastes comprise such as:

- **Normal vehicle collection**
- **Point collection**
- **Special vehicle collection**

In view of an advantage of utilizing the existing collection system (i.e., maximum use of current resources and cost saving), **normal vehicle collection** appears to be most recommended as the separate collection method in the M/P. Meanwhile, as for the separate collection for markets, in which limited in number of major generators are put together, **point collection** could be recommended, if the collection point can be managed as part of market facilities.

b. Haulage System

b.1 Transfer Station

Currently visual waste inspections are carried out at the transfer stations, in order to determine the optimum waste destination (S/P or final disposal site) for respective incoming wastes. Therefore, even in a case where separate collection is implemented in the future, it is judged that the present system of transfer stations can cope with the change.

b.2 Transportation

Separate transport routes by which wastes are transported are: from station to S/P, from station to final disposal, and from S/P to final disposal. Therefore, it is judged that present system can be adapted to the future transportation system in which mixed waste and separate waste are to be transported independently.

5.1.3 Intermediate Treatment System

The objectives of the intermediate treatment system are the minimization of waste volume to be disposed of and material recycling. There are three selection plants in the DF, but their material recovery ratio is not high enough.

In the M/P, the efficiency upgrading of these S/Ps and the installation of a new compost facility are planned. The compost facility will be fed with organic waste from the sub-system and its capacity is expanded as the source separation program proceeds.

In Phase 3, the latter half of the M/P (2005-2010), when and if the shortage of the final disposal site is anticipated to emerge, possibility of the introduction of an incinerator should be examined.

5.1.4 Final Disposal System

The standard of the final disposal method employed by the GDF at present is high and the minor improvement of the leachate treatment system should be enough to operate the Bordo Poniente final disposal site technically satisfactorily.

However efficiently the Bordo Poniente final disposal site is used, it is certain that the GDF needs another new final disposal site around 2013 in addition to Etapa V. Under the present land use condition in the DF, however, obtaining a new land for the final disposal within the DF is very likely to encounter serious difficulty.

As it is anticipated that substantially long time of discussion will be required before its implementation, the coordination with municipalities outside of DF for the future landfill (to be used after the year 2013) should be started at latest in the year 2007 or around by the GDF and other entities.

5.1.5 Outline of the Master Plan

Table 5-2 shows outline of the master plan.

Table 5-2: Outline of the Master Plan

		Data of 1997	Phase 1 (1999 - 2001)	Phase 2 (2002 - 2004)	Phase 3 (2005 - 2010)
Population		8,610,000	8,654,000-8,747,000	8,796,000-8,896,000	8,946,000-9,206,000
Waste generation amount (ton/year)					
Household		1,926,000	1,946,000-1,965,000	1,976,000-1,998,000	2,009,000-2,072,000
Commercial		1,210,000	1,217,000-1,223,000	1,229,000-1,236,000	1,244,000-1,267,000
Service		636,000	642,000-649,000	652,000-657,000	659,000-669,000
Special		130,000	131,000-134,000	134,000-136,000	136,000-140,000
Others		267,000	268,000-270,000	271,000-275,000	276,000-282,000
Total		4,169,000	4,204,000-4,241,000	4,262,000-4,302,000	4,324,000-4,430,000
Discharge/Storage					
	Sub System	-	Introduction of source separation	Introduction of source separation	Maintaining source separation
	Delegation	Mixed	Mixed	Introduction of source separation	Introduction of source separation
Collection					
Amount (ton/year)	Sub System	-	853,000-858,000	861,000-867,000	870,000-884,000
	Delegation	4,169,000	3,293,000-3,325,000	3,342,000-3,376,000	3,395,000-3,485,000
Method	Sub System	-	Introduction of separate collection	Introduction of separate collection	Maintaining separate collection
	Delegation	Mixed	Mixed	Introduction of separate collection	Introduction of separate collection
Transfer Station and Transport					
Transfer Station and Transport			• Installation of weighbridges for every station. • Utilization of a single common format for data compilation	• Utilization of the transport monitoring and control system (for 5 flows[2]) based on the accurate incoming/outgoing weight measuring • Efficient transport allocation by the monitoring and control system	
Transfer amount (ton/year)		3,123,000	3,725,000-3,757,000	3,776,000-3,812,000	3,830,000-3,922,000

[2] 5 flows refer to current waste flows (from the transfer stations to the S/Ps, from the transfer stations to the final disposal sites, and from the S/Ps to the final disposal site) and additional flows from the transfer stations to the NIT and the NIT to the final disposal site.

		Data of 1997	Phase 1 (1999 - 2001)	Phase 2 (2002 - 2004)	Phase 3 (2005 - 2010)
O&M cost(U$/year)		43,547,000	51,941,000-52,387,000	52,652,000-53,154,000	53,405,000-54,688,000
Intermediate Treatment					
Selection plant			• Experiment of operation modification to incorporate an objective of quantity oriented picking. • Experiment of "storage system" for recovered materials to cope with market prices fluctuation.	• Implementation of operation control with 2 objectives of: - revenue oriented picking: -quantitative picking, • Establishment of "storage system" for recovered materials to cope with market prices fluctuation, in view of experiment results.	• Implementation of operation control with the major objective of "quantity oriented picking". • Utilization of the optimum "storage system" for recovered materials to cope with market prices fluctuation.
Input amount (ton/year)	Mixed	1,794,000	1,650,000-1,546,000	1,288,000- 725,000	567,000 - 0
	Recyclable	-	0 - 98,000	210,000-438,000	504,000-844,000
Recycle amount(t/y)		182,000	166,000-224,000	277,000-380,000	409,000-591,000
Recovery rate (%)		10.0	10.0-13.6	18.5-32.7	38.2-70.0
O&M cost (US$ 1,000)		11,232	10,565- 10,537	9,857 - 8,296	7,867 - 6,809
Composting plant		-	Design and construction	Starting operation	Operation and maintenance
Input amount (ton/year)		-	-	253,000 - 424,000	425,000 - 431,000
Compost production amount (ton/year)		-	-	34,000 - 57,000	57,000 - 58,000
Investment (U$D)		-	3,959,000	1,345,000	1,334,000
O&M cost(US$/year)		-	0 - 33,000	1,185,000 - 1,343,000	1,343,000 - 1,343,000
Final Disposal					
Final Disposal Site		BP "Etapa IV" Santa Catarina	BP "Etapa IV" vertical expansion Design & construction of BP "Etapa V"	Operation of BP "Etapa V"	Operation of BP "Etapa IV" & "Etapa V"
Disposal amount (ton/year)	GDF	3,489,000	3,619,000 - 3,592,000	3,325,000 - 3,101,000	3,089,000 - 2,994,000
	State of Mexico	262,000	284,000	284,000	284,000
	Total	3,751,000	3,903,000-3,876,000	3,609,000-3,385,000	3,373,000-3,278,000
Investment (US$)		-	12,708,000	-	-
O&M cost (US$/year)	Bordo Poniente	9,925,694	8,570,000 (2001)	9,400,000 (2003)	4,072,000 (2005)
	Santa Catarina	?	-	-	-
Others					
Street sweeping	Length (km/day)	1,273.4	1,285-1,296	1,303-1,316	1,323-1,357
	O&M cost (US$/y)	3,293,000	3,323,000-3,352,000	3,369,000-3,403,000	3,421,000-3,509,000

Note: US$ 1 = 9.1 pesos.

5.2 Description of the Master Plan

5.2.1 Projection until 2010

a. Population

Table 5-3 presents the population data and forecast from 1997 to 2010, which are officially approved by DGSU.

Table 5-3: Population Forecast

Year / Delegation	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Alvaro Obregon	688,923	691,954	694,999	698,057	701,338	704,634	707,946	711,273	714,616	717,975	721,349	724,739	728,145	731,600
Azcapotzalco	439,158	440,286	441,387	442,490	443,729	444,971	446,217	447,466	448,719	449,975	451,235	452,498	453,765	455,100
Benito Juarez	376,576	377,517	378,461	379,407	380,469	381,534	382,602	383,673	384,747	385,824	386,904	387,987	389,073	390,200
Coyoacan	703,686	706,250	709,428	712,620	716,753	720,910	725,091	729,297	733,527	737,781	742,060	746,364	750,693	755,100
Cuajimalpa	147,340	149,874	152,452	155,074	157,788	160,549	163,359	166,218	169,127	172,087	175,099	178,163	181,281	184,500
Cuauhtemoc	538,315	539,930	541,550	543,175	544,967	546,765	548,569	550,379	552,195	554,017	555,845	557,679	559,519	561,400
Gustavo A.Madero	1,214,625	1,215,840	1,217,056	1,218,273	1,219,857	1,221,443	1,223,031	1,224,621	1,226,213	1,227,807	1,229,403	1,231,001	1,232,601	1,234,300
Iztacalco	414,048	414,172	414,296	414,420	416,119	417,825	419,538	421,258	422,985	424,719	426,460	428,208	429,964	431,800
Iztapalapa	1,717,259	1,726,360	1,735,510	1,744,708	1,756,572	1,768,517	1,780,543	1,792,651	1,804,841	1,817,114	1,829,470	1,841,910	1,854,435	1,867,100
M.Contreras	221,463	224,298	227,169	230,077	231,480	232,892	234,313	235,742	237,180	238,627	240,083	241,548	243,021	244,600
Miguel Hidalgo	367,495	368,597	369,703	370,812	372,036	373,264	374,496	375,732	376,972	378,216	379,464	380,716	381,972	383,300
Milpa Alta	75,866	76,921	77,990	79,074	80,205	81,352	82,515	83,695	84,892	86,106	87,337	88,586	89,853	91,200
Tlahuac	264,349	268,050	271,803	275,608	280,321	285,114	289,989	294,948	299,992	305,122	310,340	315,647	321,045	326,600
Tlalpan	600,703	606,590	612,535	618,538	624,785	631,095	637,469	643,907	650,410	656,979	663,614	670,317	677,087	684,000
V.Carranza	471,241	472,466	473,694	474,926	476,303	477,684	479,069	480,458	481,851	483,248	484,649	486,054	487,464	488,900
Xochimilco	326,658	331,231	335,868	340,570	343,942	347,347	350,786	354,259	357,766	361,308	364,885	368,497	372,145	375,900
DF Total	8,567,135	8,610,336	8,653,901	8,697,829	8,746,664	8,795,896	8,845,533	8,895,577	8,946,033	8,996,905	9,048,197	9,099,914	9,152,063	9,205,600

b. Waste Generation Amount and Composition

b.1 Waste Generation Amount

b.1.1 Waste Generation Ratio

In this M/P, the future waste generation ratio is set up at the present waste generation ratio.

The generation ratio at each source surveyed by the DGSU is shown in Table 5-4.

Table 5-4: Waste Generation Ratio

Type of Source Generation	Classification	Generation Ratio	
Domestic	Household	0.616	kg/Person/Day
Commercial	Commercial Establishment		
	- Auto Service Shop	637.000	kg/Establishment/Day
	- Department Store	368.000	kg/Establishment/Day
	- Commercial Place	6.650	kg/Establishment/Day
	Market		
	- Meat Market	4.430	kg/Stall/Day
	- Vegetable Market	7.920	kg/Stall/Day
	- Grocery store	1.025	kg/Stall/Day
	- Food Preparation	14.960	kg/Stall/Day
	- Various	0.803	kg/Stall/Day
	- Shifting Market (Tianguis)	575.800	kg/Tianguis/Day

Type of Source Generation	Classification	Generation Ratio	
Service	Restaurant and Bar	25.442	kg/Establishment/Day
	Amusement and Sports Center		
	- Amusement Center	1.230	kg/Employee/Day
	- Sports Center	2.620	kg/Employee/Day
	- Cultural Center	0.330	kg/Employee/Day
	Public Service		
	- Services Office	3.460	kg/Establishment/Day
	- Repair and Maintenance Service	1.940	kg/Establishment/Day
	- Gas station	53.120	kg/Establishment/Day
	Hotel		
	- Five-star hotel	1,016.900	kg/Establishment/Day
	- Four-star hotel	218.500	kg/Establishment/Day
	- Three-star hotel	16.810	kg/Establishment/Day
	Education Center		
	- Kindergarten	0.040	kg/student/Day
	- Elementary School	0.055	kg/student/Day
	- Job Training Center	0.060	kg/student/Day
	- Junior High School	0.065	kg/student/Day
	- Technical School	0.060	kg/student/Day
	- Senior High School	0.060	kg/student/Day
	- University	0.070	kg/student/Day
	Public Office	0.413	kg/Employee/Day
Special	Medical Institution		
	- 1st. Level	1.279	kg/Consultation Room/Day
	- 2nd. Level	4.730	kg/Bed/Day
	- 3rd. Level	5.390	kg/Bed/Day
	Laboratory	6.340	kg/Laboratory/Day
	Veterinary	1.700	kg/Employee/Day
	Bus Terminal	2,103.000	kg/Terminal/Day
	Airport	28,887.000	kg/Airport/Day
	Road Sweeping	125.530	kg/km/Day
	Social Rehabilitation Center	0.540	kg/Person/Day
Others	Green Area	0.00993	kg/m^2/Day
	Bulky Waste	28.850	kg/Ton-Solid Waste/Day
	Demolition Waste and Small Repair	20.850	kg/Ton-Solid waste/Day

b.1.2 Waste Generation Amount

The future waste amount is forecast by multiplying the waste generation ratios listed in Table 5-4 by factors such as population, employees and number of shops. The factors such as employees and number of shops are estimated to increase in proportion to the population. However, as for the large-scale public facilities such as airports and bus terminals, the factor (the future quantity) is estimated to be the same as present.

Meanwhile, future wastes brought from the 10 municipalities in the Mexico State are assumed to be the same as present (i.e., 284,000 ton/year) based on the DGSU's estimation.

Table 5-5: Forecast of Waste Generation Amount in DF

unit : ton/year

Year	Total	Household	Commercial	Market	Restaurant & Bar	Sports & Amusement center	Public service	H.S.S.	Public office	Education center	Hospital	Laboratory	Veterinary	Bus terminal	Airport	Road sweeping	Social rehabilitation center	Green Area	Bulky waste	Demolition waste
1999	4,204,000	1,945,000	630,000	587,000	273,000	26,000	63,000	19,000	204,000	57,000	54,000	1,000	0	6,000	11,000	55,000	3,000	77,000	111,000	80,000
2000	4,222,000	1,953,000	632,000	588,000	275,000	26,000	63,000	19,000	206,000	58,000	55,000	1,000	0	6,000	11,000	56,000	3,000	77,000	112,000	81,000
2001	4,241,000	1,965,000	633,000	590,000	276,000	26,000	63,000	19,000	207,000	58,000	55,000	1,000	0	6,000	11,000	58,000	3,000	77,000	112,000	81,000
2002	4,262,000	1,976,000	638,000	591,000	276,000	26,000	63,000	19,000	210,000	58,000	55,000	1,000	0	6,000	11,000	58,000	3,000	78,000	112,000	81,000
2003	4,283,000	1,989,000	642,000	592,000	278,000	26,000	63,000	19,000	210,000	58,000	56,000	1,000	0	6,000	11,000	58,000	3,000	78,000	112,000	81,000
2004	4,302,000	1,998,000	643,000	593,000	280,000	26,000	63,000	19,000	210,000	59,000	56,000	1,000	0	6,000	11,000	59,000	3,000	79,000	115,000	81,000
2005	4,324,000	2,009,000	650,000	594,000	281,000	26,000	63,000	19,000	211,000	59,000	56,000	1,000	0	6,000	11,000	59,000	3,000	79,000	115,000	82,000
2006	4,344,000	2,021,000	652,000	596,000	282,000	26,000	63,000	19,000	211,000	60,000	57,000	1,000	0	6,000	11,000	60,000	3,000	79,000	115,000	82,000
2007	4,365,000	2,033,000	656,000	597,000	283,000	26,000	63,000	19,000	212,000	60,000	57,000	1,000	0	6,000	11,000	61,000	3,000	80,000	115,000	82,000
2008	4,386,000	2,046,000	658,000	597,000	285,000	26,000	65,000	19,000	212,000	60,000	57,000	1,000	0	6,000	11,000	62,000	3,000	81,000	115,000	82,000
2009	4,408,000	2,060,000	661,000	600,000	285,000	26,000	65,000	19,000	212,000	60,000	57,000	1,000	0	6,000	11,000	62,000	3,000	81,000	116,000	83,000
2010	4,430,000	2,072,000	667,000	600,000	286,000	26,000	65,000	19,000	212,000	61,000	57,000	1,000	0	6,000	11,000	62,000	3,000	81,000	117,000	84,000

b.2 Waste Composition

In this M/P, the future waste composition is set at the present one.

Table 5-6: Waste Composition

unit : %

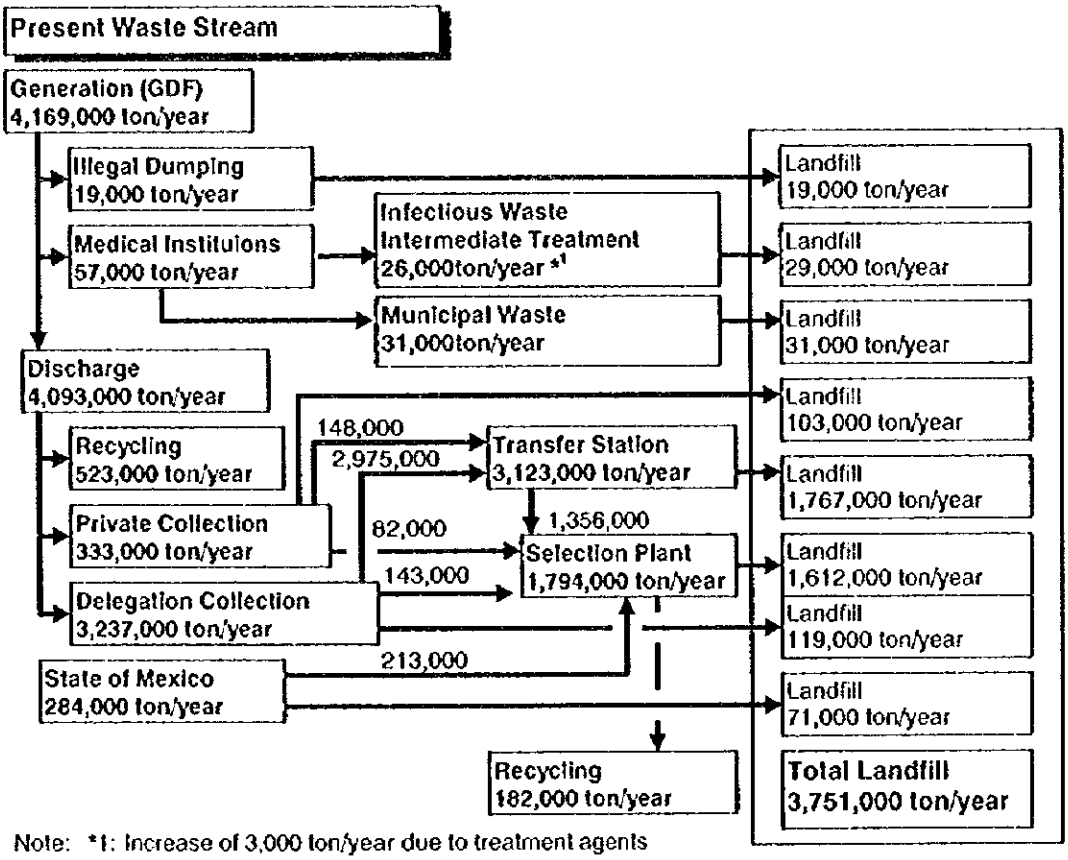
Generation sources / Composition	Domestic	Commercial		Service						Special							Others			Total
	Household	Commercial	Market	Restaurant	Sports and amusement center	Public service	Hotel	Public service office	Education center	Hospital	Laboratory	Veterinary	Bus terminal	Airport	Road	Social rehabilitation center	Green area	Bulky waste	Demolition waste	
Spatula										1.970										0.030
Cotton	2.150	0.070	0.830			0.380	0.030	2.990	0.170	1.970	10.380	5.570								1.300
Cardboard	5.360	11.510	5.290	5.970	11.040	23.180	3.770	11.200	8.980	8.300	8.010	2.560	4.340	5.310	3.660	5.060	4.000			6.680
Leather	0.110			0.020		3.690			0.040											0.110
Paper container	1.960	1.970	2.220	1.430	5.180	1.980	0.760		6.050	1.070		0.690	0.550		6.530	0.520	3.120			1.910
Vegetable fiber	0.060	1.790	2.630			1.130	0.080	0.010	0.780	0.200										0.690
Synthetic fiber	1.430	0.290	0.890	0.040			0.010	0.240		0.270	3.100				0.100					0.850
Gauze										3.770	5.740	5.940								0.050
Bone	0.080	0.440	1.110			0.210			0.670	0.070		0.380								0.270
Vinyl	0.200	1.070	0.160			0.360	0.180	0.830	1.330	2.070										0.370
Disposable syringe										2.800	1.310	1.380								0.040
Cans	1.580	0.310	1.470	0.250	1.230	3.100	0.520	0.280	4.890	1.730		2.310	4.530	3.170	4.770					1.280
Ceramics	0.370	0.120	0.090	0.450	0.290		0.180	0.080	2.010										2.090	0.300
Wood	0.100	1.200	1.170	0.670		6.720		0.010	3.920	0.430		4.820	0.290				5.120	20.000	1.530	1.240
Construction waste	0.630			0.520	0.090		2.890						1.240						95.270	2.140
Metal	1.390	2.590	0.070	0.920	5.650	0.710	1.790	0.150	0.400	1.900		0.690			0.410		2.860	50.000		2.560
Nonferrous metal	0.060	0.510				1.300		6.540		0.070	1.180	1.310					2.290			0.490
Paper	1.190	5.310	1.870	1.540	3.570	18.750	9.210	37.610	14.330	6.570	17.230	0.880	9.100	6.410	5.410	3.110	6.820		0.970	4.410
News paper	4.610	5.950	4.540	0.950	3.170	15.500	5.240	11.910	6.990	4.370	11.970	20.640	6.070	15.340	9.710	7.730	2.220			4.960
Toilet paper	8.780	1.940	4.270	3.400	9.590	4.200	8.160	1.990	10.720	11.000	9.620	7.380	15.200	8.920	9.520	4.650				5.890
Disposable diaper	3.370	0.140		0.080	0.090	0.320	0.890		0.300	1.430			1.940							1.620
X-ray film										0.300										0.000
Plastic film	6.240	5.380	1.500	3.080	7.130	2.140	3.580	0.160	1.950	3.270		0.440	5.340	3.910	5.380	2.000	9.290		0.140	4.530
Hard plastic	4.330	3.940	2.960	1.260	15.340	1.390	1.690	0.880	2.690	0.970	8.640	1.630	3.080	5.460	6.620	1.260	4.000			3.490
Polyurethane	0.160	0.110	0.080	0.030		2.700			0.670	0.760	2.170	2.560								0.160
Foamed polyurethane	0.780	0.120	0.460	0.350	0.720	1.850	0.160	0.110	0.460	1.700	2.270	1.060	1.100	1.180	1.220		1.230			0.580
Food waste	34.660	38.730	63.080	74.430	16.170	5.710	43.230	21.220	16.020	26.960	1.740	3.310	30.440	16.320	7.670	42.490				37.700
Garden waste	5.120	0.150	0.050	0.080	0.420	0.590	3.660	0.300	6.320	1.300	1.890	0.560		1.530	11.460	7.460	25.360			3.180
Sanitary napkin		0.170						0.040	0.630		1.610		0.010			2.000				0.040
Rags	0.640	0.200	0.300	0.120	1.140		1.720	0.310	1.020	0.500	1.840			4.880		3.000		30.000		1.220
Bandage										0.360					0.020					0.010
Color glass	4.000	1.770	0.300	1.530	4.670	2.810	3.090	0.260	2.440	6.700	4.860	2.000	3.450	8.070	8.640	0.420				2.620
Transparent glass	6.770	5.180	0.440	2.820	11.760	1.280	8.520	0.760	4.660	5.630	3.050	0.940	7.790	7.140	8.370	0.950	0.850			4.610
Fine fraction	1.210	0.070	3.970	0.030	2.750		0.260	0.010	0.730	0.430	0.030			3.610	4.020		26.300			1.710
Others	2.660	8.960	0.250	0.030			0.380	2.110	0.830	1.130	3.350	23.950	5.520	8.750	6.500	19.380	6.540			3.000
Total	100.000	99.990	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	99.990	100.000	99.990	100.000	100.010	100.030	100.000	100.000	100.000	100.000

5.2.2 Waste System

a. Optimum Waste Stream

Figure 5-2 illustrates the present waste stream and the optimum waste stream estimated for the GDF, on the bases of the waste amount in 1997, is illustrated in Figure 5-3.

unit: ton/year

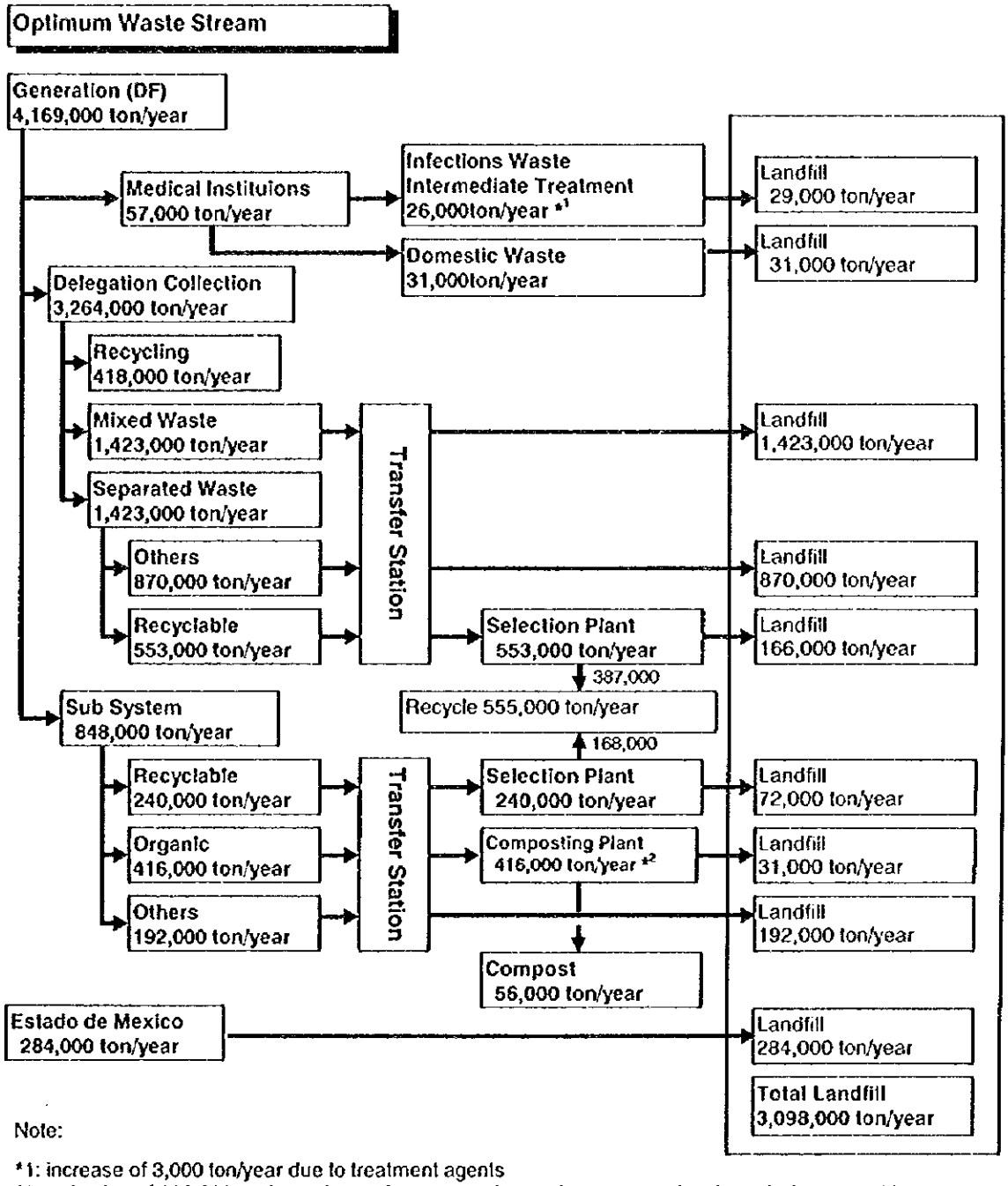


Note: *1: Increase of 3,000 ton/year due to treatment agents

Figure 5-2: Present Waste Stream

By converting the present waste stream into this optimum waste stream, the material recovery ratio at S/Ps will be improved from 10% (present) to 70% (optimum stream), and about 653,000 ton/year of final disposal amount will be reduced.

unit: ton/year



Note:

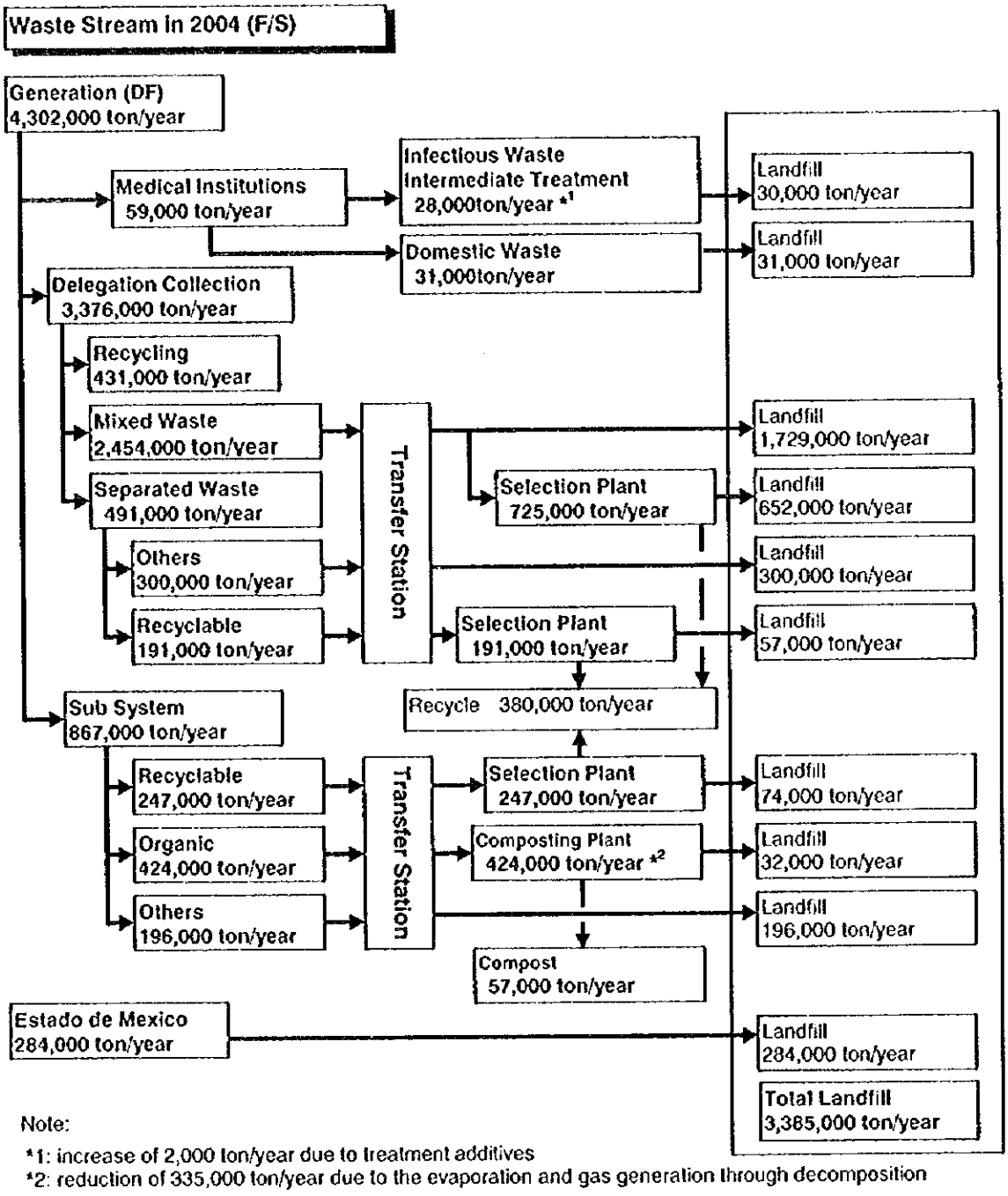
*1: increase of 3,000 ton/year due to treatment agents
*2: reduction of 329,000 ton/year due to the evaporation and gas generation through decomposition

Figure 5-3: Optimum Waste Stream

b. Future Waste Stream

Waste streams in the F/S target year (2004) and in the M/P target year (2010) are illustrated below.

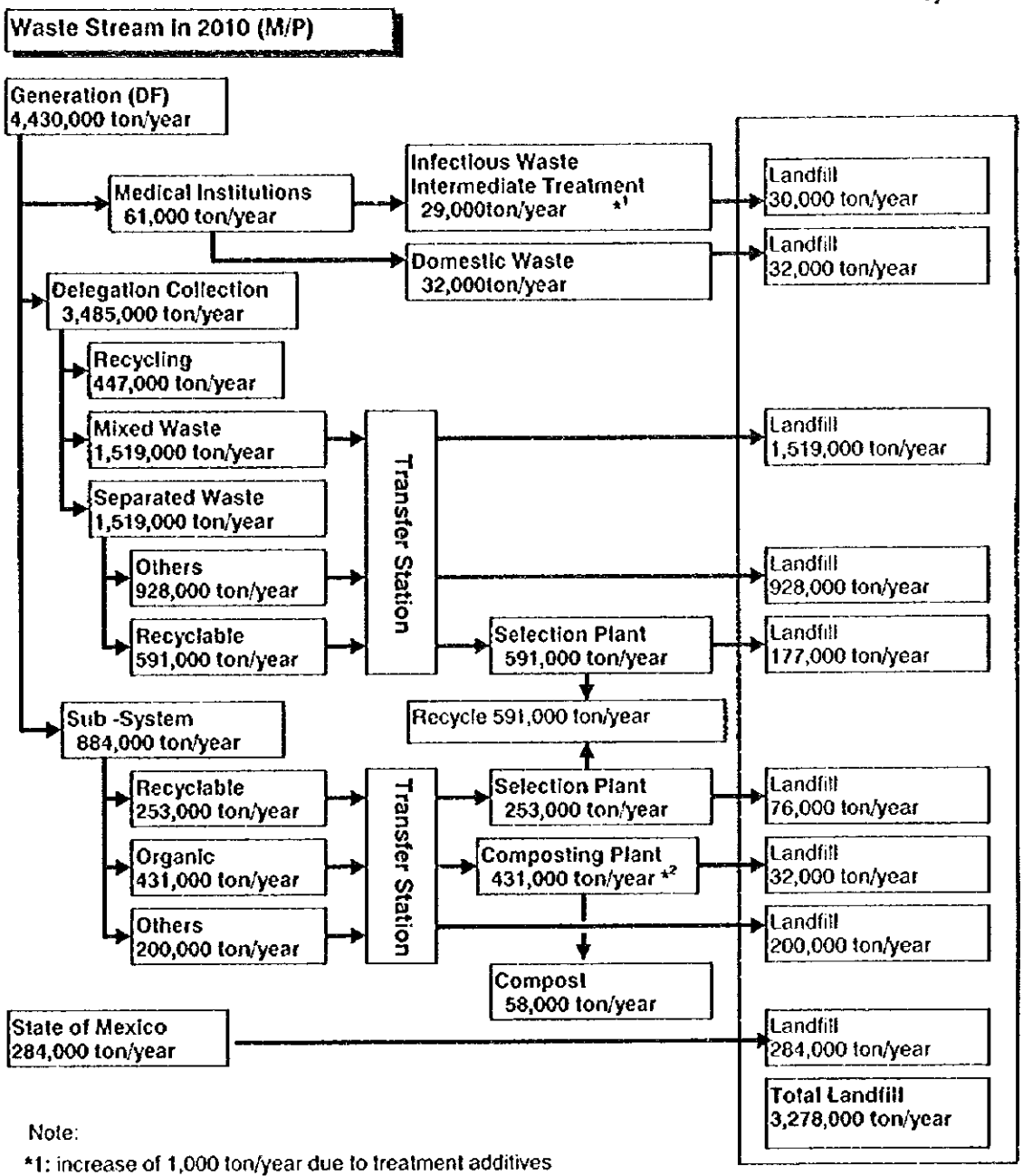
unit: ton/year



Note:
*1: increase of 2,000 ton/year due to treatment additives
*2: reduction of 335,000 ton/year due to the evaporation and gas generation through decomposition

Figure 5-4: Waste Stream in 2004 (F/S)

unit: ton/year



Note:
*1: increase of 1,000 ton/year due to treatment additives
*2: reduction of 341,000 ton/year due to the evaporation and gas generation through decomposition

Figure 5-5: Waste Stream in 2010 (M/P)

5.2.3 Institutional System of the M/P

The institutionalization of the SWM components should be in a step-by-step manner in the M/P framework. It is recommended that institutionalization should be proceeded from those "downstream (in the waste flow)" components toward the "upstream" components as shown in the Table 5-7.

Table 5-7: Institutionalization Alternative for the M/P

	Waste Flow	Institutionalization Flow	Phase 1 1999 - 2001	Phase 2 2002 - 2004	Phase 3 2005 - 2010	 2011 -
Sub-system		↓	Contract out to Private Entities	(Preparation of Concession) Contract out to Private Entities	Concession to Private Entities	Concession to Private Entities
Collection	↓		Examination of Concession (Examine conditions for institutionalizing Section 1 into private entities)	Preparation of Concession/Permission (Formalize the Section 1 as private entities with necessary funding) **2nd Priority Financing**	Start Concession and Permission to Private entities	Concession and Permission
S/Ps	↓		Examination of Concession (Examine conditions for institutionalizing Ex-pepenadores Groups into Cooperatives)	Preparation of Concession (Formalize the Ex-pepenadores Groups as Cooperatives with necessary funding) **2nd Priority Financing**	Concession	Concession
T/Ss and Transport	↓	↑	Contract out	Contract out	Contract out	Contract out
NIT	↓	↑	Investment by the DGSU **1st Priority Financing**	A1. DGSU direct operation or A2. Operation contracted our by DGSU. Examination of four options: A. Status quo (DGSU) A1. DGSU direct operation A2. Contract out operation B. Parastatal C. Concession and preparation for B or C if it is chosen.	A1, A2, B or C.	A1, A2, B or C.
Final Disposal		↑	Investment by the DGSU **1st Priority Financing**	A1. DGSU direct operation or A2. Operation contracted our by DGSU. Examination of three options: A. Status quo (DGSU) A1. DGSU direct operation A2. Contract out operation B. Parastatal and preparation for B if it is chosen.	A1, A2, or B	A1, A2, or B

Note:
This table shows alternatives proposed by the JICA team which will be subject to further examination by the GDF.

5.2.4 Social Approach toward the M/P

Table 5-8 shows applicable criteria and strategies proposed in the different components of the M/P to solve, to minimize or to mitigate social critical points.

Table 5-8: Criteria and Strategies to Solve Critical Social Aspects

Component	Objectives	Criteria and Strategies to solve, minimize or mitigate critical social aspects
1. Management at the Source	• Hygienic waste management at home • Waste reduction, reuse and recycling • Separation at the Source • Raising recognition in population as waste generators	◆ Community education program ◆ Demonstration Program under current execution ◆ Encouraging environmental education at primary schools
	• Crating and Packing minimization by industries	◆ Education (Conscience and awareness of Industries) ◆ Approval and Reinforcement of Regulatory Laws
2. Collection	• Informal workers incorporate to the formal system.	◆ Worker Harmonization and Promotion ◆ Regularization of informal activities ◆ Identification of local characteristics
	• Separate collection	◆ Recognition of local characteristics ◆ Environmental education in communities and schools ◆ Employment promotion ◆ Harmonization (associations and Sección 1)
	• To maintain payment culture	◆ Harmonization (to formalize current system)
	• Attention to peripheral sectors with difficult access	◆ Community participation and sustainability ◆ Supervision and control
	• Occupational Health and security against accidents	◆ Training ◆ Supervision and Control
3. Selection Plants (S/Ps)	• To conclude closure at Sta. Catarina sanitary landfill	◆ Harmonization (Negotiation with waste picker organization)
	• To reduce cost caused by the GDF	◆ Harmonization
	• More efficiency in Selection	◆ Education and Harmonization
4. T/S, Haulage and Final disposal	• Fulfillment of contracts with enterprises	◆ Supervision and control

5.3 Projects Cost Estimates

This section estimates costs of projects that are required in the master plan. They are as follows:

1) Vertical expansion of the existing landfill (Etapa IV)
2) A new landfill development (Etapa V)
3) Composting plant
4) O&M cost of transfer stations and transport
5) O&M cost of selection plants

a. Landfill and Composting Plant

Table 5-9: Summary of Investment and Operation and Maintenance Cost

Unit : US$ 1,000

Item	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
BP Etapa IV	B/D	33												33
	D/D&S/V		298											298
	Con		7,902											7,902
	OP			4,109	536	446	536	3,828	3,909	446	536	3,718	3,563	21,627
	BP IV total	33	8,200	4,109	536	446	536	3,828	3,909	446	536	3,718	3,563	29,860
BP Etapa V	B/D	41												41
	D/D&S/V		204	162										366
	Con			4,068										4,058
	OP				9,194	8,954	8,825	244	301	5,658	3,822	241	301	37,774
	BP V total	41	204	4,461	9,191	8,954	8,825	244	301	5,658	3,822	241	301	42,249
Landfill total		74	8,404	8,570	9,730	9,400	9,361	4,072	4,210	6,104	4,358	3,962	3,864	72,109
Composting facility	B/D	50												50
	P/P	10	10											20
	D/D&S/V		164	99	33	33				13	2			344
	Con			2,376	551	551								3,478
	Equipment			1,250	177						1,142	177		2,746
	OP			33	1,185	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	11,962
	Total	60	174	3,758	1,946	1,927	1,343	1,343	1,343	1,356	2,487	1,520	1,343	18,600
Landfill, composting total		134	8,578	12,328	11,676	11,327	10,704	5,415	5,553	7,460	6,845	5,482	5,207	90,709

Notes : B/D : basic design, D/D : detailed design, Con.: construction, OP : operation, P/P: Pilot project, S/V supervision

b. Operation and Maintenance Cost of Transfer Station and Transport

O&M costs for transfer stations and transport till the year 2010 are estimated based on the present unit cost and estimated transfer amount in respective years (see Table 5-10).

Table 5-10: O & M Cost of Transfer Station and Transport

Year	Transfer amount(ton/year)	O&M Cost(pesos)	O&M Cost(US)
1997	3,123,000	396,276,313	43,547,000
1999	3,725,000	472,665,250	51,941,000
2000	3,740,000	474,568,600	52,150,000
2001	3,757,000	476,725,730	52,387,000
2002	3,776,000	479,136,640	52,652,000
2003	3,795,000	481,547,550	52,917,000
2004	3,812,000	483,704,680	53,154,000
2005	3,830,000	485,988,700	53,405,000
2006	3,848,000	488,272,720	53,656,000
2007	3,866,000	490,556,740	53,907,000
2008	3,884,000	492,840,760	54,158,000
2009	3,903,000	495,251,670	54,423,000
2010	3,922,000	497,662,580	54,688,000

c. Operation and Maintenance Cost of Selection Plant

O&M costs for selection plants till the year 2010 are estimated based on these unit costs and estimated input amount in respective years as summarized in Table 5-11.

Table 5-11: Operation and Maintenance Cost of Selection Plants

year	Input amount (ton/year)	Operation and Maintenance Cost (peso/year)						
		Technical control	Operation of machinery and equipment	Cleansing	Control of harmful fauna	Transportation of persons	Total	Total (U$/year)
1997	1,793,245	19,274,456	56,754,875	4,320,348	15,676,443	6,181,090	102,207,212	11,232,000
1999	1,650,000	17,738,000	52,223,000	4,320,000	15,680,000	6,180,000	96,141,000	10,565,000
2000	1,647,000	17,705,000	52,128,000	4,320,000	15,680,000	6,180,000	96,013,000	10,551,000
2001	1,644,000	17,673,000	52,033,000	4,320,000	15,680,000	6,180,000	95,886,000	10,537,000
2002	1,498,000	16,104,000	47,412,000	4,320,000	15,680,000	6,180,000	89,696,000	9,857,000
2003	1,367,000	14,695,000	43,266,000	4,320,000	15,680,000	6,180,000	84,141,000	9,246,000
2004	1,163,000	12,502,000	36,809,000	4,320,000	15,680,000	6,180,000	75,491,000	8,296,000
2005	1,071,000	11,513,000	33,897,000	4,320,000	15,680,000	6,180,000	71,590,000	7,867,000
2006	993,000	10,675,000	31,428,000	4,320,000	15,680,000	6,180,000	68,283,000	7,504,000
2007	932,000	10,019,000	29,498,000	4,320,000	15,680,000	6,180,000	65,697,000	7,219,000
2008	887,000	9,535,000	28,074,000	4,320,000	15,680,000	6,180,000	63,789,000	7,010,000
2009	857,000	9,213,000	27,124,000	4,320,000	15,680,000	6,180,000	62,517,000	6,870,000
2010	844,000	9,073,000	26,713,000	4,320,000	15,680,000	6,180,000	61,966,000	6,809,000

5.4 Evaluation of the Master Plan

5.4.1 Technical Evaluation

It has been examined whether the technical systems proposed in the M/P are compatible and enforceable in comparison with the technical skills maintained by the GDF.

The technical systems proposed in the M/P mainly comprise:

- stepwise introduction of separate discharge and collection.
- establishment of monitoring and control system on transfer and transport.
- improvement of material recovery ratio at S/Ps.
- composting of organic wastes.
- vertical expansion of the Bordo Poniente Etapa IV disposal site.
- construction of the Bordo Poniente Etapa V new disposal site.

a. Separate Discharge and Collection

Pilot projects on 3-category separate discharge and collection have been implemented since 1996. The pilot project in 1998 achieved separation ratio of 92%. It indicates that technical and empirical know-how on separate discharge and collection have been accumulated in the DGSU. Therefore, it will be judged that stepwise introduction of the separate discharge and collection should be technically viable.

b. Transport Monitoring and Control System

The M/P proposes that a single common format should be introduced for data compilation and comprehensive monitoring of transfer amount, together with the trailer assignment control, which has already established the central monitoring and control system.

The DGSU already reserves technical capability of central monitoring and control on trailers assignment. By developing the existing control system (on trailer assignment), another control (on transfer amount) will be realized. This proposal in the M/P is surely judged as a workable measure.

c. Improvement of Selection Plant Recovery Ratio

The proposal on improvement of S/P recovery ratio recommends, as technical aspects, the input amount reduction and lowering of sorting line velocity. This does not require any new technical renovation nor technology introduction. It only requires plant operation changes. Therefore, this proposal in the M/P is also workable from the technical aspects.

d. Composting

The DGSU is currently operating a small windrow compost plant for processing the gardening wastes (e.g., pruned tree branches and grasses), and the compost products are with satisfactory quality. It proves that the DGSU already reserves technical capability on operating a windrow composting plant. Therefore, in utilizing and developing the DGSU's technical capabilities on composting, the proposal in the M/P i.e., composting of separated organic wastes, becomes viable.

e. Vertical Expansion of the Bordo Poniente Etapa IV

This proposal in the M/P is in line with the current technical practices of landfill operation by the DGSU. It is judged that the DGSU could comply with the technical requirements of this proposal.

f. Construction of New Final Disposal Site (Bordo Poniente Etapa V)

Etapa V is proposed to be constructed with the same technical components as what are employed in the present landfill (Etapa IV). Therefore, it is obviously judged that no technical problem is foreseen.

5.4.2 Financial Evaluation

The proposed sector investment plan, which covers a wide range of activities concerned with the beautification of the environment and prevention of human health damage, is to efficiently and effectively improve the solid waste management service needed for the plan. This is because:

- the annual revenue of the DGSU in 1997 was 742.1 million pesos (US$ 81.5 million)
- the expenditure used for the O&M of the present landfill (Etapa IV) in that year was about 105.7 million pesos (US$ 11.6 million), which was about 14.2% of the total expenditure of the DGSU
- the DGSU's annual revenue in 1999 is estimated to be about 992.1 million pesos (US$ 109.0 million)
- suppose that 14% of the revenue can be used for the priority projects, about US$ 15 million is available
- US$ 15 million can cover the estimated largest annual expenditure of US$ 12.3 million for the priority projects in 2001.

Therefore, the investment plan is considered to be financially appropriate and to maximize benefits and welfare of people.

5.4.3 Economic Evaluation

With the incremental supply of efficient and effective services for solid waste management in the region, the prospective investment plan is the least-cost and environmentally sound solution to mitigate sanitary and ambience degradation and to enhance the habitat and financial basis that is conducive to an improved level of people's welfare and urban beautification. In addition, the project will help augment both the availability and reliability in the provision of solid waste management services in DF, thus providing one of the basic prerequisites for possible investment programs from domestic and external resources and welfare growth therein.

5.4.4 Institutional Evaluation

The components' institutionalization (either private, parastatal, or other) is inevitably required in view of seeking cost-effective SWM, although there are large variance in timing of the transformation by component.

With respect to cost-effective SWM, the institutionalization process (from the downstream) proposed in the M/P is recommendable.

On the other hand, one of the M/P goals includes:

- "promoting well-being of those who work for SWM".

In this connection, the M/P suggests that a longer time should be spent for the institutionalization of upstream components at which a lot of people work for SWM.

The institutional transition showed in the M/P is, therefore, deemed to be recommendable and pertinent to the GDF.

For the success of SWM institutionalization in the longer term, it will also be necessary for the DGSU to gradually shift its role from as an implementation body to as a supervisor. The key requisites for the DGSU as a supervisor should include the following.

- encourage competition.
- monitor the activities of the service providers.
- regulate service quality.

As a result, an entire SWM system will be ensured to be fair and sustainable, and satisfactory for the beneficiaries.

5.4.5 Social Evaluation

Table 5-12 shows the possible social benefits that can be achieved in the diverse components of SWM if the proposals in the Master Plan are applied.

Table 5-12: Social Evaluation of the Proposed M/P

Components	Public Health	Population's well-being	Employment and Working Conditions	Citizen participation and Sustainability
Storage and Discharge	• Internal household sanitary management • Prevents proliferation of harmful fauna at the source	• Improves the tidiness and aesthetics in the discharge • Prevents offensive odors • Reduces annoyances to pedestrians and to the traffic	• No negative impact on employment since it is an activity of the community	• Direct community participation • Sustainable for its being based on public education
Separation at the source	• Sanitary management of 2 or 3 categories of garbage	• Raises the population's environmental education • Reduction, Reuse and Recycling of solid wastes	• Does not affect employment since it is an internal household activity • With a greater recovery, more possibilities to be employed at the recycling industry (*)	• Direct community participation • Sustainable activity • Benefit for the environment and natural resources
Collection	• Reduction of the risk of accidents through staff training	• A cleaner, tidier and more aesthetic process • A more efficient collection	• Progressive regularization of informal personnel • Increase of employment by separate collection of sub-system	• Strengthened relation between citizenry and GDF
Transfer Stations and Transport	• Improvement of occupational health	• A cleaner, tidier and more aesthetic process	• Possible increase of employment • Improvement of labor conditions	• Greater participation of private sector
S/Ps	• Sanitary management of facilities by reducing noise, dust and other disturbances • Reduction of the risk of accidents	• A cleaner, tidier, more aesthetic and more efficient process	• Possibility of more employment in the recycling industry • Improvement of labor conditions	• Greater participation of private sector
NIT (Composting Plant)	• Controlled and sanitary management of organic wastes	• Preservation of natural resources	• Possibility of more employment • Improvement of labor conditions	• Greater participation of private sector
Final Disposal	• Prevention of vector proliferation at the sanitary final disposal • Prevention of waste burning	• Prevention of groundwater pollution • Protection of landscape and natural sites	• Possibility of more employment • Improvement of labor conditions	• Greater participation of private sector

Note (*): However, it should be noticed that further recovery of recyclable material might lead to a reduction in the unit price of these elements, which in turn would have a negative impact on the group of pickers.

5.4.6 Environmental Evaluation

The following should be highlighted in the M/P from the environmental point of view.

- The optimum location for final disposal site is chosen.
- Resource conservation is attempted.
- Separated organic waste is to be treated by composting.

These are further discussed below.

a. Location of the Final Disposal Site

The M/P proposes the vertical expansion of the Bordo Poniente Etapa IV and the construction of Etapa V.

The both locations appear to be the most suitable for final disposal site development. They are within the ex-Lake Texcoco area where soil and surface groundwater are so saline that their usage is considerably restricted. Reusing the site of Etapa IV by vertical expansion should significantly reduce the environmental effect that could be brought by development of other new final disposal site with the same landfill capacity.

It is certain that the environmental impact can not be eliminated completely, but the proposal of the site location by the M/P should minimize the impact.

b. Resource Conservation

The M/P aims to transform inefficient material recovery to a systematic approach towards resource conservation by promoting waste separation at source, improving the S/Ps and introducing a composting plant. Wastes are to follow respective routes from their generation points to the final destinations according to their categories. Therefore, recovery efficiency and cost performance should be significantly improved.

c. Introduction of Composting

A composting facility is to be introduced as an intermediate treatment of solid waste. It will bring the following environmental benefits.

i. Organic waste, which is the most reactive component in the non-hazardous waste, is stabilized through aerobic decomposition faster than when it is disposed of at the final disposal site which is anaerobic.

ii. Aerobic decomposition generates less methane gas, which is the most efficient contributor to the global warming, than the anaerobic landfill.

iii. The output may be used as environmentally friendly soil conditioner to promote vegetation. This will raise environmental and aesthetic value of the area, create a buffer zone around the final disposal site, or prevent a soil dust effect in the ex-Lago Texcoco area, depending on its application.

5.4.7 Overall Evaluation

In this section, the validity of the M/P for the SWM in the DF has been assessed from the point of technical, institutional, social, environmental, financial and economical views.

Technically, the M/P was revealed to be appropriate taking into account of the current technical level of the GDF. Institutional building and social approaches proposed in the M/P were considered to well agree with the technical system and to be recommendable. The implementation of the M/P was justified environmentally with positive perspectives for the betterment of the urban environment.

Financially and economically, it was shown that the increase of financial cost arising from the M/P would not give excessive burden to the GDF and that the M/P would bring economical benefit to the DF society.

Accordingly it is concluded that the execution of the M/P is judged to be viable and appropriate for SWM in the DF.

5.5 Phased Implementation Plan

The proposed implementation plan of the Master Plan is shown in Figure 5-6.

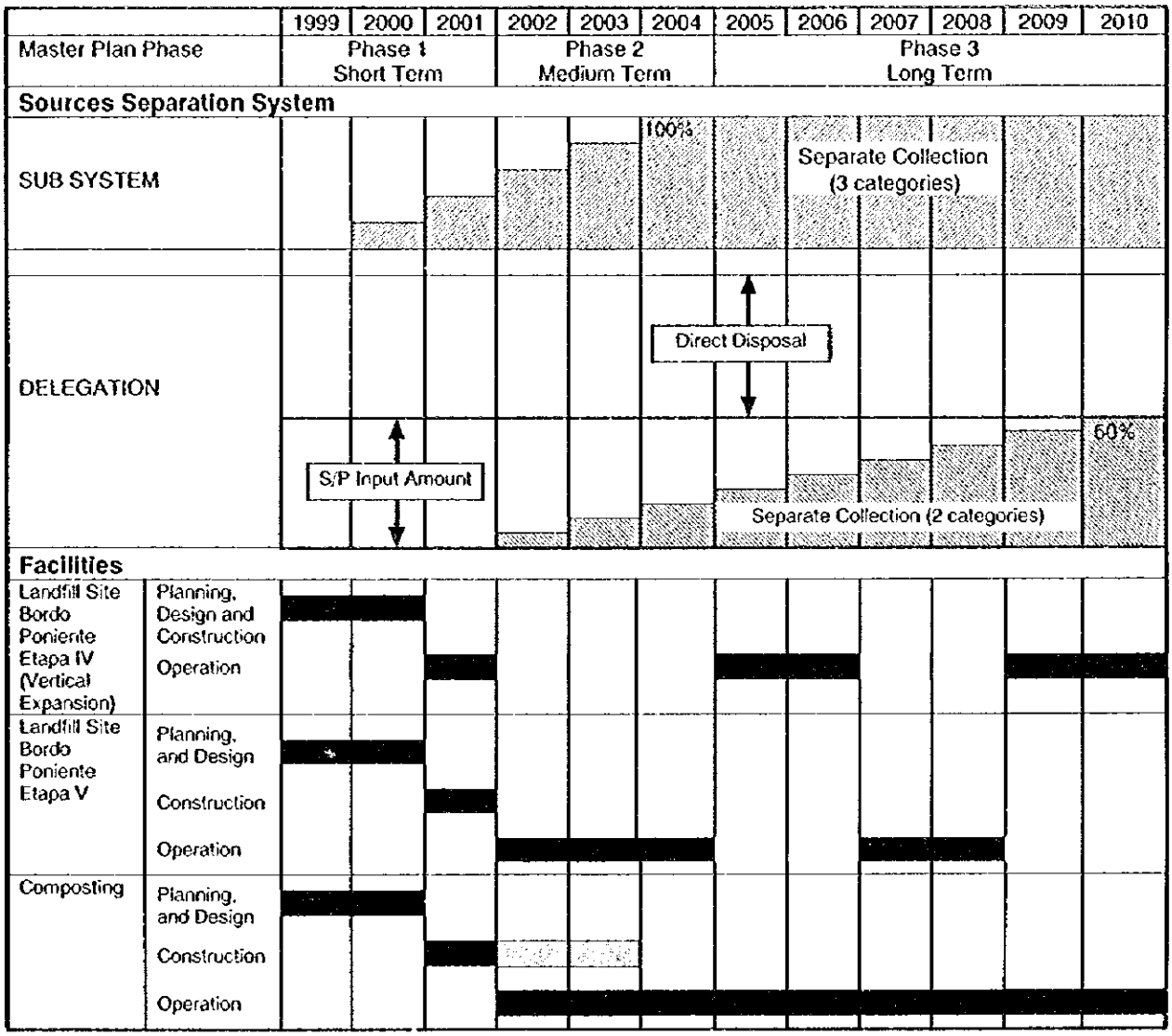


Figure 5-6: Phased Implementation Plan

5.6 Selection of Priority Projects

The projects, which are planned to be constructed in the short term (Phase 1: year 1999 to 2001), i.e., vertical expansion of Etapa IV, new establishment of Etapa V and a composting facility, should be selected as the priority projects of the Study.

5.7 Initial Environment Examination

The IEE (Initial Environmental Examination) of the proposed three projects, i.e. new establishment of Bordo Poniente Etapa V, vertical expansion of Etapa IV and introduction of a composting plant, was attempted.

IEE is a process aiming to determine (i) whether detailed EIA (Environmental Impact Assessment) is required and (ii) if so, what types of impacts should be further studied. The former is often called "screening" and the latter "scoping". Detail of the examination is described in Annex G.

6 Feasibility Study for the Priority Projects

6.1 Outline of the Projects

6.1.1 Target

Final disposal sites are indispensable components of the solid waste management for the GDF to provide cleansing services for the citizens. However, urbanization in and around the DF makes it difficult year by year for the GDF to secure lands for future final disposal sites. Furthermore, as an urgent and critical issue of the DF's SWM, the existing final disposal sites have a very limited remaining disposal capacity (i.e., the remaining service life is only up to the beginning of the year 2001.).

Therefore, actions for:

- minimization of final disposal amount; and
- establishment of a new final disposal site

are urgently required for the GDF to comply its mission of solid waste management. In order to facilitate the actions required for the "minimization of final disposal amount" and to solve the critical issue of "a new final disposal site establishment", priority projects are selected herewith, and their preliminary design, estimated cost, and feasibility are examined in its regard.

In practice, the priority projects comprise:

- **a composting plant** for processing organic wastes separately delivered from the sub-system, with a prime objective of prolongation of final disposal sites' service lives; and
- **the vertical expansion** of existing final disposal site **(BP-IV)** and the construction of a **new final disposal site (BP-V)**.

Figure 6-1 shows the location of those priority projects.

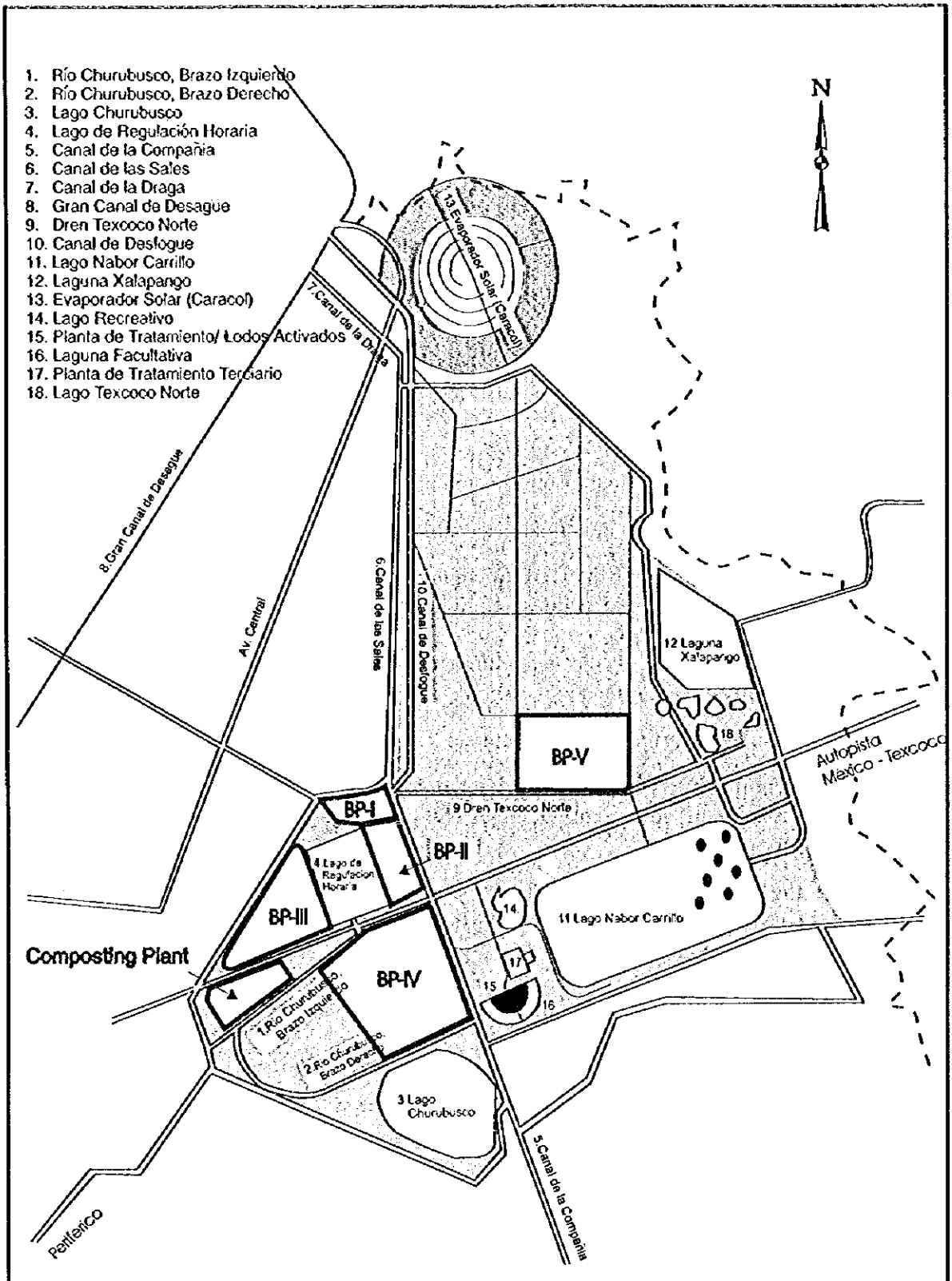


Figure 6-1:
Location of Priority Projects

KOKUSAI KOGYO Co., Ltd.

6.1.2 Outline of the Projects

Table 6-1 shows the outline of the projects.

Table 6-1: Outline of the Projects

		*Present	1999	2000	2001	2002	2003	2004
Population		8,610,000	8,654,000	8,698,000	8,747,000	8,796,000	8,846,000	8,896,000
Waste generation amount		(ton/year)						
Household		1,925,000	1,946,000	1,956,000	1,967,000	1,976,000	1,989,000	1,999,000
Commercial		1,210,000	1,217,000	1,221,000	1,225,000	1,230,000	1,234,000	1,238,000
Service		636,000	639,000	641,000	645,000	647,000	650,000	657,000
Special		133,000	135,000	135,000	135,000	137,000	137,000	137,000
Others		265,000	267,000	269,000	269,000	272,000	273,000	274,000
Total		4,169,000	4,204,000	4,222,000	4,241,000	4,262,000	4,283,000	4,302,000
Composting								
**Construction and Operation schedule		F/S	B/D,P/P(1)	P/P(2),D/D, S/V	CON(3/5)	OP(3/5) CON(1/5)	OP(4/5) CON(1/5)	OP(5/5)
Treatment capacity (t/d)		-	-	-	-	750	1,000	1,250
Treatment amount (t/y)		-	-	-	-	253,000	338,000	424,000
Final disposal								
**Construction and Operation schedule	BP-IV	F/S	B/D	D/D, CON	OP	-	-	-
	BP-V		B/D	D/D	CON	OP	OP	OP
Site to be used		BP-IV	BP-IV	BP-IV	BP-IV	BP-V	BP-V	BP-V
Disposal amount (t/y)		3,751,000	3,903,000	3,889,000	3,876,000	3,609,000	3,493,000	3,385,000

* : 1997/1998 data
** F/S : feasibility study, B/D : basic design, D/D : detailed design, CON : construction, OP : operation, S/V: supervision, P/P : Pilot Project
t/d : ton/day
t/y : ton/year

6.2 Preliminary Design of Technical System

6.2.1 Composting Facility

6.2.1.1 Conceptual Design and Cost Estimation

a. Outline

Treatment capacity of the proposed plant is projected to be 1,250 ton/day, i.e.:

- by the Master Plan target year of 2010, 431,000 ton/year of organic waste is treated.
- the proposed plant operates 350 days per year.

Compost production is planned to be about 166 ton/day, or about 58,000 ton/year.

Main processes of the proposed facility comprise (refer to Figure 6-2):

- a composting process.
- a curing process.
- a separation process.

The process times are assumed for the purpose of the preliminary design to be 28 days for composting and 120 days for curing.

Auxiliary facilities of the plant comprise:

- truck scale.
- waste reception areas.
- temporary storage areas.
- machine/equipment maintenance workshop.
- site office and laboratory.

b. Composting Facility Design Parameters

b.1 Design Principals

- It is planned that the composting plant starts operating in the year 2002, when separate collection of MSW from the subsystem is projected to reach about 60%. The required composting capacity at this time will be 750 ton/day. Separate collection is estimated to further increase to 80% by 2003, and to 100% by 2004.
- The implementation schedule for this design comprises phase 1 (a 750 ton/day windrow yard and a 240 ton/day curing yard in 2001) and phases 2 and 3, in 2002 and 2003 respectively (each consisting of a 250 ton/day windrow yard and a 80 ton/day curing yard). It is planned that the total composting capacity reaches 1,250 ton/day in 2004, and this capacity is maintained until 2010.
- Since stepwise improvement of the separation facility is neither practicable nor rational, it is planned to construct the 100% capacity separation facility in the year 2001.
- Considering that the proposed facility is to be constructed on highly compressible ground (in the ex-Lake Texcoco region), it is proposed that all machinery and equipment are mobile, and buildings are lightweight, so that problems of ground subsidence will be reduced.

b.2 Main Design Parameters

Table 6-2 summarizes the design parameters.

Table 6-2: Design Parameters

Composting section				
	Raw Material (Organic Waste)	Amount	431,000 ton/year	
		Compostable content	16.4 to 26.4 (% by wt.)	
		Moisture content	68 to 78 (% by wt.)	
		Bulk density	280 kg/m^3	
		C/N ratio	20 - 27	
	Operation		350 day/year 24 hour/day	
	Treatment Capacity	Total	1,250 ton/day	
		Year 2002	750 ton/day	
		Year 2003	1,000 ton/day	
		Year 2004 and onward	1,250 ton/day	
	Windrow		Trapezoidal shape	*1
		Width (bottom)	5.0 m	*1
		Width (top)	3.0 m	*1
		Height	1.5 m	*1
		Cross section area	6.0 m^2	*1
	Composting Period		28 days	
	Turning Frequency		1 time/5 - 6 days	
	Windrow Temperature		55°C	
Curing section				
	Operation		350 day/year 16 hour/day	
	Treatment Capacity	Young compost production	400 ton/day (max.)	*2
		Year 2002	240 ton/day	
		Year 2003	320 ton/day	
		Year 2004 and onward	400 ton/day	
		Moisture content	45 %	
		Bulk density	600 kg/m^3	
	Curing Period		120 days	
Separation				
	Operation		350 day/year 16 hour/day	
	Treatment Capacity	Mature compost production	300 ton/day (max.)	*2
		Moisture content	30 %	
		Bulk density	600 kg/ m^3	

*1 :These figures are referred to the specification of the turning machine used by the DGSU for composting green waste from public parks and gardens.

*2 :These figures are calculated from the *1 figures based on the conditions given in the section c.5 "Materials Balance".

b.3 Quantity and Quality of Compost Product

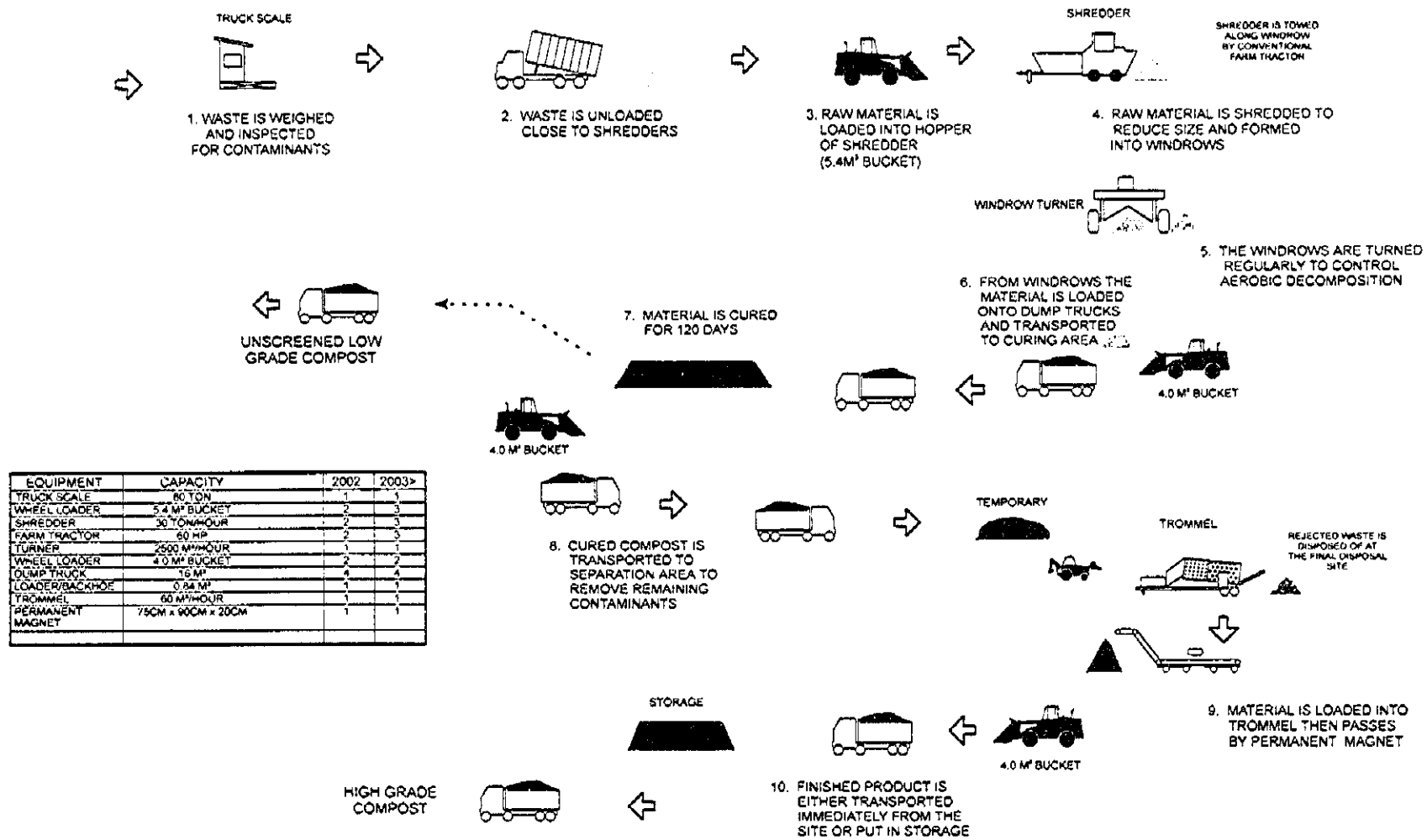
Table 6-3 shows the target quality and quantity of the compost product in the preliminary design.

Table 6-3: Quantity and Quality of Compost Product

Quantity		166 ton/day 58,000 ton/year
Quality	Moisture Content Bulk Density C/N ratio	30% by wt. 600 kg/m^3 < 15

b.4 Flow of Composting Process

Figure 6-2 shows the flow of the proposed composting process.



EQUIPMENT	CAPACITY	2002	2003>
TRUCK SCALE	80 TON	1	1
WHEEL LOADER	5.4 M³ BUCKET	2	3
SHREDDER	30 TON/HOUR	2	3
FARM TRACTOR	60 HP	2	3
TURNER	2500 M³/HOUR	1	1
WHEEL LOADER	4.0 M³ BUCKET	2	2
DUMP TRUCK	16 M³	4	4
LOADER/BACKHOE	0.84 M³	1	1
TROMMEL	60 M³/HOUR	1	1
PERMANENT MAGNET	75CM x 90CM x 20CM	1	1

Figure 6-2: Flow Sheet of Proposed Composting Facility

b.5 Material Balance

Figure 6-3 shows the material balance in the proposed composting facility for the case of 73% moisture content.

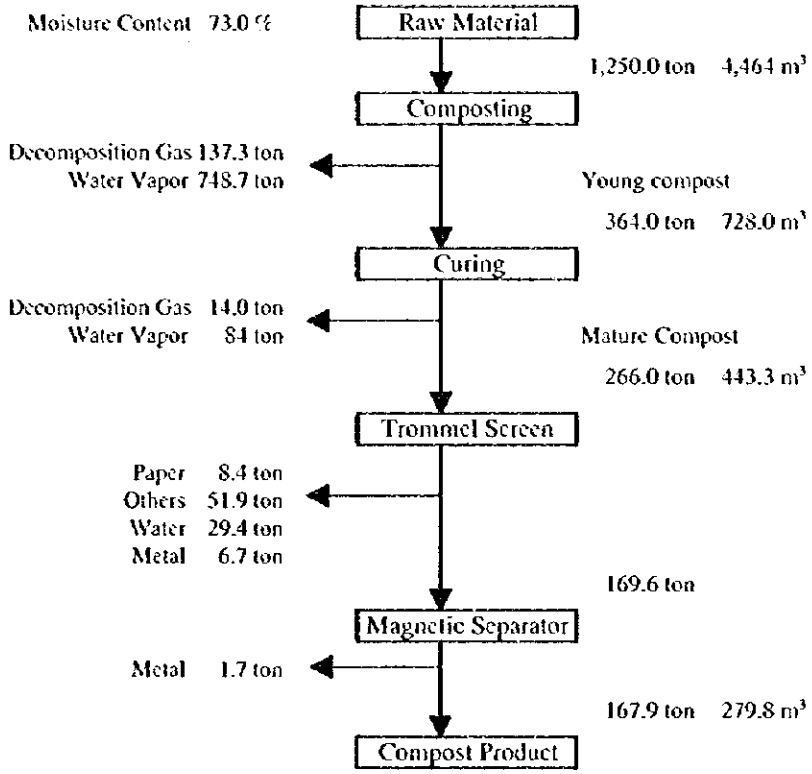


Figure 6-3: Materials Balance of Composting Facility

b.6 Layout of Proposed Composting Facility

The proposed layout of the composting facility was prepared taking the following into account.

- To avoid damaging the canal structures, the proposed facility is off-set at least 60 meters from the bank of a canal *Río Churubusco Brazo Izquierdo*.
- The composting windrow area accounts for a large portion of the total facility area. Therefore, the layout pays attention to: primarily the layout of the windrows, and subsequently the layout of the curing and separation areas to attain efficient on-site transport.
- The proposed site is located next to the Bordo Poniente Disposal Site Etapa IV and the selection plant, Construction of bridges are, however, necessary to establish direct transport routes between these sites as the Rio Churbusco lies between these and the proposed composting plant, and it is estimated that costs for the bridges are prohibitively expensive. While the site of the composting plant adjoins the Periferal Ring Road. So, the road is to be used for transportation of waste and compost without wasting a large expense for the construction of bridges.

- In order to mitigate odors and noise resulting from windrow formation and turning, at least 100 meters is maintained between the proposed windrows and nearby major roads.
- As strong winds often occur in the vicinity, the layout plan incorporates tree planting to act as a wind break. This buffer zone will also work as noise buffer and improve the appearance of the facility.

Figure 6-4 shows the proposed layout of the composting facility, and Figure 6-5 presents its cross section.

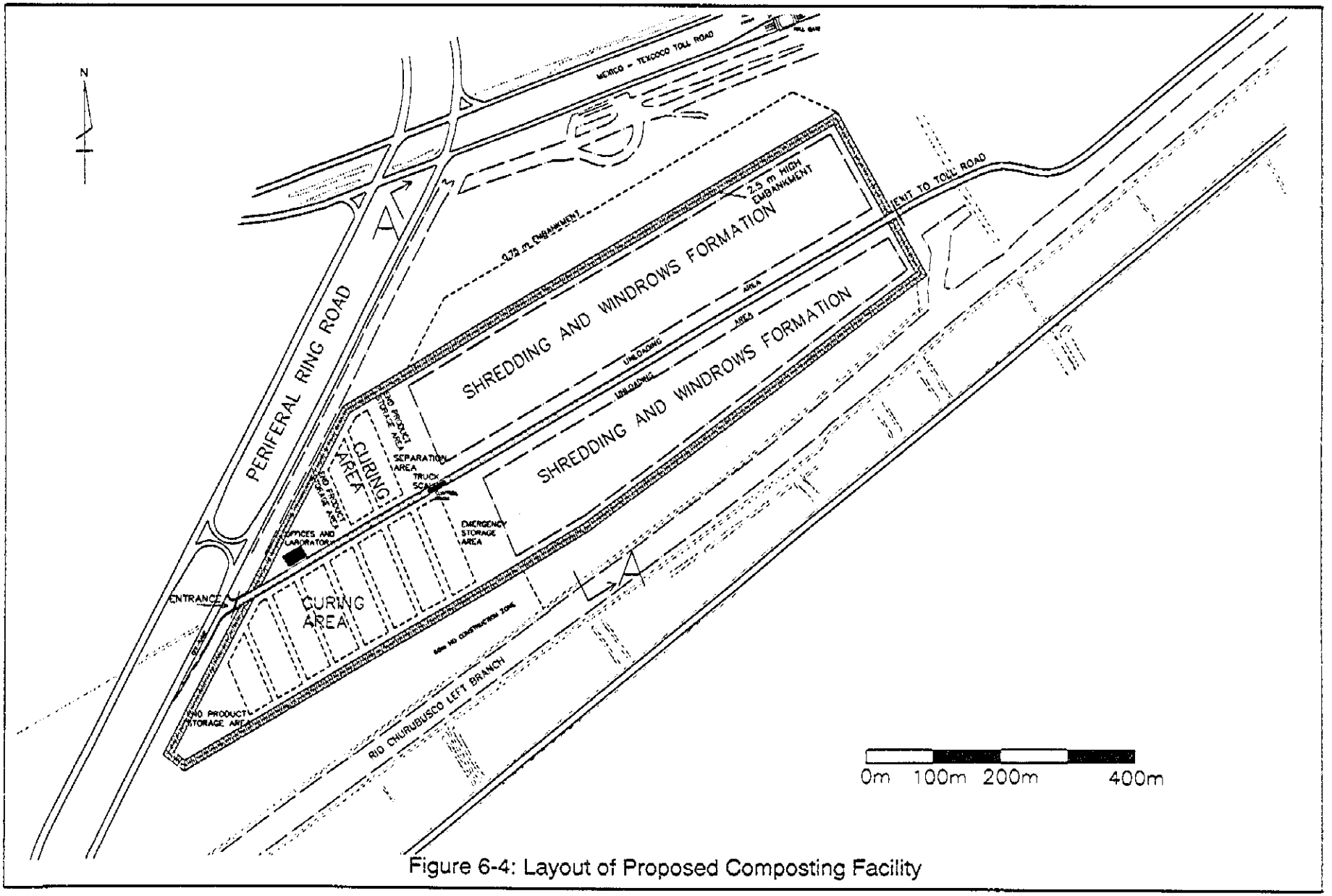
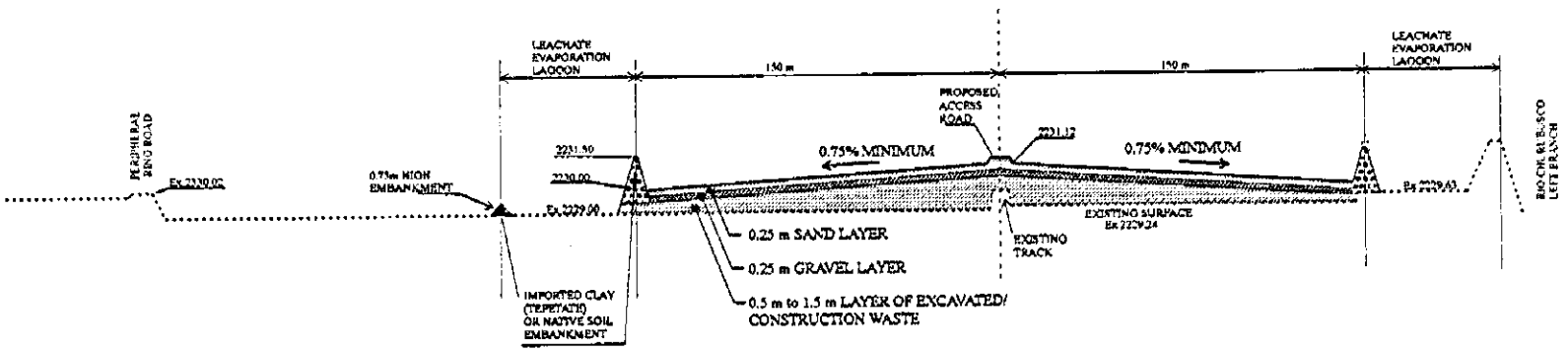
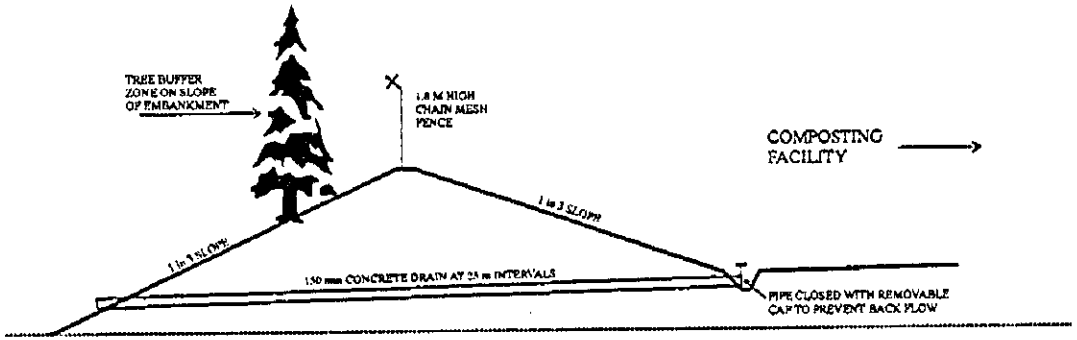


Figure 6-4: Layout of Proposed Composting Facility



SECTION A-A THROUGH COMPOSTING FACILITY

NOT TO SCALE



DETAIL OF EMBANKMENT

Figure 6-5: Cross Section A-A of Proposed Composting Facility

b.7 Construction Schedule

Table 6-4 shows the construction schedule of the composting plant.

Table 6-4: Construction Schedule of Composting Facility

Year	2001	2002	2003	2004	2010
Required Capacity (ton/day)	---	750	1,000	1,250	1,250
Composting Section (ton/day)	750	250	250	---	---
Curing Section (ton/day)	240	80	80	---	---
Separation Section (ton/day)	300	---	---	---	---

b.8 Cost Estimation

Preliminary cost estimate is presented in Table 6-5.

Table 6-5: Preliminary Cost Estimate of Composting Plant

Unit : US$ 1,000

Item	Details	unit	Unit Cost US$	Quantity	Cost US$	Cost Pesos P9.1=$1
SITE IMPROVEMENT						
earth works	spreading 1.0m layer of construction waste	m^2	1.04	370,000	385,000	3,504,000
	gravel for base, t=0.25m, A=33ha	m^3	4.2	91,000	382,000	3,476,000
	spreading sand surface, t=0.25m, A=33ha	m^3	5.35	94,000	503,000	4,577,000
	grading of surface for drainage	m^2	0.23	330,000	76,000	692,000
general improvements	embankment, exit track construction drainage, fencing, connect electricity lighting, access improvement, fuel tank water tank, portable buildings				599,000	5,451,000
Site improvement Total					1,945,000	17,700,000
Equipment						
truck scale	80 ton + foundations etc.	unit	69,000	1	60,000	546,000
wheel loader (A)	wheel loader with 5.4 m^3 refuse bucket	unit	125,400	3	376,000	3,422,000
wheel loader (B)	wheel loader with 4.0 m^3 refuse bucket	unit	100,320	2	201,000	1,829,000
compact loader	backhoe/loader, 2.36m/0.84m^3 bucket	unit	34,320	1	34,000	309,000
dump truck	16 m^3, 10 ton	unit	33,660	4	135,000	1,229,000
conventional farm tractor	60 hp (gross engine)	unit	33,000	3	99,000	901,000
water tanker	8,000 liters	unit	28,380	1	28,000	255,000
shredder	cap. 30 tons/hr, 175hp	unit	99,000	3	297,000	2,703,000
windrow turner	cap. 2500 tons/hr	unit	180,000	1	180,000	1,638,000
trommel	Screen 8 mm, & conveyors	unit	201,600	1	202,000	1,838,000
magnetic separator	permanent magnet + frame	unit	7,200	2	14,000	127,000
conveyors (separation)	w=600, side angle=25%	unit	15,000	3	45,000	410,000
pick up equipment	cap. 2 ton	unit	22,500	2	45,000	410,000
Equipment Total					1,716,000	15,617,000
sub-total (1)					3,661,000	33,317,000
miscellaneous	10%				367,000	3,332,000
Direct cost					4,028,000	36,649,000
general expenses/overhead	30%				1,209,000	10,995,000
total construction cost					5,237,000	47,644,000
physical contingency	10%				524,000	4,764,000
IVA	15%				785,000	7,147,000
Total Cost					6,546,000	59,555,000

b.9 Priority Project Cost (Composting Facility)

Table 6-7 shows costs for the composting project from 1999 to 2010 annually. Two cases shown below were set for the cost estimates.

- Case 1: Investment and operation by the DGSU
- Case 2: Investment by the DGSU and contracting out operation

Namely, the DGSU invests in all construction, procures all equipment and operates the compost facility directly in Case 1, whereas the DGSU invests in all construction,

procures some equipment and a private company supplies other equipment and operates the compost facility under a contract with the DGSU in Case 2.

Table 6-6: Procurement of Equipment in Case 2

DGSU		Private company	
Truck scale:	1	Wheel loader (A):	3
Shredder:	3	Wheel loader (A):	2
Windrow turner:	1	Compact loader:	1
Trommel:	1	Dump truck:	4
Magnetic separator:	2	Farm tractor:	3
Conveyor:	3	Water tanker:	1
		Pick up equipment:	2

Table 6-7: Priority Project Cost (Composting Facility)

unit : US$ 1,000

Case	Year	Basic Design		Pilot projects		Detail Design + supervision		Construction		Equipment		O & M (contract)		O & M (direct)		Land rental fee		Total		
		domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign	domestic + foreign
Case 1	1999	50	-	8	2	-	-	-	-	-	-	-	-	-	-	-	-	58	2	60
	2000	-	-	8	2	164	-	-	-	-	-	-	-	-	-	-	-	172	2	174
	2001	-	-	-	-	99	-	2,376	-	-	2,548	-	-	-	-	33	-	2,508	2,548	5,056
	2002	-	-	-	-	33	-	551	-	-	520	-	-	530	132	33	-	1,147	652	1,799
	2003	-	-	-	-	33	-	551	-	-	-	-	-	656	164	33	-	1,273	164	1,437
	2004	-	-	-	-	-	-	-	-	-	-	-	-	656	164	33	-	689	164	853
	2005	-	-	-	-	-	-	-	-	-	-	-	-	656	164	33	-	689	164	853
	2006	-	-	-	-	-	-	-	-	-	-	-	-	656	164	33	-	689	164	853
	2007	-	-	-	-	3	-	-	-	-	-	-	-	656	164	33	-	689	164	866
	2008	-	-	-	-	2	-	-	-	-	2,441	-	-	656	164	33	-	689	2,605	3,296
	2009	-	-	-	-	-	-	-	-	-	520	-	-	656	164	33	-	689	684	1,373
	2010	-	-	-	-	-	-	-	-	-	-	-	-	656	164	33	-	689	164	853
	Total	50	-	16	4	344	-	3,478	-	-	6,029	-	-	5,778	1,444	330	-	9,996	7,477	17,473
		50		20		344		3,478		6,029		-		7,222		330		---		
Case 2	1999	50	-	8	2	-	-	-	-	-	-	-	-	-	-	-	-	58	2	60
	2000	-	-	8	2	164	-	-	-	-	-	-	-	-	-	-	-	172	2	174
	2001	-	-	-	-	99	-	2,376	-	-	1,250	-	-	-	-	33	-	2,508	1,250	3,758
	2002	-	-	-	-	33	-	551	-	-	177	1,051	-	81	20	33	-	1,749	197	1,946
	2003	-	-	-	-	33	-	551	-	-	-	1,186	-	99	25	33	-	1,902	25	1,927
	2004	-	-	-	-	-	-	-	-	-	-	1,186	-	99	25	33	-	1,318	25	1,343
	2005	-	-	-	-	-	-	-	-	-	-	1,186	-	99	25	33	-	1,318	25	1,343
	2006	-	-	-	-	-	-	-	-	-	-	1,186	-	99	25	33	-	1,318	25	1,343
	2007	-	-	-	-	13	-	-	-	-	-	1,186	-	99	25	33	-	1,318	25	1,356
	2008	-	-	-	-	2	-	-	-	-	1,142	1,186	-	99	25	33	-	1,318	1,167	2,487
	2009	-	-	-	-	-	-	-	-	-	177	1,186	-	99	25	33	-	1,318	202	1,520
	2010	-	-	-	-	-	-	-	-	-	-	1,186	-	99	25	33	-	1,318	25	1,343
	Total	50	-	16	4	344	-	3,478	-	-	2,746	10,539	-	873	220	330	-	15,630	2,970	18,600
		50		20		344		3,478		2,746		10,539		1,093		330		---		