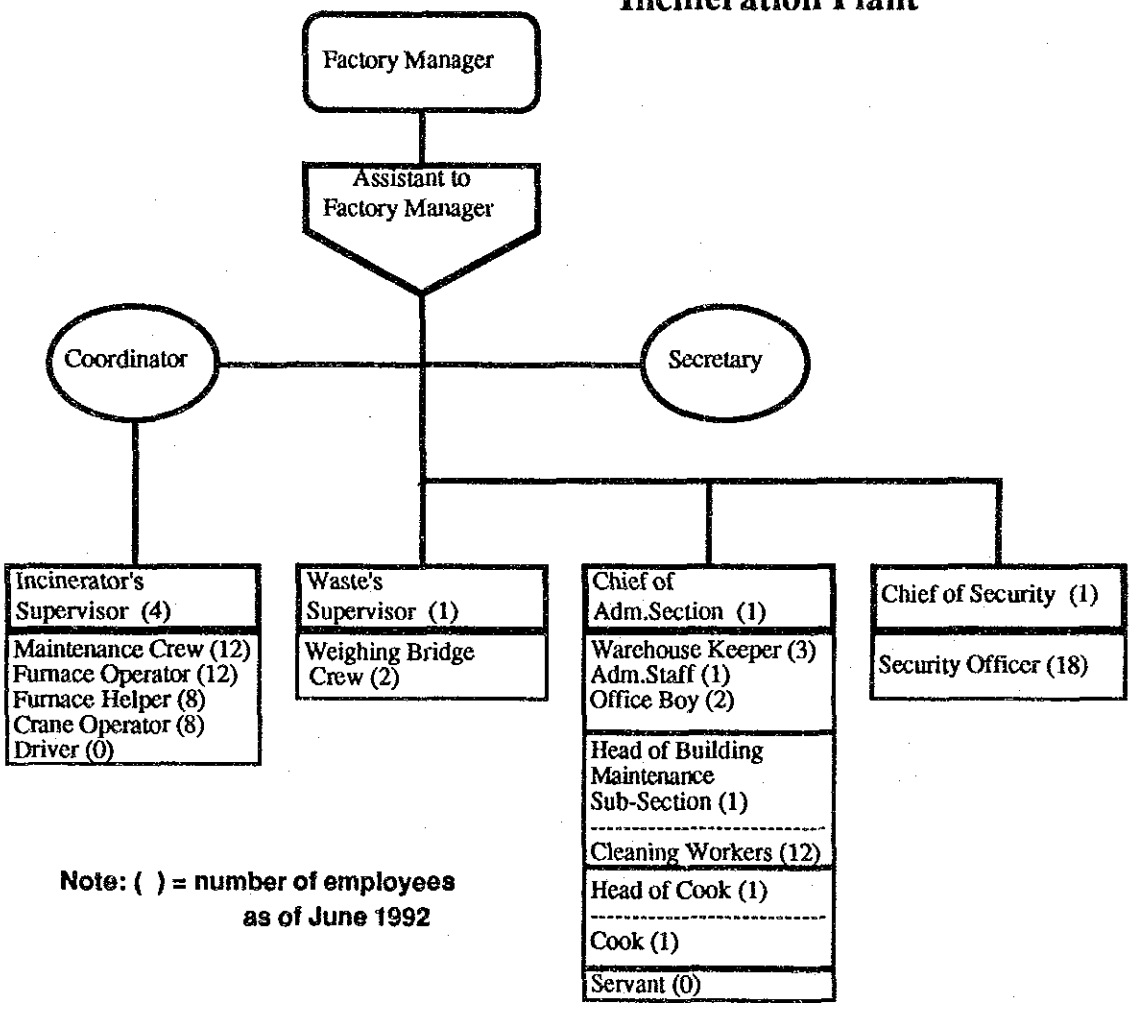
Since August 1991, Cleansing Department has started operating an incinerator. Nevertheless, so far Cleansing Department has neither divisions nor sections responsible for the operation and maintenance of the Incineration Plant. It is directly under the Chief of Cleansing Department.

There are 92 employees working for the incinerator, of which 16 employees belong to KMS, and the remaining persons are employed by a private compay. The organizational structure of the Incineration Plant is shown in the following figure.

Fig.1.3-8
Organizational Structure of Incineration Plant



Note: ( ) = number of employees as of June 1992

3.4.2 Manpower in Cleansing Department

1) Manpower by Sections

There are two categories of employees at Cleansing Department, namely permanent and temporary (daily-wage base) employees. The employees could be classified into 2 groups, i.e. those who work at the Headquarters of Cleansing Department (comprising 1 division and 5 sections) and those who work at Rayon (3 Rayons & 18 Cabangs).

The Cleansing Department has 1,722 employees, of which 1,037 are permanent employees and 685 are temporary workers (as street sweepers).

Table 1.3-13 Manpower Employed by Cleansing Department

Type of Employees	Nos.Manpower	
A. Permanent Employees		
(1)*Headquarters:*		
Administration Division	35	
Planning & Supervision Section	14	
Construction & Execution Section	14	
Evaluation & Report Section	16	
Waste Disposal/MCK&Night Soil Section	13	
Haulage Section	199	
Sub-Total (1)		291
(2)*Rayon:*		
North Rayon	238	
East Rayon	191	
South Rayon	267	
Non-Active Personnel	50	
Sub-Total (2)		746
Total (1) + (2)		1,037
B. Daily-Wage Base Employees		
Street Sweepers	685	685
Grand Total (A + B)	**1,722**	**1,722**

Note: In addition, it is estimated that all RT/RW in Surabaya City employ about 10,500 workers as waste collectors.

Cleansing Department also hires some private contractors in street sweeping (25 companies) and haulage from temporal disposal sites to final ones (5 companies). Number of field workers utilized by the private contractors is estimated at 404 (street sweepers) and 113 (haulage workers).

2) Manpower by Type of Service

The number of employees of Cleansing Department by type of service is shown below:

Table 1.3-14 Manpower by Type of Service

TYPE OF SERVICE	Nos.Manpower	
A. Office Work: 1) Headquarters	97	
2) 3 Rayons + 18 Cabangs	136	
Sub-Total (A)		233
B. Field Work:		
1) Haulage:		
a. Driver	69	
b. Assistant	32	
c. Car & Heavy Equipment Maintenance	35	
d. Depo/LPS Keeper	126	
Sub-Total 1)		262
2) Field Supervisor: a. Headquarters	28	
b. Rayon	21	
Sub-Total 2)		49
3) Final Disposal:		
a. Heavy Equipment Operator	16	
b. Site Recorder	14	
Sub-Total 3)		30
4) Street Sweeping #:		
a. Permanent Employee	375	
b. 'Daily-wage Base' Employee who work as permanent employees during day-time:		
i. Those who work as permanent street sweepers (Item a above)	261	
ii. Those who work as permenent field supervisors of Rayon office	6	

iii. Thos who work as permenent reserved field workers	9	
Sub-total of i, ii, & iii	276	
c. Pure 'daily-wage base' worker	685	
Sub-Total 4)		1,060
5) Miscellaneous	38	
Sub-Total 5)		38
C. Non-Active Personnel	50	50
TOTAL	**1,722**	**1,722**

3.4.3 Responsibility of Cleansing Department

The responsibilities of Cleansing Department, its division and sections defined by Surabaya Municipal Regulation No.4/1980 could be summarized as follows:

a. Carrying out waste collection, haulage, utilization, and elimination.
b. planning and constructing infrastructures, facilities, disposal sites for waste and night soil.
c. planning and providing sanitary equipment and heavy equipment for city cleaning development.
d. arranging and performing city cleaning and environmental pollution prevention.
e. providing guidance, guidelines, and information to the people in order that the people would participate in keeping the city clean and in environmental pollution prevention.
f. supervising the using of sanitary infrastructures and facilities.
g. cooperating with other institutions in performing the sanitary management and environmental pollution prevention.
h. formulating and planning technical policies in accord with policies determined by the Mayor.
i. securing and controlling the execution of main tasks in accord with policies determined by the Mayor.
j. carrying out other tasks given by the Chief of Cleansing Department.

3.5 SWM Expenditures and Revenues

3.5.1 SWM Expenditures

1) SWM Expenditures and KMS Budget

Annual budget of the Cleansing Department in 1992/93 is approx. Rp 11.5 billion, of which Rp 7.8 billion is the routine budget, and Rp 3.7 billion is the development budget. The 1992/93 cleansing budget Rp 11.5 billion represents 10.2% of the budget of KMS (City of Surabaya). The following table shows both SWM and KMS expenditures, and the percentage of SWM budget relative to KMS expenditures since the fiscal year 1985/86.

Table 1.3-15 SWM and KMS Expenditures 1985/86 - 1992/93

Unit: Rp Billion

Fiscal year	SWM Expenditure			KMS Total Expenditures	Percentage of SWM Exp. to KMS Exp.
	Routine (A)	Development (B)	Total (C)=(A)+(B)	(D)	(E)=(C)/(D)
1985/86	2.1	0.2	2.3	31.7	7.4%
1986/87	2.2	0.2	2.4	36.7	6.5%
1987/88	2.7	0.6	3.3	50.4	6.5%
1988/89	3.6	0.5	4.1	59.8	6.9%
1989/90	3.9	3.5	7.4	62.1	12.0%
1990/91	4.2	3.8	8.0	74.7	10.7%
1991/92	7.3	3.9	11.2	99.4	11.3%
1992/93	7.8	3.7	11.5	112.7	10.2%

NOTES :

1. All the amounts for 1985/86 - 1990/91 are the actual expenditures, while 1991/92 and 1992/93 amounts are the budgeted amounts.
2. The KMS expenditures shown in the above table do not include the budget item "cash and calculation" as KMS has no control over this budget item, and this budget item just passes through KMS (Therefore revenue and expenditures of this item are identical always).

The percentage of SWM expenditures relative to KMS expenditures has jumped to 12% in 1989/90 from 6.9% of the preceding year due to the introduction of the incineration, and the commencement of KMS's repayment of the incineration plant to P.T. Unicomindo, a private contractor.

2) SWM Budget Details

The following shows the details of the 1992/93 SWM budget.

Table 1.3-16 1992/93 SWM Budget

A. Routine Budget

Unit: Rp

1.	All personnel expenditures	3,067,018,000	34%
2.	General equipment and material for mainly administrative use	218,538,000	3%
3.	Waste collection vehicles operation and maintenance	843,710,000	11%
4.	Depo/LPS improvement	65,000,000	1%
5.	Heavy equipment maintenance for final disposal	227,500,000	3%
6.	Incinerator operation	926,000,000	12%
7.	Payment to street sweeping contractors and temporary employees	1,750,000,000	22%
8.	Payment to waste haulage contractors	600,000,000	8%
9.	Law enforcement operation	120,000,000	1%
10.	Total of routine budget	7,841,260,000	100%

B. Development Budget

11.	Incineration	3,500,000,000	95%
	a. Repayment to P.T. Unicomindo	(3,336,359,500)	
	b. Payment to BPPT & ITS for consulting services	(120,000,000)	
	c. Other expenses	(43,660,500)	
12.	Depo/LPS Construction and Containers	100,000,000	3%
	a. Depo/LPS construction	(35,500,000)	
	b. New containers purchase	(60,000,000)	
	c. Other expenses	(4,500,000)	
13.	Construction of entrances and drain	75,000,000	2%
	a. Construction of entrance to the incinerator and drain to Keputih disposal site	(52,500,000)	
	b. Construction of entrance to Lakarsantri	(19,000,000)	
	c. Other expenses	(3,500,000)	
14.	Total of Development Budget	3,675,260,000	100%
15.	Grand Total (10 + 14)	11,516,260,000	

3) 1992/93 Budget by Type of Service

The table below shows the 1992/93 SWM budget by type of services. The incineration shares 45 %, street sweeping 25 %, haulage 21 %, final disposal 3%, and administration 6 %.

Table 1.3-17 1992/93 SWM Budget by Type of Services

1. Incineration	
1.1 Repayment to P.T. Unicomindo	3,336,339,500
1.2 Operation (to be paid to Unicomindo)	926,000,000
1.3 Payment to BPPT & ITS for consulting service	120,000,000
1.4 Personnel Expenditures	40,000,000
1.5 Other expense	43,660,500
1.6 Total	4,466,000,000 (45 %)
2. Haulage	
2.1 Operation and maintenance (excluding personnel expenditures)	843,710,000
2.2 Payment to contractors	600,000,000
2.3 Depo/LPS improvement and construction	100,500,000
2.4 New container purchase	60,000,000
2.5 Other expense	4,500,000
2.6 Personnel expenditures	480,000,000
2.7 Total	2,153,210,000 (21 %)
3. Street sweeping	
3.1 Personnel expenditures	1,457,197,000
3.2 Payment to contractors	926,796,000
3.3 Equipment	87,618,000
3.4 Total	2,471,611000 (25 %)
4. Final Disposal	
4.1 Heavy equipment operation & maintenance	227,500,000
4.2 Personnel expenditures	17,742,000
4.3 Construction of entrance and drains	75,000,000
Total	320,242,000 (3%)
5. Administration	
5.1 Personnel expenditures	381,000,000
5.2 Equipment and materials for administrative use	130,920,000
5.3 Law enforcement operation	120,000,000
Total	631,920,000 (6 %)
6. Grand total	10,042,983,000 (100%)

Note: The personnel expenditures shown in the above table are those recorded at the end of the fiscal year 1991/1992. (1992/93 data are not available.)

3.5.2 Revenue of the Sanitary Retribution

The City of Surabaya (KMS) collected the retribution about Rp 4 billion in 1991/92 as shown in the table below, of which 15 % is paid as handling charges to the RT/RW, PDAM and other parties involved in the collection of the retribution. The net revenue is estimated at Rp 3.37 billion, which corresponds to about 30 % of the cleansing budget Rp 11.2 billion in 1991/92. Of the retribution of Rp 4 billion collected, 75% is paid by households, while the remaining 25% is paid by commercial, industrial establishments as well as markets, etc.

Table 1.3-18 Retribution Collected and Handling Charges Paid to Involved Parties in 1991/92

Unit: Million Rupiah

	Through PDAM (A)	Through Non-PDAM (B)	Total (C)=(A)+(B)
1. Retribution Collected	2,498	1,477	3,975
2. Handling charges paid to involved parties	250 (10% of 2,498)	355 (26% of 1,477)	605 (15.2% of 3,975)
3. Net revenue to KMS (3-4)	2,248 (90%)	1,123 (74%)	3,370 84.8%)

3.5.3 Cost of Primary Collection by RT/RW

It is estimated that the annual cost of primary collection is about Rp 8.4 billion as shown below :

Table 1.3-19 Annual Cost of Primary Collection by RT/RW

	Unit Cost	Quantity	Total (Rupiah)
1. Salary	Rp 624,000/worker	10,000 workers	6,240,000,000
2. Clothes, boots, gloves, etc.	Rp 100,250/worker	10,000 workers	1,002,500,000
3. Broom, etc.	Rp 51,700/worker	10,000 workers	517,000,000
4. Annual Depreciation of a handcart	Rp 246,500/cart	2,600 handcarts	640,900,000
5. O/M cost of a handcart	Rp 10,000/cart	2,600 handcarts	26,000,000
TOTAL			8,426,400,000

3.6 Collection and Haulage

3.6.1 General Description

1) Waste Flow and Responsible Body

In Surabaya, like many other cities of Indonesia, the waste collection (collection of waste from waste generation sources and transfer it to Depo/LPS) is mainly executed by the RW/RT, while KMS is the main body responsible for the haulage of waste from Depo/LPS to LPA(final disposal sites) as illustrated in the figure below:

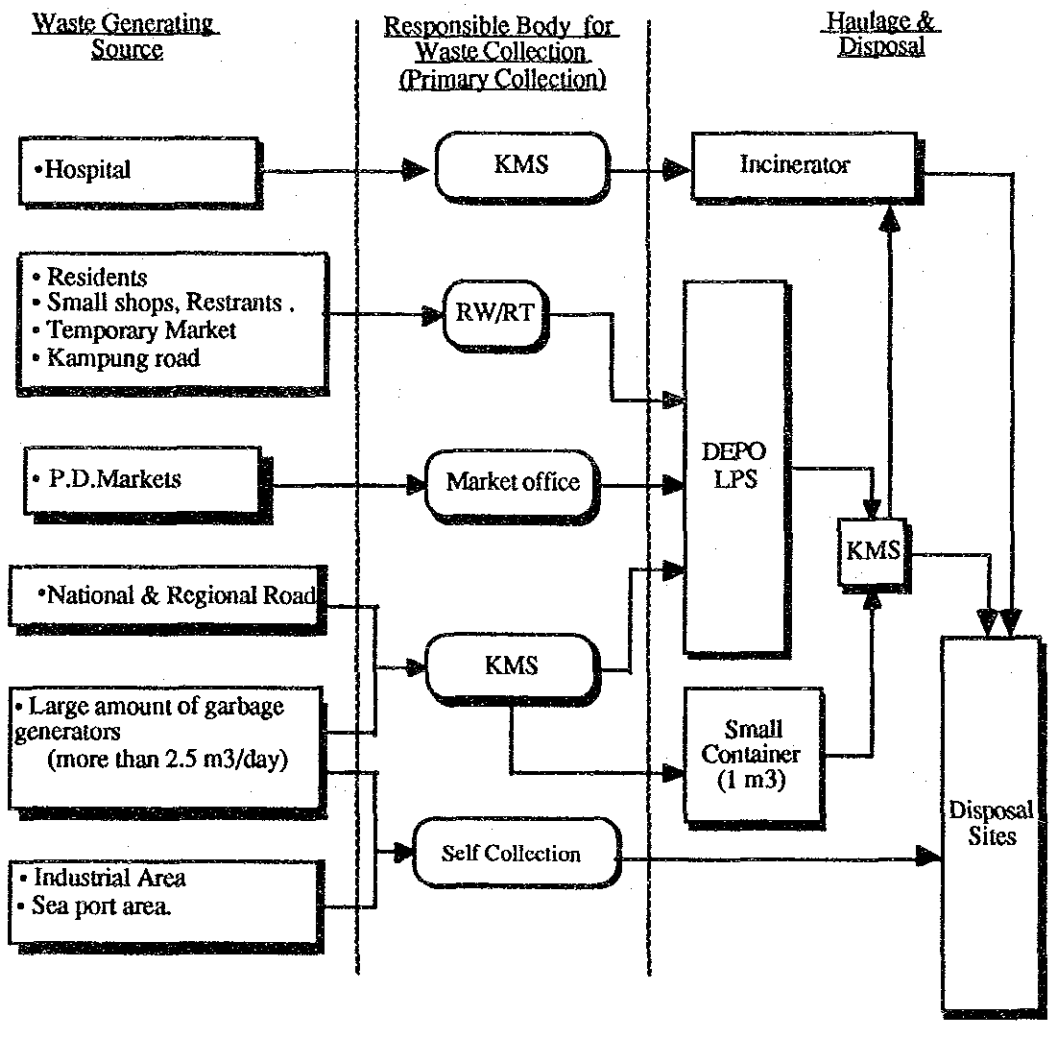


Fig.1.3-9 Waste Flows and Responsible Bodies for Collection and Haulage

2) Service Level

As shown in the table below, 936 t/d or 58 % of the total waste generation amount is collected and hauled to the three (3) official LPA. In addition, an average of 180 ton/day (11 % of total waste generation amount) is recycled before being hauled to LPA. This implies that 69 % of the total waste generation amount is either recycled or collected/hauled/ and disposed properly.

In terms of population, about 81 % of the population receive the waste haulage service.

Table 1.3-20 Waste Haulage Service Coverage in Surabaya

	Collected & Hauled to Offical LPA
1.1 Total waste generation	1,626 ton/day*1 (100 %)
1.2 Waste collected and hauled	936 ton/day*1 (58 %)
1.3 Waste recycled before being hauled to LPA	180 ton/day*1 (11 %)
1.4 Total - Waste either collected/hauled or recyled (1.2 + 1.3)	1,116 ton/day (69 %)
2.1 Total population	2,564,272 persons*2 (100 %)
2.2 Population Served	2,071,500 persons*3 (81 %)

Notes:
*1: Source of data is the Study Teams' waste amount survey.
*2: Study Team's estimation based upon the 1990 census population.
*3: Data source: Kelurahan and Kecamatan offices

Waste haulage service coverage by Kelurahan is shown in the following figure.

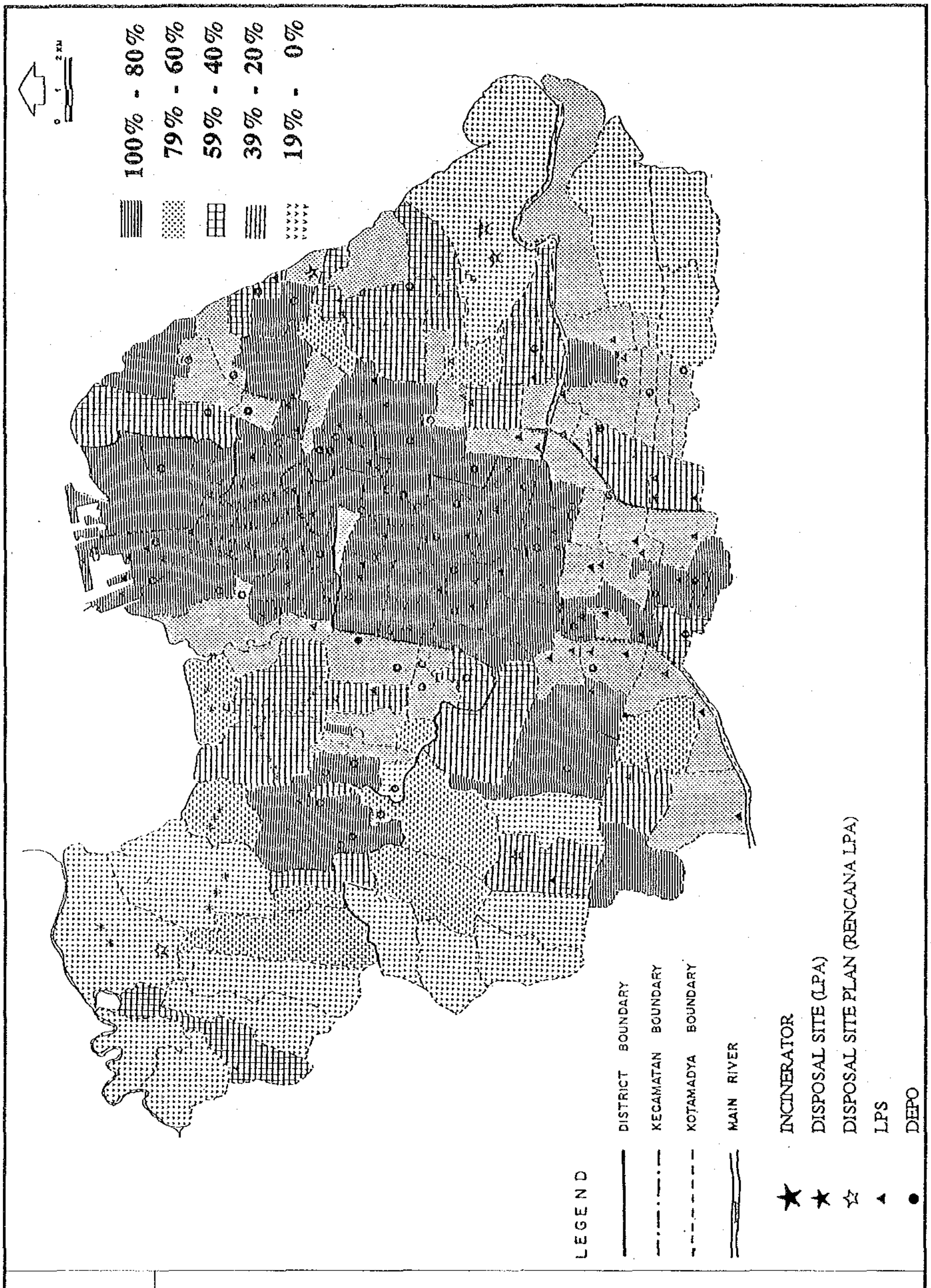


FIG. 1.3-10 **Waste Haulage Service Level by Kelurahan (1992)**

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3.6.2 Waste Collection

"Waste collection" refers to an activity of waste collection from sources and haulage of the collected waste to either Depo or LPS. "Waste haulage" refers to an activity of waste haulage from either Depo or LPS to LPA.

1) Responsibility

The Surabaya Municipal Regulations No.4/1980 and No.6/1986 stipulate that the citizens are responsible for the waste collection, while KMS is responsible in principle for waste haulage.

Waste collection is executed at a community level (RT/RW). There 1,224 RW and 7,711 RT in Surabaya. Each RW or RT employs 6 - 10 collection workers called "Pasukan Kuning" (Yellow Troop). It is said that there are 10,500 collection workers in Surabaya.

The citizens pay waste collection fees which range Rp 300 - Rp 2,000 per household per month to RT/RW. An average seems to be about Rp 1,200/household/month. Shops and offices that receive waste collection service from RT/RW pay fees at higher rates depending on the waste volume.

2) Waste Collection System

a. Waste Storage

Typical containers used by households for waste storage are as follows:

1. Concrete bins placed in front of houses
2. Small containers made of tin, bamboo or wood
3. Plastic bins

Concrete bins are mainly used by middle or high income households as well as shops. Use of concrete bins causes two problems as shown below.

1) Sanitary problem: Concrete bins are considered as small open dumping places. They are breeding beds for mice.

2) Operational problem: It is not easy for collection workers to collect waste from concrete bins. It takes more time for them to collect waste from concrete bins than from other types of mobile bins.

Pasukan Kuning (Collection workers) collect waste from bins of each house and shop, and load into a handcart. After finishing the waste collection, they carry the waste-filled handcarts to the nearest Depo/LPS designated by RW/RT. The distance between Depo/LPS and collection areas seems less than 1.5 km in most cases. Waste collection systems vary depending on waste generating sources.

b. Equipment Used

Major equipment used for waste collection is as follows:

1. Handcarts
2. Broom and wood plated (used to collect waste)
3. Yellow shirts and pants, boots and gloves

c. Collection System

In principle, collection workers collect waste on the door to door base.

d. Collection frequency.

Collection frequency depends mainly on income level. Typically, waste is collected every day in high income areas and commercial areas, three to four times a week in middle income areas, and less frequent in low income areas.

3.6.3 Waste Haulage

1) Improvements in Recent Years

The city of Surabaya has made remarkable improvements on the solid waste management (SWM) over the past decade through the implementation of the Solid Waste Improvement Plan (SWIP), a component of the City Development Project (named Urban III and V), which commenced in 1980.

The year 1980 was a starting year of containerization of Depo and LPS. Containers (6 m^3, 10 m^3 and 12 m^3) have been placed in Depo and LPS since then. In 1986, Rear End Loader (REL) compactor trucks were introduced for haulage of waste from small containers placed on roadsides.

With the containerization of Depo and LPS, the involvement of the private sector decreased sharply because the containerized haulage system requires expensive arm-roll trucks, while the contractors couldnot afford for purchase of them. Therefore, the contractors' involvement has been limited to the waste haulage from Depo/LPS where waste is openly dumped without containers, and can be collected by open dump trucks, which the contractors can afford to purchase.

2) Responsibility for Waste Haulage

KMS is responsible for haulage of waste from Depo or LPS to LPA in principle.

Responsibility of Waste Generators Generating 2.5 m3 or More Each Day

The regulation No.6/1986 stipulated that those who generate waste 2.5 m^3 or more each day are responsible for the collection and haulage of their waste unless they request KMS to do so. (It seems that the last paragraph makes it possible for the big waste generators to avoid the responsibility for haulage of self-generated waste.)

Big department stores and supermarkets use contractors for waste collection and haulage. In 1992, an average of 137 ton/day (8 % of total waste generation in Surabaya) was hauled by waste generators themselves.

Pasar (Markets), which generate 258 ton/day of waste (about 16 % of total waste generation in Surabaya) entirely depend on KMS for waste haulage service.

3) Waste Haulage Amount

In 1992, a total of 1,026 ton/day of waste was hauled to either official LPA or an unofficial place, of which 936 ton/day was hauled to official LPA, and the remaining 90 ton/day was hauled to an unofficial place in Asemrowo as shown below. 936 ton/day represents 58 % of the total waste generation amount in Surabaya.

Table 1.3-21 Waste Haulage Amount (1992)

Unit: ton/day

	Hauled by KMS and Contractors (1)	Hauled by Generators (2)	Total (1)+(2)= (3)
1. Hauled to Official LPA (Lakarsantri, Keputih & Kenjeran)	884	52	936
2. Hauled to unofficial place in Asemrowo	5	85	90
3. Total (1 + 2)	889	137	1,026

Source: JICA Study Team's waste amount survey

4) Equipment Used

KMS uses the following three major haulage systems:

1. Small containers placed on roadsides and Compactor trucks (REL) for haulage of street waste mainly

2. Large containers placed in Depo or LPS and Arm-roll trucks for haulage of waste brought into Depo or LPS

3. Open trucks to haul such waste as bulky waste, trees cut, river waste collected by citizens

Number of containers and trucks by types and capacity are shown below.

Table 1.3-22 Number of Containers and Trucks by Type of Haulage System

Haulage Systems	Number of Container	Number of Trucks Serving for Containers
1. Waste Haulage from Depo or LPS		
1.1 6 m^3 Containers & Arm-roll trucks (7 GVW)	161	26
1.2 10 m^3 Containers & Arm-roll trucks (14 GVW)	80	13
1.3 12 m^3 Containers & Arm-roll trucks (14 GVW)	19	4
1.4 Sub-total (1.1 + 1.2)	260	43
2. Waste Haulage from Roadsides		
2.1 0.6 m^3 Containers & 6 m^3 Compactor (REL) trucks (7 GVW)	68	5
2.2 1.0 m^3 Containers & 10 m^3 Compactor (REL) trucks (14GVW)	368	10
2.3 Sub-total (2.1 + 2.2)	436	15
3. Waste haulage with Open trucks	-	7
4. Total (1 + 2)	696	65

5) Depo and LPS and Haulage Destination (LPA)

a. Depo and LPS

There are 58 Depo and 110 LPS in Surabaya as of May 1992. Both Depo and LPS serve as transfer stations. Depo has an office stationed with an officer, while LPS does not have such office.

b. Haulage Destination (LPA)

There are 3 LPA (final disposal sites). They are located in Lakarsantri, Keputih and Kenjeran. The following figure show locations of Depo and LPS as well as LPA where waste is hauled to.

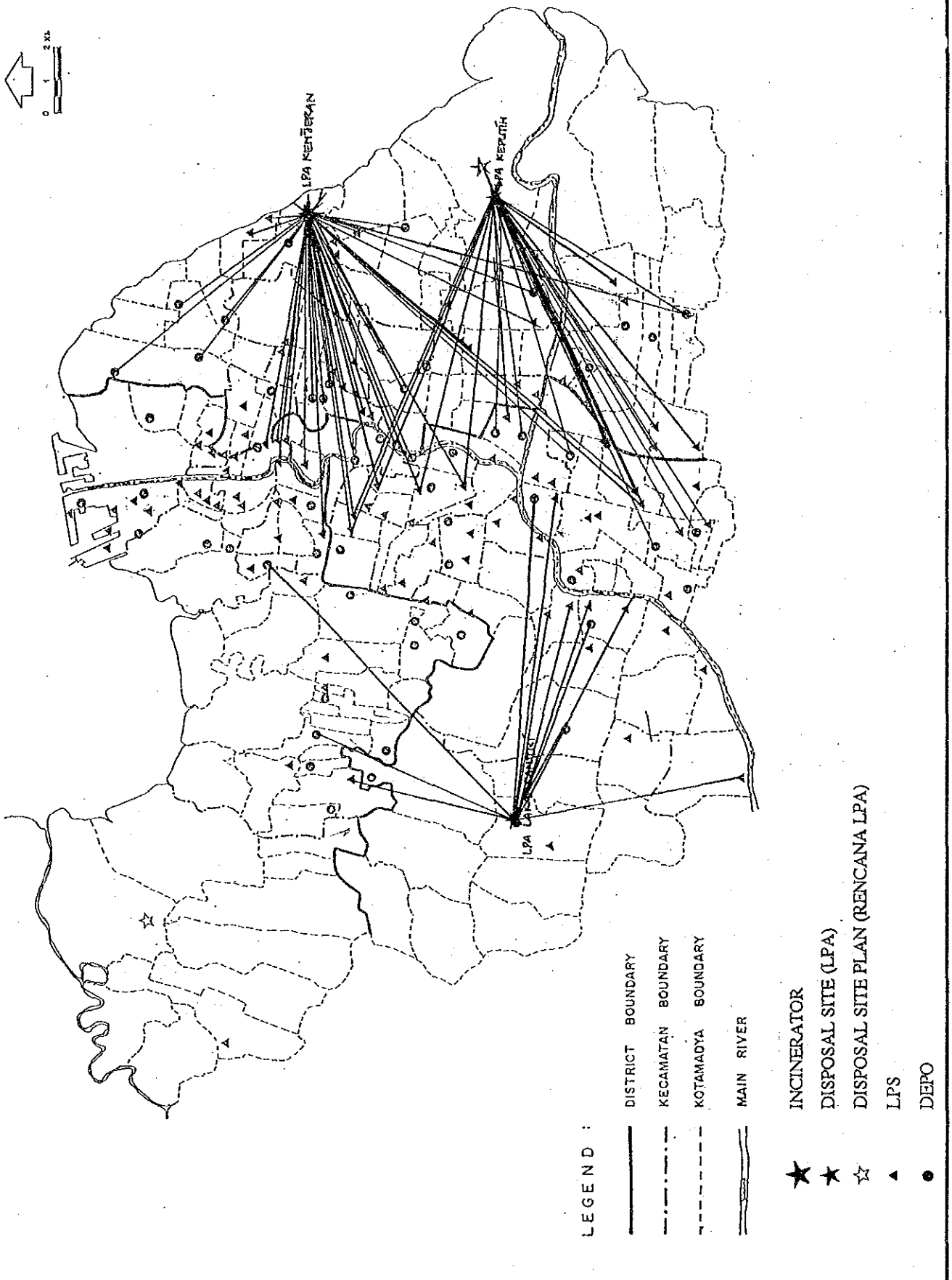

FIG. 1.3-11 Destination (LPA) of Waste Haulage from Each Depo and LPS

6) Waste Haulage Amount by KMS and Type of Trucks

As shown in the table below, KMS' trucks haul 70 % of waste, while the remaining 30 % is hauled by KMS' contractors as shown below.

A. Waste hauled by KMS' trucks:	621 ton/day	(70%)
B. Waste hauled by KMS' Contractors:	268 ton/day	(30%)
Total (A + B):	889 ton/day	(100%)

Of the waste (621 ton/day) hauled by KMS' trucks, 82 % is hauled by arm-roll trucks from Depo and LPS. 14 % is hauled by REL compactor trucks from small containers. The remaining 4 % is hauled by open trucks.

Table 1.3-23 Waste Haulage Amount by Type of Trucks

Haulage System	Waste Hauled (ton/day)
A.1 by large containers and Arm-roll trucks	
1) by 6 m^3 containers	270 t/d (43 %)
2) by 10 m^3 containers	187 t/d (30 %)
3) by 12 m^3 containers	53 t/d (9 %)
4) Sub-total (1 + 2 + 3)	509 t/d (82 %)
A.2 by small containers and REL Compactor trucks	
5) by 0.6 m^3 containers	15 t/d (2 %)
6) by 1.0 m^3 containers	72 t/d (12 %)
7) Sub-total (5 + 6)	87 t/d (14 %)
A.3 by open trucks	25 t/d (4 %)
Total (A.1 + A.2 + A.3)	621 t/d (100%)

7) Haulage Efficiency by Types of Haulage System

a. Operational Efficiency

The following table shows operational efficiency in terms of waste amount hauled by type of haulage system. It can be said that the haulage system with large containers and arm-roll truck is the most efficient haulage system. The table shows that average

haulage amount of 10 m^3 container is larger than that of 12 m^3 containers. This indicates that sizes of containers do not match with actual waste amounts.

Table 1.3-24 Operational Efficiency by Haulage System

	Average Waste Amount Hauled per Trip (ton/trip) (1)	Average Daily Trip Frequency (trips/day) (2)	Average Daily Waste Amount per Truck (ton/truck/day) (1)x(2)= (3)	Average Annual Waste Amount per Truck (t/truck/year) (3) x 365 d = (4)
1. 10 m^3 Containers & Arm-roll trcuk	3.16	4.7	14.85	5,421 (100)
2. 12 m^3 Containers & Arm-roll truck	3.20	4.3	13.76	5,022 (93)
3. 6 m^3 Containers & Arm-roll truck	1.63	5,5	8.97	3,272 (60)
4. 1.0 m^3 Containers & REL Compactor Trucks	3.45	2.5	8.63	3,148 (58)
5. Open Trucks	1.95	1.9	3.71	1,352 (25)
6. 0.6 m^3 Containers & REL Compactor Truck	1.08	2.3	2.484	907 (17)

Note: Figures in parenthesis show indeces with the waste amount of the most efficent haulage system being 100.

b. Cost Efficiency by Haulage System

As shown in the table below, the haulage system with an arm-roll truck and large containers and arm-roll trucks is the most cost-effective. The costs of this haulage system shown in the table do not include costs related to Depo/LPS construction and maintenance.

However, even if such costs are included, the haulage system with large containers and arm-roll trucks would cost much less than the haulage system with small containers and REL compactor trucks.

Table 1.3-25 Cost Efficiency by Haulage System

	Annual Cost of Haulage System (Rp/year) (1)	Annual Waste Amount Hauled per Hualage System (ton/year) (2)	Unit Cost per Ton of Waste Haulage (Rp/ton) (1) ÷ (2) = (3)
1. 6 units of 10 m^3 Containers & an Arm-roll truck	Rp 49,470,000	5,421	Rp 9,126 (100)
2. 6 units of 12 m^3 Containers & an Arm-roll trcuk	Rp 50,346,000	5,022	Rp 10,025 (110)
3. 6 units of 6 m^3 Containers & an Arm-roll trcuk	Rp 35,806,000	3,272	Rp 10,943 (120)
4. 28 units of 1.0 m^3 Container & a REL Compactor Trucks	Rp 52,971,000	3,148	Rp 16,827 (184)
5. An Open Truck	Rp 35,059,000	1,352	Rp 25,931 (284)
6. 27 units of 0.6 m^3 Containers & a REL Compactor Trucks	Rp 38,216,000	907	Rp 42,135 (462)

Notes:

1. It is assumed that a haulage system consist of one truck and some containers of which numbers are shown in the first column. The indicated number of containers include spare containers as well.
2. The above costs include annual costs of depreciation, operation including employee's salary, maintenance, loan interest of both trucks and containers. Costs related to Depo/LPS construction and maintenance are not included.
3. Figures in parenthesis show unit cost indices with the unit cost of the most cost-effective haulage system being 100.

8) Manpower Used for Waste Haulage

There are 76 drivers and 75 assistants in the Cleansing Department including both permenent and temporary workers as shown in the following table. It may be noted that more than 90% of the drivers have permanent status, while the assistants with permanent status is only 45%.

Table 1.3-26 Number of Drivers and Assistants by Employment Status

	Permanent	Temporary	Total
Drivers	69	7	76
Assistants	32	43	75
Total	101	50	151

The following table shows composition of workers by type of trucks. All the three types of arm-roll trucks and 6 m^3 REL compactor trucks are operated by one driver and one assistant per truck. A 10 m^3 compactor needs one driver and two assistants. The truck drivers and assistants come to the garage in Asemrowo before 7 o'clock morning gathering.

Table 1.3-27 Number of Workers by Type of Trucks

	Driver	Assistants	Helpers	Total
1. 6m^3 Arm-roll Truck	1	1	0	2
2. 10m^3 Arm-roll Truck	1	1	0	2
3. 12m^3 Arm-roll Truck	1	1	0	2
4. 6m^3 compactor Truck	1	1	0	2
5. 10m^3 compactor Truck	1	2	0	3
6. Open Truck	1	0	6	7

9) *Waste Volume Monitoring and Vehicle Arrangements*

There is an officer and some workers in each Depo. In each Depo, there is an officer responsible for keeping waste volume records and reporting it to the branch office (Cabang) of the Cleansing Department. On the other hand, waste volume of of LPS is checked by officers (Penjaga) of Cabang office. Records on daily waste volume of Depo and LPS are arranged in Cabang offices, and reported to the Cleansing Department on the next day.

The Cleansing Department can know the waste collection situation of each Depo/LPS through the reports submitted by Cabang offices. If some waste of a Depo/LPS is not collected due to accidents of an assigned truck, the other truck will be sent to collect waste after finishing its work in the assigned area.

Arm-roll trucks are assigned with Depo/LPS from where waste should be hauled. Such assignment is decided by the head of Haulage Section. Appropriateness of Depo/LPS assignment to respective drivers is seldom reviewed.

10) Private Sector Involvement

At present, KMS uses five (5) private contractors. They use open dump trucks to haul waste from the Depo/LPS where there are no containers. The share of the contractors has decreased in recent years in terms of waste haulage amount because KMS has increased the number of containerized Depo/LPS and reduced the open-dumped Depo/LPS, and contractors cannot afford to buy arm-roll trucks.

The total contract waste haulage volume of the private contractors is 1,327 m^3/day in 1992. Based upon the JICA Study Team's field survey, the total haulage amount of the contractors is estimated to be about 268 ton/day, 30 % of the total amount of waste hauled by KMS' trucks and the contractors.

11) Major issues

a. The number of waste vehicles is insufficient. Therefore, eight (8) arm-roll trucks serving for 6 m^3 have been operated on 2 shift working.

b. There are many troubles occuring to trucks because of lack of spare parts, especially tire tubes, bad conditions of roads leading to the final disposal sites, and execution of no preventive maintenance.

c. Efficiency of compactor trucks, especially 6 m^3 compactors is very low because the compaction system is very badly designed. In addition, the net working time per truck is short because containers served by a truck is not many.

d. The number of containers is not enough to store the waste collected by collection workers. Therefore, collection workers often have to wait until a truck with empty containers arrives. This makes the working time of collection workers much longer than otherwise.

e. In Depo/LPS, it takes a long time for collection workers to transfer waste from a handcart to a container .

f. There are problems with some Depo/LPS; leachate flows to the roadside due to lack of ditch, walls are damaged, gates are broken, etc. Some local people complain about bad smell and ugly sight.

g. There are no regular day-off for drivers. If a truck driver takes a day-off, and if there is no driver to substitute for the absent driver, the absent driver's truck is not operated on the day.

3.7 Street Sweeping

3.7.1 Responsible Body

Three parties are involved in the street weeping as shown below.

Table 1.3-28 Responsible Bodies for Street Sweeping

Responsible Bodies	Streets to be Swept
1. KMS	Primary road (85 km & Secondary roads (215 km)
2. RT and RW	Local and Kampong Roads
1. Ministry of Public Works	Highway

3.7.1 Service Coverage

Streets in Surabaya is generally clean. KMS provides street sweeping service for most of the primary and secondary roads as shown below.

a. Total length of primary and secondary roads: 300 km
b. Total length primary & secondary roads swept by KMS: 290 km

Streets with sweeping service is shown in the following figure.

3.7.2 Frequency of Sweeping Service

Sweeping frequency depends on the roads. It ranges from once a day to 4 times a day. The most important roads are swept 4 times a day with 4 working shifts. Street sweepers are given a general instruction to keep the street clean. Specific sweeping frequency is not instructed to sweepers.

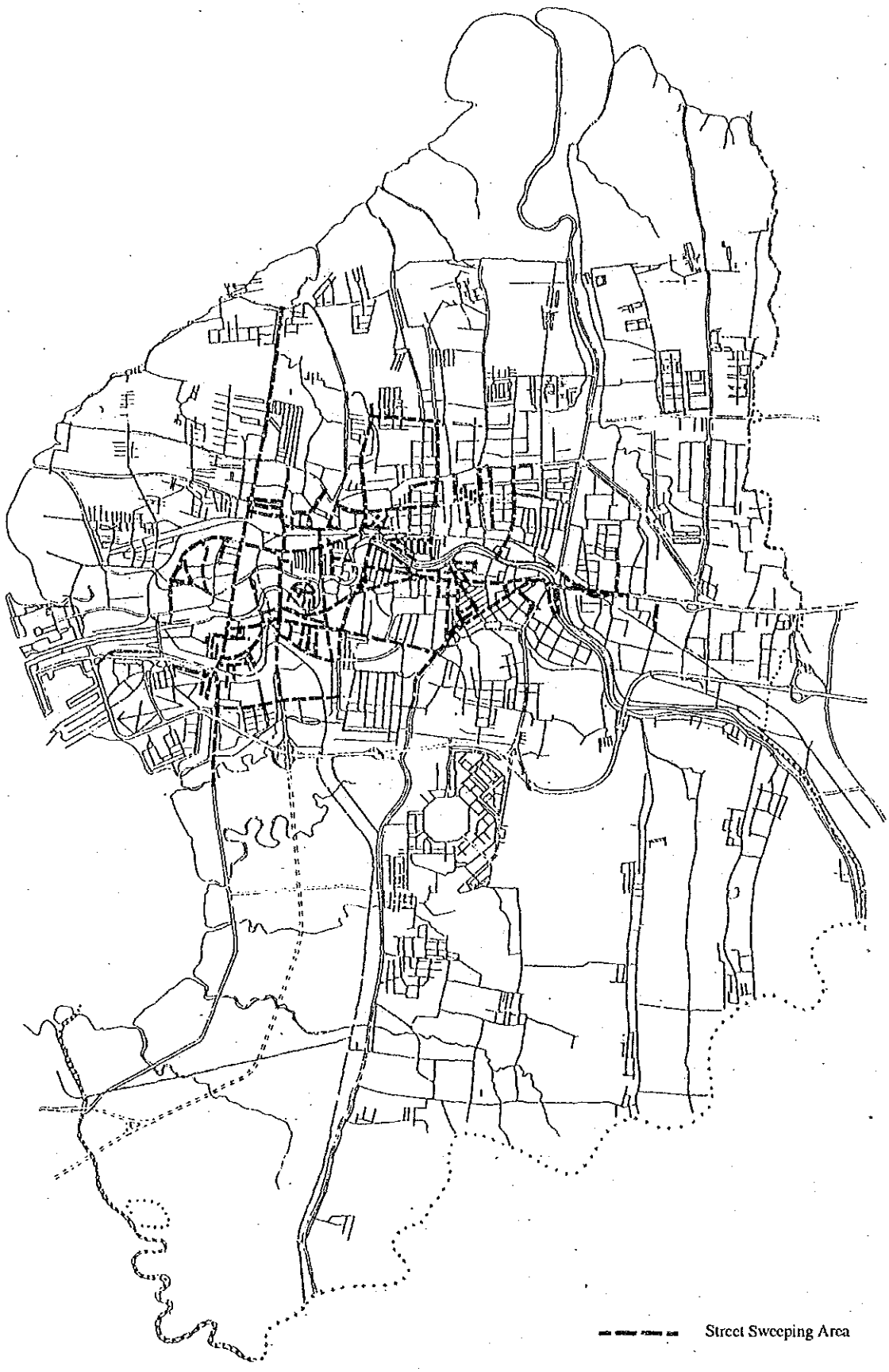

FIG. 1.3-12 Streets with Sweeping Service in Surabaya

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3.7.3 Use of Contractors

KMS uses 25 contractors for street sweeping. Length of sweeping by KMS' workers and the contractors are shown below.

Table 1.3-29 Length of Sweeping by KMS' Workers and Contractors

	Sweeping by KMS' Workers (1)	Sweeping by Contractors (2)	Total (1)+(2) = (3)
1. Sides of roads	362 km/day (181 km x 2 sides)	218 km/day (109 km x 2 sides)	580 km/day
2. Berms of roads	-	213 km/day (106.5 km x 2 sides)	213 km/day
3. Total (1 + 2)	362 km/day (46%)	431 km/day (54%)	793 km/day (100%)

3.7.4 Work System

A typical sweeping team consists of 4 to 5 workers as shown below.

- 2 sweepers with brooms
- 1 to 2 workers who collect waste swept
- 1 handcart puller

KMS has three (3) mechanical sweepers at present. They are very costly.

3.7.5 Manpower

KMS has about 1,060 sweepers, of which 375 sweepers are permanent, the remaining 685 are daily wage workers.

25 contractors use 404 sweepers in total.

3.7.6 Expenditures for Street Sweeping

According to KMS' 1992/93 budget, the expenditure for the street sweeping amounted to about Rp 2.5 billion, a 25 % of the total budget of the Cleansing Department.

1. Expenditure for KMS' Own Sweeping Operation
   - 1.1 Salary for workers
     - a. Permanent sweepers: Rp 566,065,000
     - b. Permanent workers (supervisors): Rp 67,928,000
     - c. Daily wage sweepers: Rp 823,204,000
   - 1.2 Equipment: Rp 87,618,000
   - 1.3 Sub-Total (1.1 + 1.2) Rp 1,544,815,000
2. Payment to contractors: Rp 926,796,000
3. Total: (1 + 2) Rp 2,471,611,000

3.7.7 Cost of Sweeping

The following table compares the costs of sweeping by KMS and contractors. It can be seen that KMS' unit cost of 1 km sweeping is Rp 11,692/km/day, 2.2 times costly than the contractors' unit cost of Rp 5,256/km/day.

Table 1.3-30 Comparison of Costs of Street Sweeping

	Sweeping by Contractors	Sweeping by KMS' Direct Operation
1. Total sweeping length per day	431 km/day	362 km/day
2. Total sweeping length per year (Item 1 x 365 days/year)	157,315 km/day	132,130 km/day
3. Total cost per year	Rp 926,796,000/year	Rp 1,544,815,000/year
4. Unit cost/km/day (3 + 2)	Rp 5,256/km/day (100)	Rp 11,692/km/day (222)

Note: Figures in parenthesis are indices with the unit cost of contractors being 100.

3.8 Incineration and Other Intermediate Treatment

3.8.1 General

It was in 1986 that KMS started seriously considering the introduction of an incinerator.

In July 1989, KMS signed the contract with P.T. Unicomindo for the construction and operation of the incinerator after obtaining an approval from both the governor of the East Java Provincial Government and the Minister of Home Affairs. The contract is based on BOT (Build, Operate, and Transfer) system. This is the first incinerator constructed for municipal solid waste in Indonesia. KMS's stated reason for the introduction of an incinerator was the difficulty in land acquisition for final disposal sites.

The construction took about 1.5 years. The operation of the incineration plant commenced in June 1991.

The plant has 6 furnaces with the total design capacity 200 ton/day (33.6 ton/day/furnace x 6 furnaces). It is Cadoux Inc., a French company which manufactured and supplied the plant under a separate contract with P.T. Unicomindo.

According to the contract between KMS and P.T. Unicomindo, KMS will pay a total of approx. US$ 18.6 million to the P.T. Unicomindo during the period 1989/90 - 1998/99, of which US$ 13.1 million is the construction cost of the incineration plant, and the remaining US$ 5.5 million is the amount of interest to be paid.

There are 92 employees involved in the operation and maintenance of the incinerator, of which 16 persons are from KMS Cleansing Department, and the remaining 76 are from P.T. Unicomindo (as of June 1992).

The incineration plant is a continuous combustion type with stoker furnaces. It has pits and cranes for waste feeding.

3.8.2 Performance and Evaluation

1) Operation

The operation of the incinerator started in June 1991. The performance record is available from August 1991, and summarized in the table below. The average daily incineration amount was 147 tons/day, 73% of the design rated capacity.

Table 1.3-31 Operation Record of Keputih Incinerator (Aug. 1991 - Jan. 1992)

No.		Aug. '91	Sep '91	Oct '91	Nov '91	Dec '91	Jan '92	Average
1.	Incineration Amount (ton/month)	2,921	5,358	5,769	5,619	4,100	3,235	4,500
2.	Daily Average (ton/day)	94	178	186	187	132	104	147 ton/day
3.	Hourly Average per operating furnace (ton/hour/furnace)	1.70	1.79	1.54	1.48	1.00	0.93	1.41
4.	Monthly Fuel Consumption (liter/month)	47,079	70,287	59,406	57,460	95,909	73,240	67,230
5.	Unit Fuel Cost (Rp/liter)	292	292	292	292	292	292	292
6.	Fuel Cost (Million Rp/ month) (4 x 5)	13.7	20.5	17.3	16.8	28	21.4	19.6
7.	Unit Consumption per ton of Waste Incineration (liter/ton) (4/1)	16.1	13.1	10.3	10.2	23.4	22.6	15.95
8.	Fuel Cost per ton of Waste Incineration (Rp/ton) (6/1)	4,690	3,830	3,000	2,990	6,830	6,620	4,660
								Operation Rate (%)
9.	Number of Operation Days (day/month)							
	- Furnace 1	14	27	31	30	30	24	85
	- Furnace 2	17	26	17	24	30	24	75
	- Furnace 3	18	17	31	30	30	24	82
	- Furnace 4	11	28	31	28	31	23	83
	- Furnace 5	11	20	30	27	19	26	83
	- Furnace 6	0	7	16	20	30	25	53
	TOTAL	71	125	156	159	170	146	75
10.	Rate of Operation (calculated from Item 9)	38.2%	69.4%	83.9%	89.0	91.5	78.5%	74.9%

Combustion Temperature

Until September 1991, the combustion temperature was set at 500°C, it was then increased to 600°C since October 1991. Actual variation of the temperature is ± 30°C over the set temperature. In April 1992, the combustion temperature was reset to 800 °C to avoid the corrosion of the grates due to the low temperature.

Incineration Ash

The incineration ash amounts to about 10 % of the incoming waste. A 15% of the incineration ash is the organic matter according to the Report "Investigation of Air, Water, and Land Pollution from the Waste Incineration Plant in Surabaya" issued by the Cleansing Department in 1991.

3.8.3 Cost of Incineration

It is estimated that the annual average cost of the incineration is Rp 4,593 million, and the unit incineration cost is Rp 85,600 per ton assuming that:

1) the operation period would be 15 years, and
2) the average incineration amount will be 53,655 ton/year [(147 ton/day, the average daily incineration amount recorded during Aug. 1991 - Jan. 1992) x 365 days/year]

The breakdown of the costs are shown in the table below.

Table 1.3-32 Cost of Incineration

COST ITEMS	ANNUAL COST	UNIT COST
a. Depreciation and Interest	Rp 2,482 million*1	Rp 46,260/ton
b. Operation	Rp 930 million	Rp 17,330/ton
c. Maintenance	Rp 1,181 million	Rp 22,010/ton
d. Total	Rp 4,593 million	Rp 85,600/ton

*1: Of the 2,482 million, Rp 1,750 million is depreciation cost, the remaining Rp 732 million is interest to be paid.

It is anticipated that the cost Item a. (Depreciation and interest) and Item c. (Maintenance) will increase in the future, in terms of local currency, due to the

continuing appreciation of US dollar against Rupiah. During the past few years, US dollar appreciated 5 % per year on average.

3.8.4 Composting

KMS does not have any intermediate treatment facilities other than the incineration plant.

In Surabaya, a private company called PT Kurnia Pelita, a sister company of Mercu Buana Group used to operate a compost plant in Tandes, north part of Surabaya during the period 1976 - 1986. The company's purpose for construction of the compost plant was to fulfill internal needs of Mercu Buana Group.

The composting business was in good shape for about 4 years from 1979 to 1983 during which the company had a compost-supply-contract with the State Plantation Company. PT Kurnia Pelita produced 40 - 50 tons/day of compost product from 100 ton/day of waste during the period.

In 1986, the State Plantation Company terminated the contract with PT Kurnia Pelita as the Company's need for the compost had been satisfied. It is said that once compost is supplied to a plantation field, the field does not need compost for the next several years. With the termination of the contract, and also upon the satisfaction of internal need, PT Kurnia Pelita was obliged to close its compost plant in 1986. The company's compost plant has never resumed its operation since then.

3.9 Final Disposal

3.9.1 Location

KMS currently uses three final disposal sites (LPAs), in Keputih, Lakarsantri and Kenjeran among which the former two belong to KMS, while the LPA in Kenjeran belong to a private developer. Each LPA receives waste from several Kecamatans as shown in Table 1.3-33.

1) Keputih

Keputih LPA is located on a flat area in the southeastern part of Surabaya, 2 km from the seashore. It is surrounded by ponds on the north, east, and south sides. On the west side there are some water farm lands, a few residential areas and schools. Keputih LPA receives the waste from 12 Kecamatans in the south-eastern part of Surabaya.

2) Lakarsantri

Lakarsantri LPA is located in the gently hilly area in the south-western part of Surabaya surrounded by farm land. There are no residential area within 500 m radius of the LPA. In rainy season, the lower area of the farm land is used as paddy field. Lakarsantri LPA receives waste from 7 Kecamatans in the western part of Surabaya.

3) Kenjeran

Kenjeran LPA is located on a shoaling beach in the north-eastern part of Surabaya. In this LPA the sea side swamp has been reclaimed. There was an on-site road across the mangrove bush growing along the coastal line. The sea bed around the LPA is of silty sand, and runs dry during the ebb tide period. There are several small wharves for coastal fishery and for pleasure in the northward coast. This LPA receives waste from 12 Kecamatans in the eastern part of Surabaya.

Table 1.3-33 Assignment of LPA to each Kecamatan and Approximate Distance

Kecamatan	Distance to LPA (km)		
	Kenjeran	Lakarsantri	Keputih
1. Sukolilo	4	-	3
2. Kenjeran	5	-	10
3. Tambaksari	7	-	15
4. Simokerto	7	-	11
5. Gubeng	13	-	7
6. Rungkut	15	-	11
7. Semampir	11	-	16
8. Pabean Cantikan	12	-	17
9. Bubutan	-	18	-
10. Krembangan	-	24	-
11. Tandes	-	17	-
12. Benowo	-	15	-
13. Lakarsantri	-	2	-
14. Karang Pilang	-	4	-
15. Wonocolo	17	-	14
16. Wonokromo	15	-	12
17. Sawahan	-	22	-
18. Tegalsari	14	-	10
19. Genteng	11	-	14

3.9.2 Disposal Operation

1) Method of Landfill

KMS applies a traditional landfill method of open dumping: the waste has been piled up with no cover soil before the time of completion. The dumping point is not strictly controlled, so the wide area of the LPA is used as working face where the waste is kept exposed for long time. There are no leachate retention pond and leachate treatment facility provided. Scavengers are working in the LPA, and live in or just next to LPA with temporary sheds. Heavy equipments are used for gathering and carrying scattered solid waste to designated places and covering soil for over layer.

2) Inventory of Final Disposal Site (LPA)

The inventory of the LPA is shown below.

Table 1.3-34 Inventory of LPA Facility, Heavy Equipment and Working Hour

		Keputih	Lakarsantri	Kenjeran
Facilities	Entrance gate			√
	Weigh bridges			
	Office (2)	√	√	
	Leachate collection			
	Leachate treatment			
	On site road		√	√
	Fence			
	Embankment			√
Heavy Equipment	Bulldozer	4 (3)	1 (1)	3 (2)
	Soil Compactor	2 (0)	0	0
Working Hours		5:00 AM to 10:00 PM	6:00 AM to 8:00 PM	5:00 AM to 12:00 PM

Note: √ means that the facility is installed.

(1) : use the gate of the neighboring recreation center

(2): not always stationed with persons in charge

(3): Figure in the bracket ( ) indicates the number of operational equipment

(4): Every site is operated 7 days a week

3.9.3 Structure of Final Disposal Site (LPA)

1) Keputih LPA

Landfill operation started in 1982. The LPA is divided into three parts, namely I, II and III. The landfill is executed one by one. The space between the part I and II is used also as landfill site although it belongs to private person(s). Landfill in the part I has already been completed, and this part is covered with sea sand conveyed by pipe lines. At the part I, the thickness of waste was planned to be 2.5 m with the cover soil of 0.4 m thick.

Since the fence or any other barrier is not provided, dumped waste has spilled beyond the boundary. On-site roads are not provided inside the LPA. On the north and west sides, there are paved approach road, however, the road on the west side is damaged too seriously to use it in rainy season. A drain system is connected directly to the neighboring river with no leachate water treatment. The heavy equipment are parked without any shelter on the ground.

2) Lakarsantri

The operation started in 1988. The LPA is divide into two areas A (7.6 ha) and B (0.5 ha), however, the area B has not been used as the landfill site so far. The main landfill area A is divided into two parts by an improved river, and provided with some on-site paved roads. The difference between the lowest part (bottom of the river) and the highest parts(top of the hill) is 14 m. Concrete poles are provided with an interval of 10 m on the boundary and steel wire are provided between the poles, but the wires are broken and wastes are spilled out beyond the boundary in many places. There is no particular drain system, so run-off and leachate water flow into the river that goes down through the site without any treatment. Heavy equipment is not used for the ordinary landfill operation.

3) Kenjeran LPA

The operation started in 1984. The landfill site is surrounded by the breakwater and the dike connected to the seashore. The dike is made of macadam which has a permeable structure. On-site roads are provided just inside the breakwater and dike. The roads are made of sandy soil brought from outside Surabaya city. The Cleansing Department operates heavy equipment on the site. There is no drain system and leachate treatment system, so the run-off and leachate flow directly into the sea without any treatment.

This site was already filled with solid waste by the end of 1992. Consequently, the water surface within the breakwater disappeared and mangrove forest beside the landfill site was entirely cut down.

3.9.4 Particulars of Final Disposal Site (LPA)

Particulars (Size of area, estimated capacity, dumped amount, settled amount and remaining capacity) of existing LPA is shown in Table 1.3-35.

Table 1.3-35 Particulars Existing LPA

	Size of Area (ha)	Assumed Capacity ($x10^3$ m^3)	Cumulative Dumped Amount by the end of 1991 ($x10^3$ m^3)	Cumulative Settled Amount by the end of 1991 ($x10^3$ m^3)	Remaining Capacity at the End of 1991 ($x10^3$ m^3)	Remaining Capacity at the End of 1992 ($x10^3$ m^3)
Keputih	29.6	1,480	5,392	841	-	943
Lakarsantri	7.6	380	1,058	165	-	397
Kenjeran	24	1,200	4,780	746	454	0

3.9.5 Sanitary Condition

1) Keputih and Lakarsantri

In these two landfill sites, the fairly wide area of several hectares are still left uncovered so that many flies proliferate on the surface of waste layer and offensive odor is also generated particularly from recent dumped layers. Odorant substances such as ammonium (NH_3) and hydrogen sulfide (H_2S) were detected at surrounding areas.

The leachate water flows directly into adjacent surface water and affects the water quality. According to the results of chemical analysis of sample water, excessive amount of BOD and colibacillus were found, that indicate the pollution is caused by organic matters, exceeding the ambient water quality standard in East Java. It was also found that the water contains very little dissolved oxygen, and almost no oxygen at the downstream just below the landfill sites. Heavy metal ions, were not detected, therefore the water quality standard for the public water body is satisfied in this regard. Agricultural chemical were not detected either.

In Keputih, a serious pollution by leachate water is observed in certain passage of downstream only: in Pojokan Semampir River, a tributary of the Wonokromo River. The influence of leachate water cannot be discriminated any longer in the Wonokromo River. Along the tributaries of Pojokan Semampir River, there are no residential areas or water intake possibly affected by water pollution.

In Lakarsantri, there is a tributary of the Kedurus River which passes through the landfill site. Some items of water quality show the same pattern as in Keputih, namely, the items of organic pollution show bad conditions whereas the items of non-organic pollution comply with the water quality standard. The water quality of the stream is apparently affected between the landfill site and the downstream about 500 m below. However, at the point about 1km

below the landfill site, no sign of leachate water is found any longer. Along the affected water body, there are no residential areas or water intake possibly affected by water pollution.

Around the downstream area in Keputih, there are no wells used to collect ground water for daily life or other purpose. According to the results of the chemical analysis of the sample water taken from the neighboring wells which belong to the other catchment area, no significant sign of pollution by leachate water was found. In Lakarsantri there are several wells used for daily life around the downstream of the tributary from the landfill site. According to the result of the chemical analysis, no significant sign of pollution by leachate water was found. Originally, the ground water in both sites have such a high salinity that it is not suitable for drinking use. They get their drinking water at the water tap installed in the neighboring community by PDAM(Municipal Water Authority), therefore it is not likely that the landfill site directly affects the health of neighbours.

2) Kenjeran

This landfill site has no facilities for controlling leachate so that the leachate water seep out through permeable stone fence or directly into the sea. The neighboring see bed was colored with this seepage water during rainy season. According to the result of chemical analysis of water sample taken from the sea surface around the landfill site and 200 m off shore, the water seemed to be polluted to a certain extent, however, it was not verified how much the leachate had affected the surrounding sea water quality. Heavy metal ions and other toxic chemicals were not detected or very slight enough to comply the water quality standard.

3.9.6 Costs

The unit disposal cost in 1991 is estimated at about Rp3,300/ton based on the following calculation.

1	Loan interest	Rp.1,800,000,000 x 10.5 %	= Rp. 189,000,000/y
2	Depreciation	Rp.1,800,000,000 / 7 years	= Rp. 257,143,000/y
3	Insurance	Rp.1,800,000,000 x 2 %	= Rp. 36,000,000/y
4	Maintenance cost	Rp.1,800,000,000 x 12.5 %	= Rp. 225,000,000/y
5	Fuel cost	20 liter/hour x 7 hour/day x 365 days x 450 Rp. x 6 unit	= Rp. 137,970,000/y
6	Salary	34 person x 100,000 x 12	= Rp. 40,800,000/y
	Total	Annual cost	Rp. 885,913,000/y

Unit costs can be estimated as shown below by dividing the annual total disposal cost (Rp 885,913,000/year) by the annual total disposal amount (1,705,000 m^3/year or 266,000 t/year assuming the waste density being 0.156 t/m^3).

Unit cost	Rp. 520 /m^3
	Rp. 3,331 /ton

3.10 Vehicles Maintenance and Repair

3.10.1 General

The Cleansing Department has a place in Asemrowo that is used as a workshop for vehicle maintenance and repair, car parking, and storage area for containers, handcarts and abandoned vehicles. The total area is about one (1) ha.

The Workshop sub-section of the Haulage Section of the Cleansing Department is responsible for the management and operation of this place. There are about 39 employees involved in the vehicle maintenance as show below:

Table 1.3-36 Personnel Involved in Vehicle Maintenance and Repair

	Number of Employers
- Workshop Chief mechanic:	1
- Mechanic section (5 group)	16
- Tire man:	2
- Paint	1
- Accessory section	2
- Crease man	1
- Container maintenance	6
- Container repair	2
- Welding	3
- Heavy equipment	2
- Administration	2
Total	39

In addition, Haulage Section has the following two sub-sections:

- Operation sub-section (Drivers assistants supervisors belong to this sub-section)
- Warehouse sub-section

3.10.2 Current Maintenance Conditions

1) Current Practice

In the workshop maintenance services such as changes of engine oil and filter are made once every 7,000 - 10,000 km of the vehicle running though the maintenance has to be done once very 5,000 Km according to the manufactures' guideline. Cleansing Department has no plans for systematic repair and maintenance services.

2) Current Problems

The current problems may be summarized as follows:

a. Lack of regularity and planning in the vehicle maintenance and repair

b. Lack of priority to the maintenance which results in inadequate funds and poor spare parts stock.

c. Existence of many abandoned vehicles (37) in the Workshop area, which causes obstacles to the on-site traffic.

3) Operation and Maintenance Expenditures

The Cleansing Department spent about Rp 790,500,000 for the vehicles operation and maintenance in the fiscal year 1991/92, of which two thirds were used for fuel and oil while the remaining one third only were used for the maintenance and repair.

Table 1.3-37 1991/1992 Expenditures for Maintenance and Repair

Item	Amount	Percent
1. Fuel	Rp. 476,200,000	60.2%
2. Oil	Rp. 47,732,000	6.0%
3. Tire & Battery	Rp. 91,658,000	11.6%
4. Other spare parts	Rp. 104,900,000	13.3%
5. Others	Rp. 65,010,000	8.2%
6. Tax	Rp. 5,000,000	0.6%
Total	Rp. 790,500,000	100.0%

3.11 Resource Recycling

Resource recycling discussed in this section is limited to that related to solid waste management.

3.11.1 Description of Recycling Activities

All the scavengers in Surabaya are subject to registration at the Association of Partners of Yellow Troop (PMPK: Paguyuban Mitra Pasukan Kuning). There are 2,700 to 3,000 registered scavengers engaged in resource recycling in Surabaya in 1991. In addition, there are some unregistered scavengers working in different type of places. In 1989, the number of scavengers who were observed actually operating by the place of work were as shown in Table 1.3-38.

Table 1.3-38 Number of Operating Scavengers (1989)

Place of Collection	Number of Scavenger
Door to Door	591
LPS	316
LPA	331
Total	1,238

Source: Dinas Kebersihan, KMS

According to the interview of scavengers on site, they have the various origins of homeland. Majority of them are immigrants from neighboring cities, and out of 25 scavengers interviewed only five people were from Surabaya, four from Lamongan and another four from Madura, so forth. Scavengers working at the final disposal sites live beside the sites and work fully during the daytime for collection and sorting of the materials.

At the final disposal site (LPA), scavengers collect resource materials from fresh dumped waste and sort them by kinds and quality of materials collected. Dealers come to the site to buy packed materials once a week. Scavenging activities at door-to-door and LPS are usually done in the morning. Many of this type scavengers have another job such as becak (tricycle taxi) driver.

Another group of people involved in the scavenging activity is the garbage collectors employed by RT/RW. They collect garbage from their assigned areas and haul it to Depo and LPS. During their collection and reloading work they pick up recyclable materials from garbage collected. Therefore they have the same function as the registered scavengers in view of resource recovery.

There are many dealers, shops located close to Depo and LPS, where scavengers visits and sell, in cash, recyclable materials collected through door-to-door or at LPS.

Dealers of recycled matter have a hierarchical structure according to size of dealer. Small dealers sell recyclable materials to bigger dealers after sorting and simple processing such as washing. Bigger dealers, then, process the purchased materials in accordance with the requirement of the material brokers or the manufactures who purchase recycled materials from the dealers.

3.11.2 Recycling Market

1) Recycling Materials

Compositions of recycling materials is shown in Table 1.3-39 and Fig. 1.3-13. The composition of materials is a little different by the place of collection. For example, paper shares as much as 30% of recyclable materials in Depo/LPS and door-to-door while paper is not collected at all in LPA. Bone and Rubber are collected only at LPA. Plastics and glass are collected at all scavenging places.

Table 1.3-39 Composition of Recycling Materials

Site / Material	LPA (%)	Depo/LPS and Door to Door (%)
Plastics	27	18
Paper	0	30
Glass	27	38
Metal	12	14
Rubber	23	0
Bone	11	0
Total	100	100

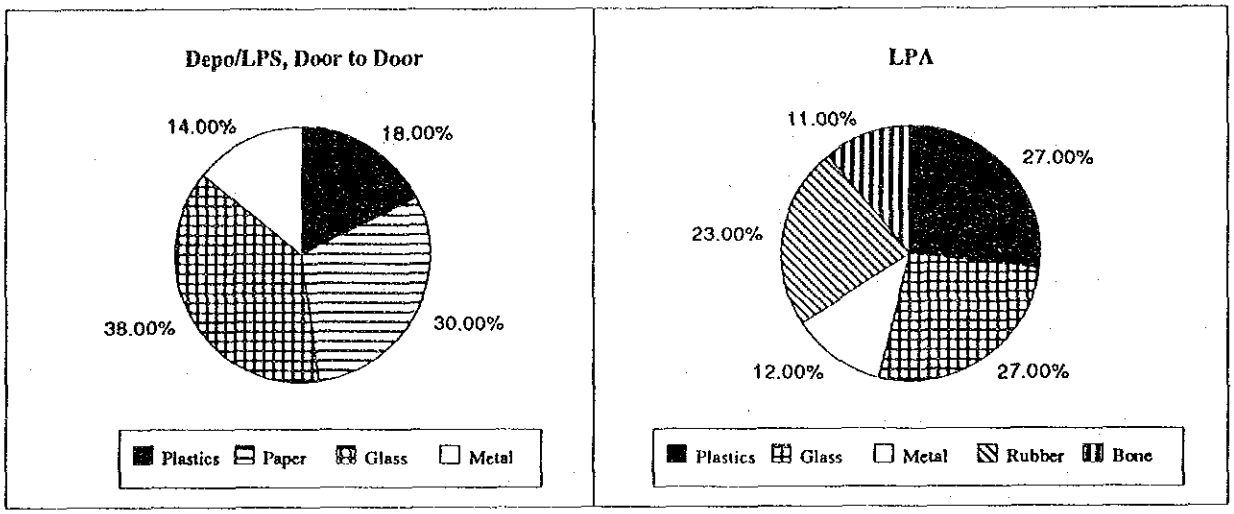

Fig. 1.3-13 Composition of Recycling Material

2) Amount Recovered

It is estimated that the total recyclable amount recovered is about 189 tons/day, which represents about 12% of the estimated total waste amount 1,626 tons/day generated in Surabaya. The amount recovered by scavengers is estimated taking into consideration the activity of both registered and unregistered scavengers as shown below:

Amount Recovered = a + b + c + d
= 9.9 ton/day + 19.0 ton/day + 34.3 ton/day + 125.7 ton/day
= 189 ton/day

Where:

a = Daily amount recovered at LPA = 9.9 ton/day
b = Daily amount recovered at Depo or LPS = 19.0 ton/day
c = Daily amount recovered by door to door = 34.3 ton/day
d = Daily amount collected by the other scavenger = 125.7 ton/day

PART 2.

MASTER PLAN

PART 2 MASTER PLAN

CHAPTER 1 Future Waste Generation and Quality

1.1 Future Waste Generation

Estimation of Waste Quantity in Tonnage

In Surabaya and other cities in Indonesia, waste quantities are expressed in cubic meter (m^3). However, waste quantities expressed in cubic meter are misleading without specifying bulk density of waste, which changes greatly depending on phases of waste flow. Therefore, JICA Study Team has attempted to estimate waste quantity in tonnage based upon the field survey.

The present waste generation amount is estimated at 1,626 ton/day approximately based upon the current survey.

The Study Team assumes that the future waste generation will increase at an annual average rate of 5 % for the period 1992 - 2010 taking into account the past economic growth in Surabaya, the future population, and increases in amounts of waste hauled by KMS during the past several years.

The projected increases (5 % / year) in the future waste generation may be decomposed into two main factors: 1) population increases that is projected at about 1.6 %/year, and 2) per capita waste generation increases that is estimated at about 3.4 %/year on average for the period 1992-2010.

Results of the projection of the future waste amounts are shown in both Table 2.1-2 and Fig. 2.1-1. A Summary is shown below.

Table 2.1-1. The Current and the Future Waste Generation

	Waste Generation Amount Projected	Per Capita Waste Generation
1992	1,626 ton/day (100%)	634 gram/day (100%)
2000	2,402 ton/day (148%)	820 gram/day (129%)
2010	3,913 ton/day (241%)	1,157 gram/day (182%)

The following points have been taken into consideration in making the projection of the future waste amounts.

a. In many cities including Bangkok and Tokyo, the economic growth was the major factor explaining the increases of waste generation during rapid economic growth periods.

b. Surabaya's economic growth in terms of real gross domestic product was as fast as 9.5 % /year during the period 1985-1990. It is considered that the economy of Surabaya will continue to grow fast in the future judging from 1) the past trend, 2) KMS' deregulation and investment promotion policy, and 3) the fact that the GDP per capita in Surabaya is US$ 838/person in 1990 which may imply a great potential for further economic growth.

c. On the other hand, the waste amounts hauled by KMS to LPA increased about 10 % per year on average during 1984-1991. This 10 % annual average increase is explained by two factors: the waste generation increases, and the increases in service coverage which was made possible due to increases in number of trucks and containers. It may be assumed that those two factors had about equal significance (5 % contribution respectively) judging from the past trend in increases of the equipment.

Table 2.1-2 Projection of Future Waste Generation and Population in Surabaya

Year	Waste Generation Amount (ton/day) (A)	Population (B)	Per Capita Waste Generation (gram/person/day) (C) = (A)/(B)
1992	1,626	2,564,000	634
1993	1,707	2,609,500	654
1994	1,793	2,655,000	675
1995	1,882	2,700,500	697
1996	1,976	2,746,000	720
1997	2,075	2,791,500	743
1998	2,179	2,837,000	768
1999	2,288	2,882,500	794
2000	2,402	2,928,000	820
2001	2,522	2,973,500	848
2002	2,649	3,019,000	877
2003	2,781	3,064,500	907
2004	2,920	3,110,000	939
2005	3,066	3,155,500	972
2006	3,219	3,201,000	1,006
2007	3,380	3,246,000	1,041
2008	3,549	3,292,000	1,078
2009	3,727	3,337,500	1,104
2010	3,913	3,383,000	1,160

Note: Waste generation amounts indicated in the above table include not only household waste but commercial, industrial and other municipal waste.

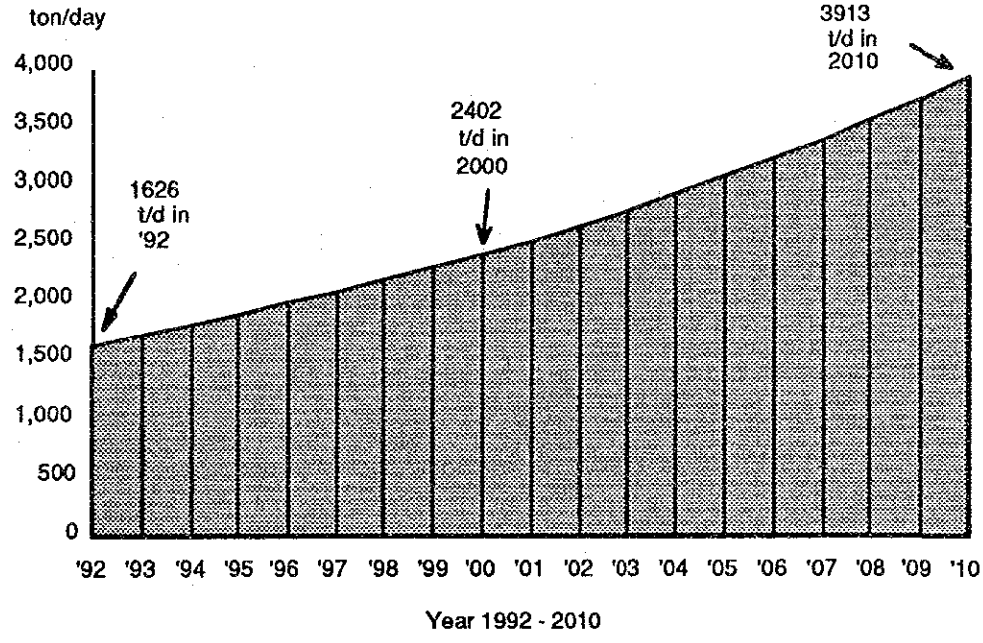

Fig. 2.1-1 Projection of the Future Waste Generation Amount in Surabaya 1992-2010

1.2 Future Waste Quality

The economical growth on affects not only the waste amount also the waste quality. Considering the background of solid waste generation, the future waste quality is projected as shown in the following tables assuming the following tendencies.

1. Paper, plastics, metal and glass contents will be increased.

2. Garbage, wood/grass contents will be decreased relatively.

Table 2.1-3 Projection of Household Waste Composition

(Unit: wt.%)

Classification	Rainy Season			Dry Season		
	1992	2000	2010	1992	2000	2010
Recyclable						
• Paper	12.6	13.3	14.1	12.5	13.1	13.9
• Plastics	7.9	9.0	10.6	7.7	8.8	10.2
• Metal	1.0	1.0	1.1	0.9	1.0	1.0
• Glass	0.9	1.0	1.2	1.1	1.2	1.4
Subtotal	22.4	24.3	26.9	22.2	24.1	26.6
Non-Recyclable						
• Textile	1.8	1.8	1.7	2.0	1.9	1.8
• Wood/Glass	19.6	19.0	18.2	18.0	17.4	16.7
• Garbage	52.3	50.8	48.7	52.0	50.4	48.3
• Other Combustible	0.8	0.8	0.9	0.6	0.6	0.7
• Other Non Combustible	3.2	3.4	3.6	5.3	5.6	5.9
Sub total	77.6	75.7	73.1	77.8	75.9	73.4
TOTAL	100	100	100	100	100	100
Moisture Content	66.1	65.5	64.8	54.7	53.4	52.8
Calorific Value (Kcal/kg)	1,020	1,050	1,090	1,290	1,360	1,410

Table 2.1-4 Projection of Market Waste Composition

(Unit: wt.%)

Classification	Rainy Season			Dry Season		
	1992	2000	2010	1992	2000	2010
Recyclable						
• Paper	5.1	5.5	6.0	2.9	3.1	3.3
• Plastics	2.8	3.2	3.8	2.6	3.0	3.7
• Metal	0.3	0.3	0.3	0.1	0.1	0.1
• Glass	0.2	0.2	0.3	0.0	0.0	0.0
Subtotal	8.4	9.2	10.4	5.6	6.3	7.1
Non-Recyclable						
• Textile	0.3	0.3	0.3	0.4	0.4	0.4
• Wood/Glass	28.7	28.4	28.1	11.1	11.0	10.8
• Garbage	61.9	61.3	60.4	78.5	77.7	76.5
• Other Combustible	0.4	0.4	0.4	0.1	0.1	0.1
• Other Non Combustible	0.3	0.4	0.4	4.3	4.6	5.1
Sub total	91.6	90.8	89.6	94.4	93.7	92.9
TOTAL	100	100	100	100	100	100
Moisture Content	77.2	74.7	74.2	68.5	66.9	66.3
Calorific Value (Kcal/kg)	300	430	450	450	530	560

Table 2.1-5 Projection of Street Waste Composition

(Unit: wt.%)

Classification	Rainy Season			Dry Season		
	1992	2000	2010	1992	2000	2010
Recyclable						
• Paper	12.6	13.3	14.1	9.1	9.6	10.3
• Plastics	7.9	9.0	10.6	4.3	4.9	5.8
• Metal	1.0	1.0	1.1	1.4	1.5	1.6
• Glass	0.9	1.0	1.2	0.4	0.4	0.5
Subtotal	22.4	24.3	26.9	15.2	16.5	18.2
Non-Recyclable						
• Textile	1.8	1.8	1.7	0.1	0.1	0.1
• Wood/Glass	19.6	19.0	18.2	21.1	20.5	19.8
• Garbage	52.3	50.8	48.7	53.1	51.8	50.1
• Other Combustible	0.8	0.8	0.9	0.7	0.8	0.8
• Other Non Combustible	3.2	3.4	3.6	9.8	10.3	11.0
Sub total	77.6	75.7	73.1	84.8	83.5	81.8
TOTAL	100	100	100	100	100	100
Moisture Content	66.1	65.5	64.8	51.8	50.4	49.6
Calorific Value (Kcal/kg)	1,020	1,050	1,090	1,180	1,250	1,290

Chapter 2. Master Plan Goals, Targets, and Benefits

2.1 Master Plan Goals, Targets and Major Means to Achieve the Goals

The purpose of municipal solid waste management is to keep the city clean and sanitary by removing waste from the living areas quickly and dispose of it sanitary in most cost-effective manner.

KMS' solid waste management has remarkably improved during the past few years. Such aspects as the public participation (collection of waste by communities) and the Depo/LPS system, street sweeping in Surabaya are praise-worthy. Yet, there are some other aspects that need some improvements.

The following table shows the KMS' Master Plan goals, targets and major means to achieve the goals.

Table 2.2-1 Master Plan Goals, Targets and Major Means to Achieve the Goals

Master Plan Goals and Targets	Major Means to Achieve Goals
A. DISPOSAL	
1. Introduction of sanitary landfill	1) Construction of a new landfill site in the western part of Surabaya. a. Acquisition of land with an area of about 40 ha in Benowo by 1994. (The location is shown in the front page map.) b. Construction of the 1st phase landfill site by 1996. c. Acquisition of additional land with an area of about 110 ha by 2002. d. Construction of the 2nd phase landfill site by 2004. 2) Construction of a new landfill site in the eastern part of Surabaya. a. Acquisition of land with an areas of about 14 ha in the east by 1995, 31 ha by 1999 and 75 ha by 2005. b. Staged construction of landfill site by 1996, 2000 and 2006.
1.1 Construction of two (2) sanitary landfill sites; one in Benowo, the other in the east part of Surabaya. (Sanitary landfill is the most appropriate disposal method for Surabaya from environmental and economic view points. Two (2) LPA [sanitary landfill] are necessary in order to save haulage costs. Haulage cost with only one (1) LPA in Benowo will be 2.2 times larger than the case with two (2) LPA.)	

1.2 Improvement of existing landfill sites.	3) Acquisition of land adjacent to the site. 4) Installation of facilities for improvement.
B. HAULAGE	
2. Increases of the service coverage	
2.1 Complete elimination of "waste that is collected by RT/RW but not hauled to official LPA" by 2000 through KMS' provision of waste haulage service for all areas where RT/RW collect garbage.	5) Provision of Depo and LPS for all Kelurahan. 6) Provision of small containers where Depo or LPS may not be placed.
2.2 Reduction of non-collected waste from the current 15 % of generated waste to 5 % by 2010.	7) Grant of handcarts to low-income RT/RW.
3. Increases of efficiency of waste haulage	8) Use of more contractors. Haulage of waste from small containers with compactor trucks should be fully contracted out. 9) Use of larger containers (14 m^3). 10) Reduction of crew of arm-roll trucks from the current 2 (1 driver & 1 assistant) to 1 driver by 2000.
4. Upgrading of sanitary conditions of Depo/LPS	11) Rehabilitation of Depo/LPS (provision of drainage, piped water, trees, etc.) 12) Complete containerization of Depo/LPS. (to provide container for all Depo & LPS.)
C. STREET SWEEPING	
5. Increases of the efficiency of street sweeping	13) Reduction of street sweeping frequency wherever possible. 14) More use of contractors.

D. VEHICLE MAINTENANCE	
6. Strengthening of vehicle maintenance	15) Introduction of daily checking of vehicles. 16) Introduction of regular maintenance and repair. 17) Quick procurement of adequate spare parts. 18) Removal of abandoned vehicles and containers from the Asemrowo workshop. 19) Remodeling and improvement of the Asemrowo workshop. 20) Construction of a new garage, in the new East LPA, with facilities for car washing and minor repairs.
E. INSTITUTION	
7. Saving of SWM Costs	
7.1 Shift of waste haulage responsibility from KMS to generators of large waste amount (2.5 m^3 or more each day). The target is to increase share of the self-haulage from the current 8 % to 25 % of the total waste generation amount by 2000, which corresponds to nearly all waste of large amount waste generators.	21) To make necessary legal arrangements. 22) To apply the law, at first, to major waste generators including the Market (Pasar) Authority.
7.2 Use of more contractors. The policy is that KMS will keep the amount of waste to be hauled by KMS' direct operation at the current level (621 ton/day), and contractors should haul all the remaining and incremental waste in the future. As a result, the rate of usage of contractors will increase to the current 30% to about 75% by 2010 in terms of rate of waste amount hauled by contractors relative to total waste hauled by KMS and contractors.	23) Increases in the rates of contract price. 24) Application of longer contract period - at least one (1) year. 25) To use waste weight-based contract, which would provide contractors with incentive to haul more waste. 26) To make contractors responsible for provision of small containers as well, which would lead to increases in placement of containers and service coverage under the arrangement shown in Item 25 above. 27) To sell or lease KMS' used vehicles if accepted by contractors.

8. Improvement of fee revenue	28) Increases of the sanitary retribution rates. 29) Use of PLN' (electric company) tariff collection points. 30) Application of volume-based fee rates to business waste.
9. Institutional Strengthening 9.1 Privatization	31) Establishment of an independent cleansing authority (Perusahaan Daerah Kebersihan Surabaya).
9.2 Reorganization	32) Formation of a Disposal Section responsible for planning and operation of waste disposal.
F. WASTE AMOUNT REDUCTION	
10. Control of waste generation	33) Promotion for the reduction of weight of agricultural products coming into markets by such means as removing nutshell of agricultural products before transportation
11. Resources recycling	34) Supports of scavengers. The target is to increase the waste recycling amounts so that it will be constant at 11 % in terms of share to the total waste generation in Surabaya.
G. INCINERATION	
12. Improvement of the operation and facilities of the existing incinerator.	35) To select more suitable waste, and take measures to keep waste drier in the pit. 36) To install air-preheater to promote drying process of waste in the furnace.
13. Effective use of the incinerator	37) Use of the incinerator for incineration of medical waste (already implemented).

2.2 Expected Benefits Deriving from the Implementation of the Master Plan

Expected benefits deriving from the successful implementation of the master plan is *summarized below.*

1. Continued obtainment of Adipura Award, which would contribute to increases of the citizens' pride and the social coherence.

2. Achievement of higher standard of environmental sanitation and cleanliness in the city of Surabaya through the improvement of the KMS' capacity and means of the solid waste management (collection, haulage, disposal).

   a. Increases of coverage of solid waste management (SWM) service through the procurement of adequate trucks, containers and handcarts, and also through the construction of additional Depo and LPS. As a result, waste neither recycled nor properly disposed would decrease from the current 31 % of the total waste generation amount to 10 % in 2000, and 5 % in 2010.

   b. Reduction of negative environmental impacts on the citizens living around Depo or LPS through rehabilitation of Depo and LPS and containerization of Depo and LPS.

   c. Improvement of waste disposal standard from the current open dumping to the sanitary landfill, which would contribute to the substantial reduction of the following risks.

      (1) Pollution of water body with waste leachate
      (2) Pollution of surrounding area with waste
      (3) Diffusion of offensive odor

3. SWM Cost Savings

It is estimated that the implementation of the master plan will bring about Rp 42.3 billion (Rp 2,352 million/year on average) during the master plan period 1993 - 2010 as shown in the table below.

Table 2.2-2 Means to Save SWM Costs and Expected Amount of Saving

Means to Save SWM Costs	Amount of Cost to be Saved during the Master Plan Period	Remarks
1. Shift of the waste haulage responsibility from KMS to those that generate waste of 2.5 m^3 or more each day. [The target is to increase the waste to be hauled by waste generators from the current 8 % to 25 % of the total waste generation by 2000.]	Rp 19.0 billion (Rp 1,055 million/year on average)	Unit average cost of haulage of waste from Depo/LPS (Rp 7,000/ton) x cumulative incremental waste to be hauled by waste generators under this policy during the master plan period (2,719,162 ton) = Rp 19.0 billion
2. More use of contractors for waste haulage [The target is to increase the use of contractors from the current 30 % to 73 % by 2010 in terms of waste haulage amount.]	Rp 13.5 billion (Rp 750 million /year on ave-rage)	Average unit saving or cost difference between contractors and KMS' direct haulage cost (Rp 4,811/ton) x cumulative incremental waste to be hauled by contractors under the policy of more use of contractors during the master plan (2,814,697 ton) = Rp 13.5 billion
3. Use of larger containers (8 m^3 & 14 m^3) and compatible trucks instead of the existing smaller containers (6 m^3, 10 m^3, 12 m^3).	Rp 2.2 billion (Rp 124 million/year on average)	Average unit cost difference between the planed equipment and the existing one (Rp 700/ton) x cumulative waste to be from Depo/LPS during the master plan period by KMS' own equipment) (3,179,880 ton) = Rp 2.2 billion
4. More use of contractors for street sweeping Target is to reduce KMS' direct street sweeping to about 25 % from the current 50 % in terms of sweeping length of road side and berm (not street length)	Rp 7.6 billion (Rp 423 million/ year on average)	Average cost saving or difference between KMS' direct operation and contractors (Rp 6,436/km /day) x Sweeping length to be contracted out (180 km/day x 365 days/year) x 18 years = Rp 7.6 billion
	Rp 42.3 billion (Rp 2,352 million/year on average)	

4. Net Fee Revenue Increases

The net fee revenue will increase by about 10 %/year on average in real term through the implementation of 1) increases of rates of the sanitary retribution, 2) introduction of new collection method with the use of PLN tariff collection points as points of collection of the sanitary retribution, 3) gradual application of volume-based rates of the sanitary retribution to business establishments that discharge less than 2.5 m^3 per day.

Chapter 3. Plan for Collection, Haulage and Street Sweeping

3.1 Policy and Targets

3.1.1 Responsibility for Solid Waste Management

1) General

Municipal solid waste management consists of such activities as waste collection, haulage, treatment and disposal, and street sweeping. It is proposed that responsible bodies for respective activities will be as shown below.

Table 2.3-1 SWM Activities and Responsible Bodies

Solid Waste Management Activities	Responsible Bodies
1. Collection & Transfer to Depo/LPS	
1.1 Waste of large amount (2.5 m^3 or more each day) - Collection & direct haulage to LPA	Waste generators
1.2 Hospital waste	KMS
1.3 Household and all other waste	Local communities (RT/RW)
2. Haulage from Depo/LPS to LPA	
2.1 Haulage of large amount waste (2.5 m^3 or more each day)	Waste generators
2.2 All other waste	KMS
3. Treatment and Disposal	KMS

2) Waste Collection

Like many other cities of Indonesia, local communities (RT/RW), in Surabaya, is responsible for collection of waste, and transfer to Depo or LPS. In principle, unless socio-economic conditions of Surabaya changes substantially, this system should be maintained in the future in view of the following advantages:

(1) People can choose level of collection service suitable to their needs and financial capacity.

(2) Beneficiary Pay Principle (BPP) can be best realized.

(3) The local people can supervise waste activities of collection workers.

(4) In addition, it is easy for RT/RW to cope with increases in waste discharge volume, for example, by increasing the number of Pasukan Kuning (collection workers), handcarts, etc.

(5) Waste collection services of RT/RW create the employment opportunity for many people.

The current waste collection is carried out by using workers and handcarts. In the future, however, it might be more feasible to use capital intensive methods (trucks) owning to the future upgrading of the economic standard. In such case, it might be difficult for each local community to manage the waste collection because the collection with trucks require technical know-how in the selection, operation and maintenance of trucks. It may be more suitable for KMS to take over the responsibility of waste collection.

3) Shift of Waste Haulage Responsibility from KMS to Generators of Large Waste Amount (2.5 m^3 or more per day)

As KMS official agreed, it is planned that KMS will shift the waste haulage responsibility to generators of large waste amount in the future due to the reasons stated below.

1. KMS can save costs. (Over Rp 1 billion/year, See Table 2.2-2)
2. The planned shift of responsibility conforms to the Beneficiary Pay Principle (BPP)
3. The planned shift will provide the waste generators with incentives for reducing waste generation, which is environmentally advisable.

It is advised for KMS to gradually apply this shift. It is planned that 25 % of the total waste generated in Surabaya will be collected and hauled by waste generators themselves by the year 2000.

More details on the shift of responsibility is shown in Part 2 Section 7.2 of this report.

3.1.2 Target Service Level

At present, 58 % of the waste generated in Surabaya is collected, is collected and hauled to official LPA. 11 % is recycled. In other words, 69 % of the waste generated in Surabaya is either recycled or properly managed.

Table 2.3-2 Target Level of Waste Collection and Haulage

Unit: Ton/day

Year	Waste to be Collected & Hauled to Official LPA by either KMS or Waste Generators (1)	Waste to be Recycled through Waste Pickers before being Hauled to LPA (2)	Waste either Recycled to Properly Managed (1) + (2) = (3)	Waste to be Generated (4)
1992	936 t/d (58 %)	180 t/d (11 %)	1,116 t/d (69 %)	1,626 t/d (100 %)
1995	1,244 t/d (66 %)	207 t/d (11 %)	1,451 t/d (77 %)	1,882 t/d (100 %)
2000	1,906 t/d (79 %)	264 t/d (11 %)	2,170 t/d (90 %)	2,402 t/d (100 %)
2010	3,270 t/d (84 %)	430 t/d (11 %)	3,700 t/d (95 %)	3,913 t/d (100 %)

Note: Figures in parenthesis show percentages to total waste generation.

It is planned that KMS will increase the service level of collection, haulage, and disposal so that waste to be either recycled or properly managed will increase as follows: 77 % in 1995, 90 % in 2000, and 95 % in 2010 as shown in the table above.

Waste Recycling through Waste Pickers

Waste to be recycled will maintain the same percentage as the current 11 %, which means recycled waste will increase in amounts.

The target level 95 % (either recycled or properly managed) in 2010 is very high as compared to the current 69 %. In order to achieve the target, much efforts will be needed on the part of both KMS and citizens.

Reduction of Illegal Dumping and Non-Collection

It is necessary to reduce the illegal dumping and non-collection to achieve the target service level. Target reduction as expressed by KMS officials is shown in the following table.

Table 2.3-3 Target Reduction of Illegal Dumping and Non-Collection

Unit: ton/day

Year	Illegally Dumped Waste (1)	Non-Collection (2)	Total (Waste Not Properly Managed) (1) + (2) = (3)
1992	261 t/d (16 %)	249 t/d (15 %)	510 t/d (31 %)
1995	188 t/d (10 %)	240 t/d (13 %)	428 t/d (23 %)
2000	0 t/d (0 %)	225 t/d (9 %)	225 t/d (9 %)
2010	0 t/d (0 %)	196 t/d (5 %)	196 t/d (5 %)

Note: Figures in parenthesis show percentages to total waste generation.

Target Service Level in terms of Population

According to the information given by Kelurahan and Kecamatan offices, 81 % of the population in Surabaya receive waste collection and haulage services at present. The target coverage in terms of population will gradually increase, and it will reach 90 % in 2000, and 95 % in 2010.

3.1.3 Use of Contractors (Contracting-Out)

At present, KMS uses 5 contractors for haulage of waste. They haul 30 % of the total amount of waste hauled under the responsibility of KMS. As KMS officials agreed, it is planned that KMS will increase the use of contractors in view of the following benefits.

1. KMS can save substantial costs (It is estimated that cost of using contractors is two thirds of the cost of KMS' direct operation.)
2. Technological development can possibly be promoted by using contractors.
3. Coverage of waste collection and haulage can be expanded if an appropriate contract method is applied.

Target rate of contracting-out is 38 % in 1995, 53 % in 2000, and 73 % in 2010.

Type of Haulage Service Contracted-Out

It is also planned that KMS will concentrate on the haulage of a constant amount of waste (621 ton/day on average) from Depo and LPS in the future, while contractors

will haul all the remaining and incremental waste from Depo and LPS in addition to all waste from small containers placed on roadsides. Refer to Part 2 Section 7.3 for more explanation on the contracting-out.

Based upon the above-explained policy and targets, the future waste amount to be recycled, collected and hauled are shown in the following table and figure.

Table 2.3-4 Waste Amount to be Generated, Recycled and Hauled (Average Throughout Year)

(ton/day)

Year	Waste to be Gene-rated	Waste That May not be Colle-cted	To be Recycled before being hauled to LPA	To be Collected by RT/RW but Disposed at Unidenti-fied Places	To be Collected and Hauled by Waste Generators	To be Hauled under KMS' Respon-sibility	To be Hauled by KMS' Trucks	To be Hauled by KMS' Cont-ractors
	(1)	(2)	(3)	(4)	(5)	(6)=(1)-(2)-(3)-(4)-(5)	(7)	(8)=(6)-(7)
1992	1,626	249	180	171	137	889	621	268
1993	1,707	246	188	146	202	925	621	304
1994	1,793	243	197	121	267	965	621	344
1995	1,882	240	207	96	332	1,007	621	386
1996	1,976	237	217	71	397	1,054	621	433
1997	2,075	234	228	46	462	1,105	621	484
1998	2,179	231	240	21	527	1,160	621	539
1999	2,288	228	252	0	572	1,236	621	615
2000	2,402	225	264	0	601	1,312	621	691
2001	2,522	222	277	0	631	1,392	621	771
2002	2,649	219	291	0	662	1,477	621	856
2003	2,781	216	306	0	695	1,564	621	943
2004	2,920	213	321	0	730	1,656	621	1,035
2005	3,066	210	337	0	767	1,752	621	1,131
2006	3,219	207	354	0	805	1,853	621	1,232
2007	3,380	204	372	0	845	1,959	621	1,338
2008	3,549	201	390	0	887	2,071	621	1,450
2009	3,727	198	410	0	932	2,187	621	1,566
2010	3,913	195	430	0	978	2,310	621	1,689

Note: Of the waste amount hauled by KMS and the generators (shown in columns (5) & (6) respectively), it is projected that 90 ton/day is hauled to unofficial LPA in Asemrowo till 1999.

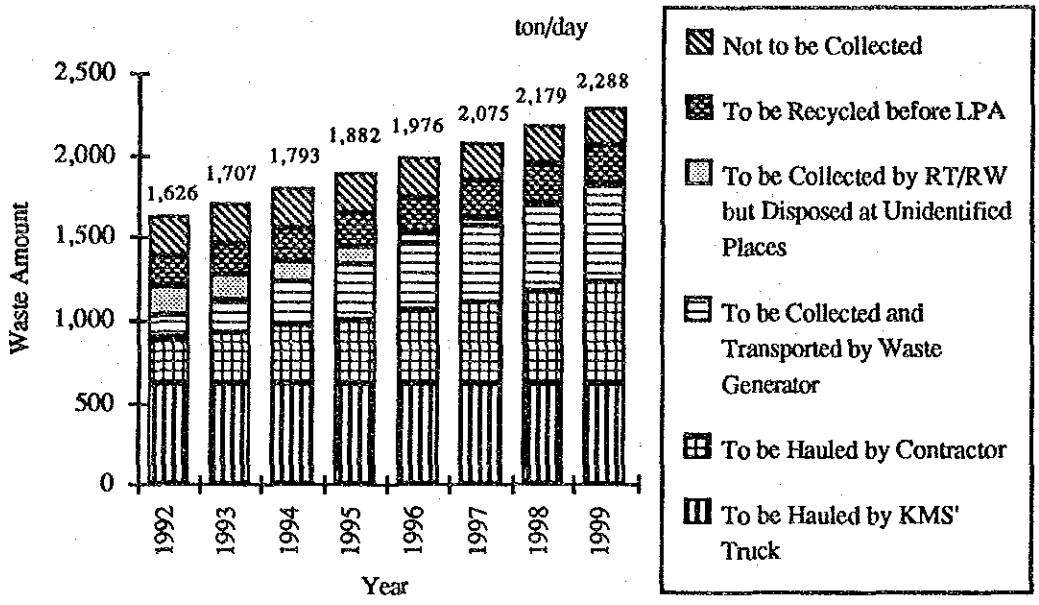

Fig. 2.3-1 Future Amount of Waste to be Generated, Recycled, and Hauled

3.2 Measures to Achieve the Targets

Targets and measures to achieve the target can be summarized as shown below.

Table 2.3-5 Targets and Measures to Achieve the Targets

Targets	Measures to Achieve the Targets
1. Increases of service coverage	
1.1 Complete elimination of illegal dumping by 2000.	1) Provision of Depo and LPS for all Kelurahan. 2) Provision of small containers where Depo or LPS cannot be constructed.
1.2 Reduction of non-collected waste from the current 15 % to 5 % by 2010.	3) Grant of handcarts to low-income RT/RW.

2. Increases of efficiency of waste collection	4) Discouragement of use of concrete bins as they are both inefficient and unsanitary. 5) Encouragement of use of plastic bins as they are more sanitary and easier for workers to handle.
3. Increases of efficiency of waste haulage	6) Use of more contractors 7) Use of containers of larger sizes (14 m^3 & 8 m^3) 10) Construction of LPA in the east part of Surabaya.
4. Upgrading of sanitary conditions of Depo and LPS	11) Rehabilitation of Depo and LPS (Provision of drainage, piped water, trees, etc.) 12) Elimination of open dumping practice in Depo/LPS through the complete containerization of Depo/LPS (to provide containers for all Depo & LPS).

3.3 Equipment

3.3.1 Criteria for Selection of Equipment

Appropriate types, capacity and quantity of respective equipment should be selected considering the following aspects:

1. Cost-effectiveness
2. Safety
3. Relevant road regulations

3.3.2 Recommended Equipment

Recommended equipment is summarized below.

Table 2.3-6 Recommended Equipment

	Containers	Trucks
1. Haulage of waste from Depo and LPS	a. 8 m^3 containers (closed type)* b. 14 m^3 containers (closed type)*	a. 7 GVW arm-roll trucks with single rear axle for 8 m^3 containers b. 14 GVW arm-roll trucks with single rear axle for 14 m^3 containers
2. Haulage of special waste (bulky waste, river waste, trees cut, etc.)	None	c. Dump trucks
3. Haulage of waste from small containers placed on roadsides	KMS will not purchase containers and trucks for this type of haulage. This type of haulage service will be fully contracted out. (With respect to type of trucks for this type of haulage, JICA Study Team recommend 14 m^3 REL with 14 GVW chassis unless FEL trucks prove to be good through a test operation.)	

* Open type containers are recommended for markets to make it easier for workers to put waste into containers.

Necessary quantity, procurement costs, and reasons for recommendation of the above-shown- equipment are provided in Part 3 Chapter 2 of this report.

3.4 Construction and Rehabilitation of Depo and LPS

3.4.1 Construction of New Depo and LPS

In order to increase the service coverage of collection and haulage, new Depo and LPS should be constructed. In principle, each Kelurahan should be provided with either a Depo or LPS.

3.4.2 Rehabilitation of the Existing Depo and LPS

Some of the existing Depo and LPS need rehabilitation. It is expected that Depo and LPS will be more sanitary through the provision of piped water, drainage, wall, and trees, etc., and will be more acceptable to the residents.

3.4.3 Plan for Construction and Rehabilitation of Depo and LPS

A complete feasibility study was carried out by JICA Study Team. Results of the study are shown in Part 3 Chapter 4 of this report. The period of the construction and rehabilitation will be 4 years from 1994/94 through 1997/98. Number of Depo and LPS to be constructed or rehabilitated are shown below.

Table 2.3-7 Number of Depo and LPS to be Constructed or Rehabilitated during the SUDP Period

	Depo (1)	LPS (2)	Total (1)+(2)=(3)
1. Construction of New Depo and LPS	24	12	36
2. Rehabilitation of the Existing Depo and LPS	30	34	64

3.5 Necessity for Construction of LPA in the East Part of Surabaya

It is strongly recommended that KMS should construct LPA not only in Benowo (west part of Surabaya) but also in the east part of Surabaya in order to save the future costs of waste haulage.

3.5.1 Definition of Two Cases

In order to know the waste haulage cost difference between with and without LPA in the east part of Surabaya, a comparative study was made for the following two cases:

Case A: 2 LPA are available: one in the west (Benowo) and the other in the east part of Surabaya.

Case B: Only one LPA is available in the west (Benowo)

3.5.2 Results of the Comparison

A summary of the comparison is shown in the following table:

Table 2.3-8 Summary of the Comparison of the Two Cases

	Case A	Case B	Difference between the 2 Cases
1. Average Trips to be made per truck per day	7.7 trips/truck/d	3.4 trips/truck/d	4.2 trips/truck/d
2. Estimated Average Unit Haulage Cost per Ton	Rp 10,000/ton	Rp 22,000/ton	Rp 12,000
3. Annual Average Haulage Cost throughout Years 1992 -2010	Rp 5,355 million	Rp11,780 million	Rp 6,425 million
4. Cost Index (Case A=100)	100	220	120

Notes:

1. The average trips shown in the table are the grand average trips of container (arm-roll) trucks collecting from each parts of Surabaya (east, west, center, north and south). The average trips were obtained from the field survey conducted by JICA Study Team, of which results are shown in the following table:

Sub-Districts	Average Daily Trips to be made under Case A	Average Daily Trips to be Made under Case B	Percentages of Waste Haulage Amount
1. Center	7.8 trips/truck/d	3.8 trips/truck/d	20.9 %
2 North	4.9 trips/truck/d	3.8 trips/truck/d	17.6 %
3 East	11.4 trips/truck/d	2.8 trips/truck/d	30.1 %
4 south	6.0 trips/truck/d	3.5 trips/truck/d	23.8 %
5 West	4.7 trips/truck/d	4.7 trips/truck/d	7.6 %
Weighted Average	7.7 trips/truck/d	3.5 trips/truck/d	(Total) 100 %

2. It is assumed that the average unit haulage cost per ton (Item 2) is inversely proportional to the average number of trips (Item 1). This assumption is appropriate because the unit cost of haulage per ton per truck is inversely proportional to amount of waste hauled per truck, which in turn is proportional to number of trips made per truck.

3. The average unit haulage cost (Rp 10,000/ton) is estimated on the base of weighted average of 1) the existing KMS' grand average cost (Rp 12,000/ton) of haulage with arm-roll trucks and compactor trucks, and 2) the estimated corresponding average cost of the future contractors (Rp 8,000/ton) assuming further that ratio of waste haulage of KMS and contractors is 50 to 50.

4. Annual average haulage costs (Item 4) are estimated by using future annual average waste amount to be hauled under KMS' responsibility during 1992 - 2010.(Average 1,467 ton/day x 365 days/year = 535,455 ton/year).

3.5.3 Conclusion

As can be seen from the table above, Case B with one LPA in Benowo is 2.2 times costlier than the Case A. Annual average cost difference (KMS' expected saving by having LPA in the east part of Surabaya) is estimated to be Rp 6,425 million/year on average throughout the years 1992 -2010. Such difference is too large to ignore.

Furthermore, due to the future development in the east part of Surabaya, it is expected that the waste generation amount will increase faster in the east part of Surabaya than in the rest of Surabaya. Then, the real cost difference in the future may be even greater than the estimated Rp 6,425 million.

According to KMS officials, a land use plan is already determined for the east part of Surabaya. Development priority of different sectors should be carefully determined. In doing so, it should be noted that land after completion of landfill can be used for residential, commercial, industrial and other purposes, while it is difficult to reverse the development process (use land for non-swm purposes at first, and later use it for landfill purpose).

It is very strongly recommended that KMS should make all efforts to obtain a land in the east part of Surabaya, and construct a LPA before the existing LPA in Keputih is closed, which will happen in 1997 at the latest.

3.6 Plan for Street Sweeping

A reason for Surabaya to win the Adipura Award many times in the past may be the well swept streets. KMS spends about 25 % of its cleansing budget for the street sweeping. KMS provides 4 times a day sweeping service for busy and important roads.

The issue regarding the street sweeping is how KMS will reduce sweeping costs without lowering the current cleanliness of the streets. It is proposed that KMS should implement the following things to reduce the costs of street sweeping.

1. Increases in the use of contractors

   It is estimated that the cost of using sweeping contractors is less than a half of the cost of sweeping by KMS' workers.

2. Reduction of sweeping frequency from four times a day to a less frequent level.

   Most of the street waste are sand and leaves of trees, which are harmless in terms of sight, odor and sanitation. It is advised that KMS will examine the sweeping frequency of each street to identify streets where KMS can possibly reduce sweeping frequency without much affecting the cleanliness of streets.

3. No more purchase of mechanical sweepers

   Mechanical sweepers are very expensive both in terms of purchase and operational costs. They collect mostly sand. No more purchase of mechanical sweepers is advised.

Chapter 4. Treatment and Disposal Plan

4.1 Policy for Treatment and Disposal

4.1.1 Type of Waste to be Disposed

At the final disposal sites, KMS will accept continuously the same type of waste as covered by present operation. Concerning the management of the other type of waste, the following understandings are taken into consideration as a basis of future disposal plan.

1) Hazardous Industrial Waste

Toxic and hazardous waste are planned to be treated by the facility which will be constructed according to a national project "Centralized Hazardous and Toxic Waste Treatment Facility in GKS Region". The scope of the project covers the planning period from 1993 to 2013, therefore the disposal of this type of waste can be entrusted to the facility and be out of the responsibility of KMS.

2) Ash from Incinerator

The existing incineration plant in Keputih generates ash every day, which corresponds to about 10% of incinerated raw waste in weight . The ash is now removed to the dumping site (1.2 ha) adjacent to the incineration plant. The dumping site was originally a swampy area, and its capacity is estimated at about 5 years by the time the area becomes solid flat land with its level same as that of the plant yard.

After having exhausted the capacity of the present ash dump site, the ash would be disposed at the final disposal site, however, it can be used as cover material. It is not a waste that requires treatment because it contains fewer organic matter and moderate porosity, which meet technical requirements of cover material.

3) Sludge from Human Waste Treatment

The human waste treatment plant in Keputih generates the sludge of 2 ton/day from the purification process and some sand from the bottom of the primary sedimentation pond. These sludge and sand, after drying process are dumped at the open and wet area inside the plant yard at present.

The present internal dump site is neither environmentally sound nor sufficient in capacity. Though the amount of the sludge and sand is small, they should be properly disposed. At least they should not be dumped at wet places.

4) Sludge from Public Service Sectors Other than the Cleansing Dept. of KMS

Public service authorities such as Municipal Water Company (PDAM), Brantas Project Office and Kanwil Dinas PU generate sludge as a result of their activities. These authorities are responsible for disposal of their waste. It is understood that those authorities will continue to be responsible for disposal of their waste.

5) Hospital Waste

Cleansing Department of KMS commenced special collection service for major hospitals was started in May 1992. The Cleansing Dept. has prepared special containers for storage of hospital waste. The Department collects the waste from hospitals and haul to the incineration plant directly. The incineration temperature has been recently raised to around 800°C, in order to make the waste harmless.

It is however advisable for KMS to make further improvement on the management of hospital waste. For instance, it is desirous to develop a special containers with shield structure to prevent hospital waste contacting with people and environment.

4.1.2 Methods of Disposal

1) Alternative Methods

It is considered that the following three alternative methods are worth studying their applicability as a major means of waste disposal in Surabaya.

Alternative 1. Sanitary landfill
Alternative 2. Sea reclamation
Alternative 3. Incineration

Composting is considered not feasible as a major means of waste disposal in Surabaya judging from the fact that a private company which once constructed and operated a compost plant in Surabaya had to stop its operation due to the insufficient demand for the compost. Refer to PART 1, Chapter 3.8.4 for the explanation of the composting in Surabaya.

2) Criteria for Selection of Appropriate Disposal Alternatives

The most appropriate disposal alternative is one which can achieve the purpose (to dispose of solid waste in environmentally-sound manner) at the least cost. Environmental-soundness and costs are two key factors (criteria) that have to be considered in the selection of appropriate disposal methods.

3) Evaluation of the Disposal Alternatives

The following table shows the unit costs of the three disposal alternatives as well as the results of the evaluation.

Table 2.4-1 Unit Costs and Evaluation of the Disposal Alternatives

	ALT. 1 Sanitary Landfill	ALT. 2 Sea Reclamation	ALT. 3 Incineration
1. Land cost (Rp/ton)	3,300	0	0
2. Construction (Rp/ton)	7,930	15,500	50,200
3. Operation/maintenance (Rp/ton)	4,330	4,620	56,830
4. Total (1+ 2 + 3) (Rp/ton)	15,560	20,120	107,030
5. Land Value Created (Rp/ton)	6,600	3,300	0
6. Net Cost (4 - 5) (Rp/ton)	8,960	16,820	107,030
7. Cost Index (ALT.1 = 1)	1	2	12
8. Cost Evaluation	A	B	D
9. Environmental Soundness	A	B	A
10. Overall Evaluation	A	B	C

Notes: 1. The breakdown of the above-estimated costs are shown in the Supporting Report I.

2. The grades are explained in the table below:

GRADES	COST	ENVIRONMENTAL SOUNDNESS
A	Low cost	Sound
B	Reasonable	Need further assessment before making a decision
C	Costly	Risky
D	Very costly	Not sound

3. Major facilities included in the above-shown alternatives are as follows:

ALTERNATIVES	MAJOR FACILITIES EQUIPPED
ALT.1 Sanitary Landfill	Water proof lining, Leachate collection facility, Rain water drainage, Leachate treatment pond, Gas ventilation facility, Embankments, Fence, Cover soil
ALT.2 Sea Reclamation	It is assumed that reclamation area will be 300 m off the coasts to protect mangrove. In addition to all the facilities of ALT.1, chemical treatment facilities, access roads will be provided.
ALT.3 Incineration	Continuous combustion type with stoker furnaces, pits and cranes for waste feeding, electric precipitator, etc. No power generating facilities. (It is estimated that the over all cost of incineration with electric generators is 3 times more costly than those without electric generators even taking into account the benefits of power generation.)

As a result of the evaluation of the disposal alternatives from both environmental and economic view points, they are evaluated as follows:

- Most Appropriate Alternative:	Alt. 1 Sanitary Landfill
- Second Best Alternative:	Alt. 2 Sea Reclamation
- Third Best Alternative:	Alt. 3 Incineration

Respective alternatives are commented as follows:

Alt. 1 Sanitary Landfill

From both environmental and economic view point, this alternative is the most appropriate for Surabaya. The biggest problem with the sanitary landfill is that it may not be easy for KMS to acquire land. However, it should be noted that there are about 5,300 ha of fish ponds and salt fields in Surabaya, which might possibly be used as future LPA, while the total land area neede for the implementation of 100 % sanitary landfill is 270 ha in total by the year 2010, a 5 % of the potential area.

Land acquisition cost can be recovered some time after the completion of the landfill by converting the completed site into public parks or housing or industrial areas or other purposes. The value of the completed land may be even higher than the initial acquisition cost depending on the purposes of the land use. A suggestive example is the KMS' Lakarsantri LPA which is coming near to its completion. KMS plans to exchange the land (7.6 ha) of Lakarsantri LPA with the land (40 ha) in Benowo which KMS plans to use as a future LPA. A private developer has a plan to use the completed area of Lakarsantri LPA for the housing development. If the planned exchange comes true, it would indicate that the land value of the completed area (7.6 ha) of Lakarsantri LPA is equivalent to that of the land in Benowo (40 ha) which is 5.5 times larger than the Lakarsantri LPA. For the estimation of the net cost of the sanitary landfill (Alt.1), it is modestly assumed that the value of the land of a LPA would be two times higher after the completion of sanitary landfill than the value of the land (fish ponds or salt fields) before the commencement of sanitary landfill.

In the estimation of costs of sanitary landfill, the land acquisition cost is assumed to be Rp 23,000/ m^2. It is calculated that even if the future land value would be zero, the cost of sanitary landfill would exceed that of incineration only if the land acquisition cost exceed Rp 667,700/m^2, which is about 29 times higher than the assumed land price of Rp 23,000/m^2. In reality, however, the value of the land after the completion of sanitary landfill is higher than the initial acquisition cost. All these indicate that it is

advisable for KMS to acquire land even at a price much higher than the market price though KMS does not have to spend more than necessary.

Alt. 2 Sea Reclamation

This method is applied in many cities in the world which have difficulty in the land acquisition. The environmental pollution can be minimized by taking appropriate measures such as construction of embankments and leachate treatment facilities. Like the sanitary landfill, reclaimed areas can be used for recreational or industrial purposes.

It is anticipated, however, that it would be difficult for KMS to apply a sea reclamation for waste disposal in the near future considering the current situation where the existing sea reclamation practiced in Kenjeran has been causing the sea water pollution, and affecting the people engaged in the fishery, who have been complaining about the situation. It may be difficult for KMS to convince the citizens to accept the construction of a new sea reclamation before improving the current situation in Kenjeran by taking some appropriate pollution control measures although a new sea reclamation would be equipped with appropriate facilities to prevent the sea water pollution.

Alt. 3 Incineration

The incineration method can be highly evaluated from environmental view point. However, this method is extremely costly; 50 times more costly than the sanitary landfill method, and 6.5 times more costly than the sea reclamation. The necessity for the use of incineration method entirely depends on the availability of land for sanitary landfill or seashore for the sea reclamation.

4) Conclusion

a. KMS should apply sanitary landfill as a major means of waste disposal provided that land is available for sanitary landfill.

b. The availability of land largely depends of the amount of KMS's land acquisition efforts. In many cases, the availability also importantly depends of acquisition prices or amounts of compensation offered to people who would be affected.

c. If the land acquisition proved impossible, KMS should seriously consider the application of the sea reclamation method, before jumping into the incineration option.

d. The incineration option is the last option which KMS may inevitably have to choose if neither the sanitary landfill nor sea reclamation are applicable due to the difficulty in the acquisition of land or seashore areas. It should be noted that the use of costly incinerators, under the KMS's limited budget, may affect the speed and degree of the development and improvements of other sectors and services.

e. Policy for Renewal of the Existing Incinerator in Surabaya

As has been discussed, the cost of incineration is extremely high relative to the cost of other disposal methods such as sanitary landfill. As a matter of fact, the existing incinerator is a financial burden to the city of Surabaya. The incinerators may not be justified economic-rational view point - particularly in short run.

However, it is also true that the necessity for incinerators will increase as the land available for sanitary landfill will be less and less in the future. The past experience in Japan and other countries shows that it would take ten years or more for countries to modify incinerators so as to suit them to the local conditions. It also takes time to train manpower needed for the operation and maintenance of incinerators. It cannot be expected that any municipality would operate incinerators effectively and efficiently right after the introduction of them.

In this sense, it is considered that the existing incinerator of Surabaya serves as a sort of pilot incinerator for Indonesia. the experience gained through the operation of the existing incinerator is useful not only for Surabaya but also for Indonesia in making future improvements on the incinerators to better suit to Indonesian conditions, and also in deciding the future policy and plan for incineration and disposal at both central and municipal government level.

Because the experience of Surabaya in the incineration can be shared by the country as a whole, it might be rational for the central government to provide KMS with subsidies

for the incinerator though it is entirely up to the policy of the Indonesian government how much priority be given to the gaining of such experience.

Whether or not KMS should renew the existing incinerator in the future depends on the availability of the central government's financial support. Renewal of the incinerator in the future without obtaining financial supports from the central government would impose abnormally large financial burdens on KMS, which would affect appropriate resource allocation among sectors that need development funds.

5) *Disposal Options*

a. Background

As discussed in the previous sections 1) to 4), the sanitary landfill is the best for KMS as a major disposal method if land is available.

Through the discussions with KMS officials, JICA Study Team strongly recommended that KMS should construct two (2) LPA: one in Benowo, west part of Surabaya, and the other in the east part of Surabaya.

KMS expressed that 1) it is likely that KMS will construct a LPA in Benowo, 2) KMS however may not be able to construct a LPA in the east part of Surabaya as it is difficult for KMS to acquire necessary land there.

Considering this situation, and based upon KMS' request, this Section presents and evaluate some disposal options that may be available for KMS.

b. Five (5) Disposal Options

The following five (5) disposal options can be considered. (All the options have a LPA in Benowo.)

Five (5) Disposal Options

Option 1. 2 LPA are available, i.e., one in Benowo, the other in the east part of Surabaya.

Option 2. 2 LPA are available, i.e., one in Benowo, and the other (sea reclamation) in the east part of Surabaya.

Option 3. 1 LPA in Benowo, and Incinerators in the east part of Surabaya (Keputih) are available.

Option 4. 1 LPA in Benowo, and further expansion of the Benowo LPA are available.

Option 5. 2 LPA are available, i.e., one in Benowo, the other in the neighboring cities such as Sidoarjo or Gresik.

(The order of the above options follows the preference of KMS officials.)

c. Evaluation of the Disposal Options

The five disposal options are evaluated as shown in the table below.

Table 2.4-2 Comparison of Unit Haulage and Disposal Costs of the Five (5) Options

Unit: Rupiah per ton

Disposal Options	Unit Haulage Cost (1)	Unit Disposal Cost (2)	Total Unit Cost (1) + (2) = (3)	Low Cost Ranking (4)
1. Opt. 1 (1 LPA in Benowo & 1 LPA in the east)	10,000	5,730	15,730 (100)	1
2. Opt. 2 (1 LPA in Benowo & Sea Reclamation in the East)	10,000	11,025	21,025 (134)	2
3. Opt. 3 (1 LPA in Benowo & Incinerators in Keputih)	10,000	56,380	66,380 (422)	5
4. Opt. 4 (1 LPA in Benowo & further Expansion of it)	22,000	5,730	27,730 (176)	3
5. Opt. 5 (1 LPA in Benowo & 1 LPA outside Surabaya)	30,000	5,730	35,730 (227)	4

Note: Figures in parenthesis ( ) show cost indices with the cost of Option 1 being 100.

Major Assumptions Used for the Cost Estimation

1. 50 % of waste will be hauled to and disposed at LPA in Benowo, and the remaining 50 % will be hauled to and disposed at other place and by other means as indicated in each option.

2. Waste will be hauled by arm-roll trucks and large containers from Depo and LPS. (Refer to Part 2 Section 3.6 Table 2.3-8 for assumptions used for estimation of costs of haulage.)

d. Comments

The following comments can be made.

1. Option 1 is the most recommendable. However, if it is not possible for KMS to choose Option 1, Option 2 (one LPA in Benowo, and the other (sea reclamation) in the east part) is the second best.

2. Option 2 is followed by Option 4 (LPA in Benowo and further expansion of Benowo LPA), which is then followed by Option 5 (1 LPA in Benowo, and the other outside Surabaya).

3. Option 3 (with Incinerators in Keputih) is the most expensive, and the least recommendable.