

2.10 Economic and Financial Aspects

2.10.1 Recent Macro Economic Conditions

According to the *Economic Survey, 1997* lately published, inflation rate rose from 1.6% to 9.0% in 1995/96. It is largely due to upward price adjustment of petroleum products, rapid money supply and gradual extension of Value Added Tax (VAT) on consumer goods and services.

On the other hand, the estimated real Gross Domestic Product (GDP) growth in 1995/96 shows 4.6%. This figure is below the projection (5.5%) and revised one of 1994/95 (4.8%) and is mainly due to inadequate rainfall, causing slower agricultural performance, increasing prices, high cost of domestic credit, power rationing, and a more competitive trading environment brought about by macro-economic reform measures. In spite of those mentioned above, most economic sectors still recorded a steady growth.

2.10.2 Financial Conditions of NCC

The financial reports of NCC including the *Nairobi City Council Statement of Accounts, Nairobi City Council Estimates* for the last several years and other data as well as interview surveys with related staff of the City Treasurer's Office illustrate the following financial conditions of NCC, which exclude the Water and Sewerage Department because it has a separate account. (K£ 1 = Kshs. 20)

The total revenues of NCC were K£ 53 million (Kshs 1,060 million) in 1991/92, K£ 68 million (Kshs 1,360 million) in 1992/93, K£ 98 million (Kshs 1,960 million) in 1993/94 and K£ 108 million (Kshs 2,160 million) in 1994/95, while the total expenditures were K£ 71 million (Kshs 1,420 million), K£ 108 million (Kshs 2,160 million), K£ 69 million (Kshs 1,380 million) and K£ 118 million (Kshs 2,360 million), respectively.

NCC services are financed from NCC's General Fund and the Services Charge Account. These financial sources are as tabulated in Table 2.10-1. The budget of the Water and Sewage Department is separate from other Departments. NCC services cannot be financed legally by subsidies from the central government (as of October 1997).

Table 2.10-1 Revenue Sources of NCC Budget

NCC Budget Accounts	Revenue Sources	Usage
General Fund	Taxes and charges/fees	Operation of ordinary services (excluding Water and Sewage)
Services Charge	Tax on business operations	Capital expenditure (up to 50% can be used for ordinary services)

The overriding constraint of NCC services is the financing of costs of services. After salaries are paid, however, income is not enough to finance other expenditures, namely costs for NCC services including SWM, except in 1993/94. Shares of salaries (excluding benefits) in the total revenue were 50.2% in 1991/92, 42.0% in 1992/93, 26.6% in 193/94 and 41.3% in 1994/95. (See Table 2.10-2.)

Table 2.10-2 Financial Constraint of NCC

(Unit: K£)

Item	1991/92	1992/93	1993/94	1994/95
Income				
(1) Income from Services	16,169,343	22,633,586	24,732,276	42,099,696
(2) Rates	30,780,764	37,745,764	50,148,642	56,126,041
(3) Applied from Service Charge Account	6,175,237	5,134,331	8,098,956	7,558,134
(4) Other Income	159,239	2,505,296	15,075,012	2,298,171
(5) Income Total	53,284,583	68,018,977	98,054,886	108,082,042
Expenditure				
(6) Salaries	26,745,026	28,568,581	26,039,651	44,642,605
(7) Other Expenditure	43,955,023	79,387,937	42,619,152	73,072,812
(8) Expenditure Total	70,700,049	107,956,518	68,658,803	117,715,417
(9) Surplus/Deficit of the Year, (5)-(8)	-17,415,466	-39,937,541	29,396,083	-9,633,375
(10) Income after Salary Payment, (5)-(6)	26,539,557	39,450,396	72,015,235	63,439,437

Note: Benefits are not included in (6); Provision for bad debts is not included in (7).

Source: NCC

Salaries and wages increased by 71.4% in 1994/95 because new salary scales were implemented. Furthermore, it was announced that another new salary scale will be implement in 1997. It is expected that the budgetary deficit will increase much further without any reduction of other budgetary items or number of employees of NCC.

The General Fund Revenue Account accumulated a deficit of K£ 108 million in 1994/95, resulting in deficit increase by K£ 41 million from the previous year. Out of this deficit increase, K£ 29 million is attributed to the provision for arrears on the implementation of the new salary scale. NCC is de facto insolvent.

2.10.3 Financial Condition of the Cleansing Section

(1) Budget

The budget of the Cleansing Section, which is in charge of the solid waste management, consists of the following four accounts: Administration, Conservancy, Refuse Removal and Cleaning-General. Total expenditure (Actual) was K£ 6.5 million (Kshs 130 million) in 1991/92, K£ 6.7 million (Kshs 134 million) in 1992/93, K£ 6.9 million (Kshs 138 million) in 1993/94, K£ 11.2 million (Kshs 224 million) in 1994/95. The expenditure of the Cleansing Section had not been reduced even if the total NCC budget was shrunk. The shares of the Cleansing Section in the NCC is around 10% except in 1992/93. (See Table 2.10-3 and Figure 2.10-1.)

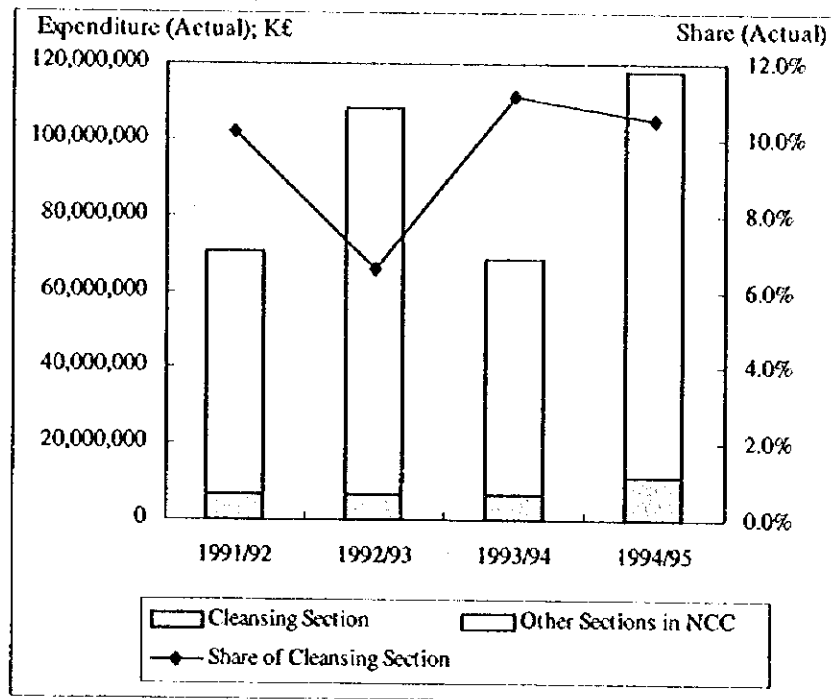


Figure 2.10-1 Budget of the Cleansing Section

Table 2.10-3 Budget of the Cleansing Section

	1991/92		1992/93		1993/94		1994/95	
	Approved Est.	Actual	Approved Est.	Actual	Approved Est.	Actual	Approved Est.	Actual
	Unit: K£							
Gross Expense for Operation and Maintenance								
Administration	748,010	861,163	858,450	938,822	5,206,900	5,074,904	1,330,800	4,166,958
Conservancy	18,080	24,761	20,690	61,683	30,290	3,794	74,600	18,023
Refuse Removal	1,899,800	1,290,603	1,788,100	775,708	1,646,500	841,883	1,117,200	1,261,960
Cleaning-General	3,896,850	4,372,497	4,124,300	4,902,879	425,300	966,390	6,419,800	5,744,496
Total	6,552,740	6,549,024	6,791,540	6,679,092	7,308,990	6,886,971	8,942,400	11,191,437
Less Income								
Administration	-16,000	-9,548	-16,000	129,760	0	-6,352	-130,000	-5,023
Conservancy	-13,000	32	-13,000	0	-13,000	0	0	0
Refuse Removal	-1,350,000	-1,339,992	-2,655,000	-3,572,645	-3,000,000	-1,570,130	-3,600,000	-1,596,574
Cleaning-General	-115,000	-89,516	-118,000	-65,876	0	-59,550	-70,000	-47,089
Total	-1,494,000	-1,439,024	-2,802,000	-3,508,761	-3,013,000	-1,636,032	-3,800,000	-1,648,686
Net Expense	5,058,740	5,110,000	3,989,540	3,170,331	4,295,990	5,250,939	5,142,400	9,542,751

Source: NCC

Capital expenditures are financed from the Services Charge Account. (See Table 2.10-4.)

Table 2.10-4 Capital Expenditures of the Cleansing Section

Year	Financed (K£)
1991/92	1,249,500
1992/93	997,400
1993/94	2,983,000
1994/95	70,000

Source: NCC

Concerning refuse removal, the expenditure (Actual) was K£ 1.29 million (Kshs 25.8 million) in 1991/92, K£ 0.78 million (Kshs 15.6 million) in 1992/93, K£ 0.84 million (Kshs 16.8 million) in 1993/94, and K£ 1.26 million (Kshs 25.2 million) in 1994/95. The expenditure for refuse removal was reduced in 1992/93 and increased since then, but it has not been restored to the 1992/93 level.

The refuse removal account in the Cleansing Section shows a net profit from 1992/93 on actual basis although the amount is decreasing (see Table 2.10-6). It should be noted, however, that the running expense for refuse vehicles was not realised fully until 1993/94 and a major part of supplies, services and equipment items were not realised. This may be due to expenditure estimates compiled with inadequate revenue estimate.

(2) Revenue from Refuse Removal

Revenue is categorised into two: those paid directly to NCC including tipping charges and those paid through the water bills. (See Table 2.10-5 for the details of containers and tariffs.

Table 2.10-5 Containers and Tariffs Managed by NCC (as of October 1997)

Charges	Volume	Tariff Approved	Tariff Enforced	Number	Description
Dustbin	70 litres			288,189	
Domestic					
Hire		40 Kshs/month	40 Kshs/month		
Refuse Removal		280 Kshs/month	10 Kshs/month		
Commercial	70 litres				
Hire		40 Kshs/month	20 Kshs/month		
Refuse Removal		420 Kshs/month	15 Kshs/month		
Standard Container	1 m ³			427	commercial centre, small industries
Hire		1,680 Kshs/month	200 Kshs/month		
Refuse Removal		2,240 Kshs/month	200 Kshs/month		
Bulk Container	9-11 m ³			87	factories, markets, hospitals
Hire (max 4 loads)		5,600 Kshs/month	600 Kshs/month		
Excess Load		2,800 Kshs/load	500 Kshs/load		
Tipping Charges					
Pickup		140 Kshs/load	30 Kshs/load		
Lorry		280 Kshs/load	30 Kshs/load		

Source: NCC

Table 2.10-6 Revenue and Expenditure on Refuse Removal

	1991/92		1992/93		1993/94		1994/95	
	Approved Estimate (K€)	Actual (K€) Realized	Approved Estimate (K€)	Actual (K€) Realized	Approved Estimate (K€)	Actual (K€) Realized	Approved Estimate (K€)	Actual (K€) Realized
Employees	335,700	339,032	332,800	282,613	0	0	370,700	364,956
Wages		100.99%		87.92%				98.45%
Running Expenses	0	0	0	0	0	0	0	0
Premises	0	0	1,000	0	0	0	2,000	0
New Tip	0	0	0	0	0	0	1,000	0
Maintenance of Roads	1,000	0	0	0	0	0	0	0
Supplies, Services and Equipment	1,000	6,005	1,000	0	2,000	0	3,000	3,155
Maintenance of Bin Containers	1,000	0	1,000	0	1,000	0	1,500	0
Bin Helix	210,000	148,697	150,000	9,818	200,000	371,355	150,000	359,819
Dust Bins	1,500	0	1,500	0	3,000	0	2,000	0
Refuse Slips	35,000	0	35,000	0	40,000	0	50,000	0
Bulk Containers	1,000	0	1,000	0	2,000	4,060	3,500	0
Litter Boxes	101,000	3,291	50,000	0	50,000	1,121	50,000	0
Stores	35,000	0	35,500	0	40,000	0	40,000	0
Uniforms	100	250	300	0	500	0	500	0
Fire Charges		250.00%		0.00%				0.00%
Transport	6,000	0	10,000	7,951	20,000	1,358	20,000	235
Other Transport - Pool	3,000	2,451	3,000	0	10,000	0	15,000	0
Tractor Shovels and Bulldozers	930,000	477,743	935,000	259,167	1,000,000	293,636	200,000	405,659
Refuse Vehicles - Running Expenses		51.37%		27.72%				202.35%
Establishment Expenses etc.	4,500	42,200	7,000	40,237	7,000	6,838	42,000	29,898
Insurances	224,000	270,934	224,000	165,922	271,000	163,515	186,000	98,038
Debt Charges	0	0	0	0	0	0	0	0
Revenue Court Capt. Outlay	1,889,800	1,290,603	1,788,100	775,708	1,646,500	841,883	1,117,200	1,261,960
TOTAL EXPENDITURE		68.29%		43.38%				51.15%
Less Income	-1,350,000	-1,359,992	-2,655,000	-3,572,645	-3,000,000	-1,570,130	-3,600,000	-1,596,574
Refuse Removal		98.26%		134.56%				44.35%
NET EXPENDITURE	539,800	-49,389	-866,900	-2,796,937	-1,353,500	-728,247	-2,482,800	-334,614
		-9.15%		322.64%				13.48%

Source : NCC

2.10.4 Charging System for Solid Waste Collection

The solid waste collection services provided by NCC are charged in the same bills as the water related tariff. Water charges, sewerage charges, other water related charges and solid waste (dust bin) charges collected are pooled in the Water Fund. The total billing amount is Kshs 100 - 120 million per month.

All the money collected under the water bills are at first pooled into the Water Fund. Then, dust bin charges are transferred to the refuse removal account in the General Fund at the end of the fiscal year.

The biggest problem of the computerised collection system is its being over-age. It was set up in 1970 when the number of accounts was only around 40,000. The number has increased to 200,000, exceeding the capacity of the computer system. Thus, the system sometimes fail. In addition, data are input manually. Since January 1997, no new account has been added to the data file. A new computerised billing system will start in June, 1998 with the assistance of the World Bank. This new system will continue the billing of waste collection.

2.10.5 Evaluation of Financial Conditions and Budgetary System of NCC

- (1) Revenues of NCC are absolutely insufficient for appropriate services to the people. The reason is that the registration/collection system of taxes and charges is inadequate. Inappropriate services in turn force NCC to get in trouble with the collection of enough revenue for appropriate services.
- (2) In spite of the above circumstances, the water and sewage billing system is comparatively successful with assistance from the World Bank.
- (3) The General Fund Revenue Account of NCC accumulated a deficit to K£ 108 million in 1994/95, which amounts to almost the same as the revenue in the same year. This is because the budgetary management procedure of NCC is not based on the actual cash inflow. Realised revenues are much lower than estimated revenues.
- (4) The share of the budget of the Cleansing Section is around 10% and lower than those of other cities in developing countries. For example, Bangkok, Thailand: 15.3%, Surabaya, Indonesia: 16.7%, Penang City, Malaysia: 24.7%. In addition, enough budget is not allocated periodically for the maintenance of vehicles/equipment.

2.11 Public Education and Social Considerations

2.11.1 Present Condition of Public Education and Awareness

Strict resource constraints currently prevent any NCC department (including the Department of Environment) from taking the initiative with respect to the promotion of solid waste management (SWM) education and awareness. The significant issues on the present condition of public education and awareness are as follows:

- (1) Neither the Cleansing Department nor the newly created Department of Environment has any proposal or policy towards the promotion of public education and awareness with respect to solid waste management.
- (2) There appears to be a general lack of awareness about the scale of solid waste management problems facing the city and, particularly, about the possible ways of addressing them.
- (3) It is felt that the NCC would itself benefit from being targeted by such an awareness promotion programme, and this study recommends the introduction of a programme of measures to inform elected council officers and staff about these issues.
- (4) The Public Relations Section is responsible for all public relations activities of NCC. No programme has been initiated recently by the NCC to improve public education and awareness of domestic solid waste management issues, and there are no proposals for any at the present time.
- (5) The Department of City Education follows the national curriculum, leading to a Kenyan Certificate of Primary Education (KCPC). The curriculum leaves little opportunity for introducing new subject areas such as environmental protection and awareness, although these issues are covered generally within the syllabus.
- (6) The Department of Social Services and Housing has a family welfare function which could be used to promote awareness of solid waste management issues, although staff shortages and funding constraints again would prevent this under current conditions.

Nevertheless, a number of groups are actively involved in the process of improving public awareness of SWM and related issues by Nairobi citizens. Mobilising the resources of these groups is considered to be of the highest priority if workable solutions are to be found to address the waste management problems of the city. Public education and awareness promotion should be designed to complement and reinforce the activities of these groups.

Although waste management has been seen as a responsibility of the NCC, it is now recognised that NCC does not have the capacity to do this without public assistance. The Council is aware of this, and is supportive of participatory arrangements to address the city's problems.

Groups which are involved to a greater or lesser extent in issues relating to SWM include:

- (a) Non-governmental organisations (NGOs)
- (b) Community-based voluntary organisations (CBOs)
- (c) Other voluntary groups
- (d) Private sector waste collectors
- (e) The Clean and Green Towns Award Group

2.11.2 Public Awareness Survey

A Public Awareness Survey was undertaken specifically to understand and ascertain the following:

- (a) Citizens' attitudes of and awareness towards SWM;
- (b) The level of citizens' satisfaction with current SWM services;
- (c) Citizens' affordability and willingness-to-pay for these services;
- (d) The SWM needs of citizens; and
- (e) Citizens' approach to removing, recycling and re-using solid waste.

The detail of survey results is described in **Supporting Report Section K**. Some important findings of the survey are summarised in **Table 2.11-1**.

Average household size in the formal (high, middle and low income) areas are found to be approximately double those in the surrounding areas. Ownership of TVs and radios is common in all areas, but very few households in low income or surrounding areas own a refrigerator.

Almost 50% of respondents reported having received advice on the safe handling of domestic wastes (70% in the surrounding areas), and all areas reported a high level of awareness of the risks involved. There was a high level of interest in participating in activities to improve sanitary conditions.

A plastic bucket is the principal means of storing waste in the house, the next most common being a plastic bag. The housekeeper is mainly responsible for disposing of waste in upper and middle-income households, and the housewife in low income and surrounding areas.

One-third of respondents reported not having a communal container or collection point, and another third reported the closest point is further than 30 metres from the house. The communal collection point is the most common place of disposal, with disposal of waste around the premises being the next. The main reason for this is the lack of a designated disposal point.

A significant majority of residents in high and middle income areas reported having a collection service, this commonly being provided by the private sector in high income areas and by the NCC in middle income areas. However, a significant majority of residents in low income and surrounding areas reported not having a collection service, and a high level of dissatisfaction was expressed by those having a service.

Indicative average costs paid for services are about Kshs. 520 per month in high income areas and Kshs. 250 per month in middle income areas. Given that the legal requirement is for all households to pay Kshs. 10 per month to the NCC, these figures presumably reflect the additional costs incurred in using private contractors.

The average cost reported by low income areas of Kshs. 80 per month is difficult to reconcile with the obligation to pay the statutory charge of Kshs. 10 only and that residents in these areas do not use privately provided services to any great extent.

Almost 50% of residents would be satisfied with collection from a common discharge point and the neighbourhood kept clean. Another 50% would prefer a door-to-door collection service. More than 50% of all areas expressed a willingness-to-pay for improved services. Although there was high variability among the groups, the average willingness to pay was Kshs. 400/month in high income areas, Kshs. 350 in medium income areas and Kshs. 106 in low income areas.

Residents in surrounding areas were not prepared to comment on the amount they would be willing to pay. A possible explanation for this is that these people can be extremely poor with little capacity to pay for formally provided services. The dynamics of these communities are also complex - driven largely by the pressures of poverty - and it is for this reason that NGOs and CBOs working with the communities have adopted integrated approaches to improving the overall quality of life of the residents. As mentioned above, single-issue objectives are unlikely to meet with any success in these areas.

A very high proportion of residents was aware of recycling, although there was some reluctance to separate kitchen wastes, particularly in low income areas. A possible reason for this is the small amount of space available to keep more than one container. Almost 50% of residents reported having a collector call about once a week, this figure being almost 80% in low income areas.

Table 2.11-1 General Findings of the Public Awareness Survey

Item	High Income Area		Medium Income Area		Low Income Area		Surrounding Areas	
Existence of waste collection service	Yes: 74%	No: 26%	Yes: 84%	No: 16%	Yes: 25%	No: 75%	Yes: 26%	No: 74%
Collection by: - NCC - private company	27%	73%	83%	17%	64%	36%	-	-
Satisfaction with the waste collection service	Yes: 76%	No: 24%	Yes: 78%	No: 22%	Yes: 39%	No: 61%	-	-
Willingness to pay for improved services	Yes: 53%	No: 47%	Yes: 59%	No: 41%	Yes: 58%	No: 42%	Yes: 67%	No: 33%
Point of waste disposal from the house: - own bin - communal collection - around the premises - other	48%	10%	16%	58%	13%	55%	6%	56%
Person dealing with the waste: - housekeeper - wife - head of household - child - other	85%	6%	30%	13%	9%	43%	15%	46%
Sweeping of road shoulder	Good: 85%	Poor: 15%	Good: 60%	Poor: 40%	Good: 37%	Poor: 63%	Good: 29%	Poor: 71%
Cleanliness of the drains	Good: 85%	Poor: 15%	Good: 61%	Poor: 39%	Good: 37%	Poor: 63%	Good: 48%	Poor: 52%
Awareness of health risks from solid waste	Yes: 31%	No: 69%	Yes: 89%	No: 11%	Yes: 86%	No: 14%	Yes: 69%	No: 31%

2.11.3 Social Aspects of Scavenging

(1) Existing Policies and Plans of the NCC

Discussions with representatives of the NCC revealed that the Council currently has no specific policies towards the control and management of the scavenging community, especially the large community based at the Dandora dumpsite, and has no plans for addressing the issue specifically in the future.

It is also clear that the Council has little awareness of the important role played by the scavenging community in the materials recycling industry. This is understandable - given the lack of documented information on the significance of scavenging to the economic well-being of a large number of households in Nairobi - but it could lead to the introduction of inappropriate policies if not modified. In particular, it is considered unrealistic to talk about the elimination of scavengers from Nairobi since scavenging is an economic response to poverty, and will therefore be part of the economic and social fabric of Nairobi for many years to come.

(2) Physical Inspection of Scavenging Sites

A number of inspections were made to scavenging sites, both within the city centre and at the Dandora dumpsite. There was evidence of disease, poverty, malnutrition and hunger in the communities visited. The Dandora Scavenger Survey, described below, found the average income of 80% of survey respondents to be K.shs. 120/day.

There are significant socio-cultural differences between different groups within the scavenging community. There are three distinct groups:

- (a) Those who collect directly from households, moving from door-to-door either on foot, with a wheeled cart or bicycle, and normally specialising in the collection of a particular material;
- (b) Those operating at the main (Dandora) dump site, where the scavenging community is characterised by social organisation and strict entry conditions - groups also tend to specialise in the collection of specific materials; and
- (c) Those operating at unofficial dump sites located throughout Nairobi City and at designated sites (including school waste disposal areas) - these groups tend to be non-specific in the types of material collected.

As has been established in the public awareness survey, most of the population is aware of recycling, and almost 50% of households surveyed reported recycling collectors coming to their premises. This was particularly the case in low income areas which reported a very high incidence of (mainly weekly) visits.

These collectors represent an important component of the materials recycling industry in Nairobi and, to the extent that they reduce demand on public collection and disposal services, are a valuable community resource. The NCC

and the public generally need to be made more aware of the important role played by these people, and the public should be encouraged to participate more in their activities by separating waste products for recycling and preventing them from becoming contaminated.

There is, understandably, concern by members of the community about groups of scavengers located in central city areas. This reflects concern about health and the overall quality of life. Groups of scavengers send uncomfortable signals to other city users. However, not only is this a response to poverty - which characterises all those at this level in the recycling industry - it is also a response to the failure of the NCC to provide effective waste collection services in public areas of the city.

In a city which cannot provide effective waste collection and disposal services, scavenging not only provides an important source of income - directly and indirectly - for many, it also provides a de facto waste collection and disposal service. Although the actual volumes of waste utilised through re-use, recycling or composting are not reliably known, the amounts involved are clearly significant relative to the total amount of waste generated.

Scavenging is an inevitable response to economic conditions in Nairobi which provides a valuable service to the community through:

- (a) generating incomes (to the scavengers themselves, to those involved in the materials recycling industry, and to those who benefit from the incomes spent by these groups); and
- (b) providing a de facto waste collection and disposal service.

2.11.4 Evaluation of Public Education and Social Considerations

(1) Communications Strategy

The NCC itself seems to be unaware of the fundamental issues facing the implementation of an effective solid waste management (SWM) strategy, of its own limitations and of the need to work closely with other groups (including NGOs and CBOs) if the different sectors of society are to receive cost-effective services that they want and are prepared to pay for.

Before a public awareness and education programme is implemented it will be necessary to improve the NCC's own awareness of the requirements of a new solid waste management strategy. This will involve developing an awareness promotion programme specifically directed at the departments and staff of the NCC with an involvement in the provision of SWM services. This is a key element of the strategy development and implementation process.

The strategy should also include details about the need for and location of the next landfill site. Experience shows that a properly constructed and managed communications programme can reduce significantly the public opposition which inevitably accompanies proposals of this kind.

(2) Public Education and Awareness

People's attitudes to SWM are, to some extent at least, shaped by the poor level of service currently provided by the NCC. Without a major shift in the political willingness and ability of the NCC to provide services that people want and are prepared to pay for, it is unlikely that a public awareness and education programme will, of itself, be successful in shaping peoples attitudes towards SWM.

A public education and awareness programme should therefore be introduced at the time of the NCC's announcement of the new strategy. Any attempt to introduce such a programme before the NCC has spelt out the steps it is to take to improve solid waste management conditions in the city would be futile. It should be one part of an integrated package of measures.

(3) Waste Collection

An important finding of the public awareness survey is that almost 50% of residents would be satisfied with collection from a common discharge point and the neighbourhood kept clean. More than 50% also expressed a willingness to pay an amount for appropriate services considerably higher (even in the low-income areas) than the current charge. These factors have considerable implications for the design of the collection strategy.

The strategy should aim at providing a minimum level of service throughout Nairobi consistent with the survey findings; that is, one based on providing secondary collection services only from designated communal disposal points (CDPs). A simple basic SWM charge would then be levied on all users (a surcharge could possibly be paid by residents having a higher level service - such as one based on door-to-door collections).

(4) Informal (Slum or Surrounding) Areas

Strategies for providing SWM services to people in the peri-urban areas of Nairobi need to be structured differently to those for the formal areas. Not only do conventional approaches to delivering public services in these areas frequently fail, but subsidised services also fail to generate a sense of community responsibility or to engage or strengthen community organisations.

An alternative approach is to understand environmental health practices in peri-urban communities and to act on the priorities residents themselves identify and are willing to pay for. This usually involves redefining existing relationships between community organisations, NGOs and municipal agencies, a process which can stimulate partnerships between a community's organisations and can help shift the attitudes of municipal staff towards building closer relationships with the communities they serve.

(5) Scavenging

Scavenging is a response to poverty, and is one of the measures taken by the very poor to provide a livelihood for their families and themselves. Health and safety issues - for the scavengers and general public alike - are the major areas of concern about scavengers operating from informal city dumps, as door-to-door collectors and on the landfill site.

The significant concentrations of scavengers in city areas are largely a consequence of the failure to provide adequate collection services. Although proper collection services will not entirely eliminate the problem of scavenging in these areas, reducing the long-term build-up of waste would result in a reduction in the numbers of scavengers which can be sustained by it.

A large population of scavengers is sustained by the Dandora dumpsite, and real concern is expressed for their health and safety and of those who come in contact with them. Scavenging activities at the site appear to be governed by a level of social organisation and cohesion which, properly managed, could possibly be mobilised to provide a level of management and control over these activities at the new landfill site.

(6) Recycling

The public awareness survey has demonstrated a high level of awareness of issues related to recycling, with 50% of all respondents (78% in low income areas) reporting being visited by a collector at an average frequency of once a week. Scavenging is a fundamental component of the Kenyan recycling industry, is a major generator of income for poorer households, and significantly reduces the amount of waste to be disposed of by society.

2.12 Hospital and Industrial Wastes

2.12.1 The Present Condition of Hospital Waste Management

(1) Large Sized Hospitals

The Kenyatta National Hospital manages waste by itself utilising an incinerator for clinical waste and macerator for placentas. However, others infectious waste, paper waste and food remains are disposed of at the NCC disposal site. On the other hand, the Mathare Mental Hospital has no facility for solid waste treatment and the waste produced is collected by NCC and disposed of directly without any treatment at the disposal site. Accumulation of waste awaiting collection was indicated as one of the major items that affect the environment of the place.

In each hospital there is a stockyard for waste with an average volume of about 1,550 m³.

The number of beds in these hospitals ranges from 1100 to 2000. The charge paid by these hospitals for solid waste disposal is about of 3.4 Kshs/kg.

(2) Medium Sized Hospitals

Three out of the four hospitals selected for the survey have their own incinerators to treat clinical wastes, although one incinerator in one hospital is out of order due to the lack of maintenance. Incinerators are used to burn clinical waste and infectious waste to some extent, while the remaining wastes or those completely untreated are collected and disposed of by NCC or a private company.

Inefficiency in the collection of hospital wastes have been expressed by some respondents to the questionnaire although one respondent had indicated that NCC even without working tools is very effective on the site but under supervision.

Two hospitals have their on stockyard for waste with a volume of about 17 and 30 m³, respectively.

The number of beds in these hospitals ranges from 106 to 360. The charge paid by these hospitals for solid waste disposal ranges between 0.03 and 9 Kshs/kg.

(3) Small Sized Hospitals

The existence of only one incinerator has been confirmed by analysing the questionnaire on four hospitals. The number of beds in these hospitals range from 9 to 90.

NCC or private companies provide the services of collection and disposal although in one hospital the waste is managed by itself.

Some of the respondents to the questionnaire have indicated that NCC is not efficient in providing waste collection and disposal services.

According to the questionnaire, one hospital has its own stockyard for waste of about 4 m³ while another hospital utilizes drums to store the waste.

Not enough information was given on quantity of waste generated so that the charge paid for solid waste disposal could not be estimated.

2.12.2 Present Condition of Industrial Waste Management

Major findings are the following:

- (1) Some industries make recycling of their wastes by themselves. Some of these recycled wastes are used as raw materials for making products of lesser quality and others are sold to other companies.
- (2) Most of the respondents to the questionnaire have indicated that NCC services are very poor.

- (3) Categories of waste generated at the selected industries are both organic and inorganic and two of them are sources of chemical wastes which need special care in order to protect public health and the environment.
- (4) Sixty percent (60%) of the factories surveyed have their own stockyard for waste.
- (5) There is no factory having solid waste treatment system while in some factories open burning of waste is very common.
- (6) According to the respondents, the new landfill site should be located at a distance of between 20 and 40 km from the city centre.
- (7) The waste collection is provided by NCC with a ratio of 30%, Private with a ratio of 30%, and themselves with a ratio of 40%.
- (8) The charge paid by factories for solid waste disposal ranges between 0.05 and 0.13 Kshs/kg.

2.12.3 General Recommendations for the Improvement of Hospital and Industrial Waste Management

(1) Hospital Waste

(a) Laws and Regulations

Since there is no legislation or regulations on hospital waste, they should be formulated as soon as possible to be used as the first tool into the process of establishment of hospital waste management in the city.

(b) Policy on Hospital Waste Management

Policy should be given by concerned authorities for the establishment of a different service for collection, transportation and disposal of hospital waste in Nairobi City.

(c) Treatment System at Hospitals

The obligatory use of incinerator for clinical and infectious waste treatment should be applied in all hospital regardless of their size. This means that only the ash should be collected from hospitals and disposed of at a designated area for hospital waste.

(d) Education on Hospital Waste Handling

Education on how to deal with hospital waste should be given to all medical staff (doctors, nurses, cleaners, etc.) and to persons engaged in the collection, transportation and disposal, because all of them potentially handle infectious or dangerous waste. The elaboration of a Hospital Waste Treatment Manual by the concerned authorities would be substantially beneficial.

(e) Segregation

The first thing that must be done for source reduction is to avoid mixing wastes. A mixture of a small amount of clinical or infectious waste with a larger amount of general waste creates a large amount of material that must be treated as a clinical and/or infectious waste. Another basic rule is not to make waste liquid if it is dry. Housekeeping operations as simple as sweeping prior to washing floors can substantially reduce waste volume and perhaps it is the simplest and most inexpensive method for reducing hospital waste at source.

In conclusion, segregation practice is highly recommendable to be applied in all hospitals in Nairobi City because it permits treating smaller quantities of waste.

(2) Industrial Waste

(a) Laws and Regulations

Since there are no laws or any standards on the management or regulation of industrial waste in Kenya, they should be formulated and implemented for use in the improvement of industrial waste management in Nairobi City. The legislation should include some economic incentive system for the industries in order to minimize the production of industrial waste and to promote the use of pollution control equipment.

In the elaboration of laws, regulations and standards related to industrial waste management, the necessary coordination between NCC and the national government should be established by clearly defining the roles of each organization concerned in order to avoid duplication of activities or conflicts at the time of enforcement of the legislation.

(b) Industrial Inventory

An Inventory should be conducted to cover all industries located in Nairobi City to know the real needs of treatment, collection and disposal of the waste. Each industry should submit to NCC information on the characteristics and amount of industrial waste they generate in order to prepare an appropriate industrial waste management system.

(c) Recycling

NCC should promote recycling activities at all industries, starting with those industries that are heavier producers of waste. All industries should be required to plan the utilization of the recyclable materials and to increase the means for their use.

(d) Treatment System

The characteristics of industrial solid waste are so variable that it is necessary to find out the best treatment and final disposal alternatives from a technical and economic point of view.

(e) Hazardous Industrial Waste

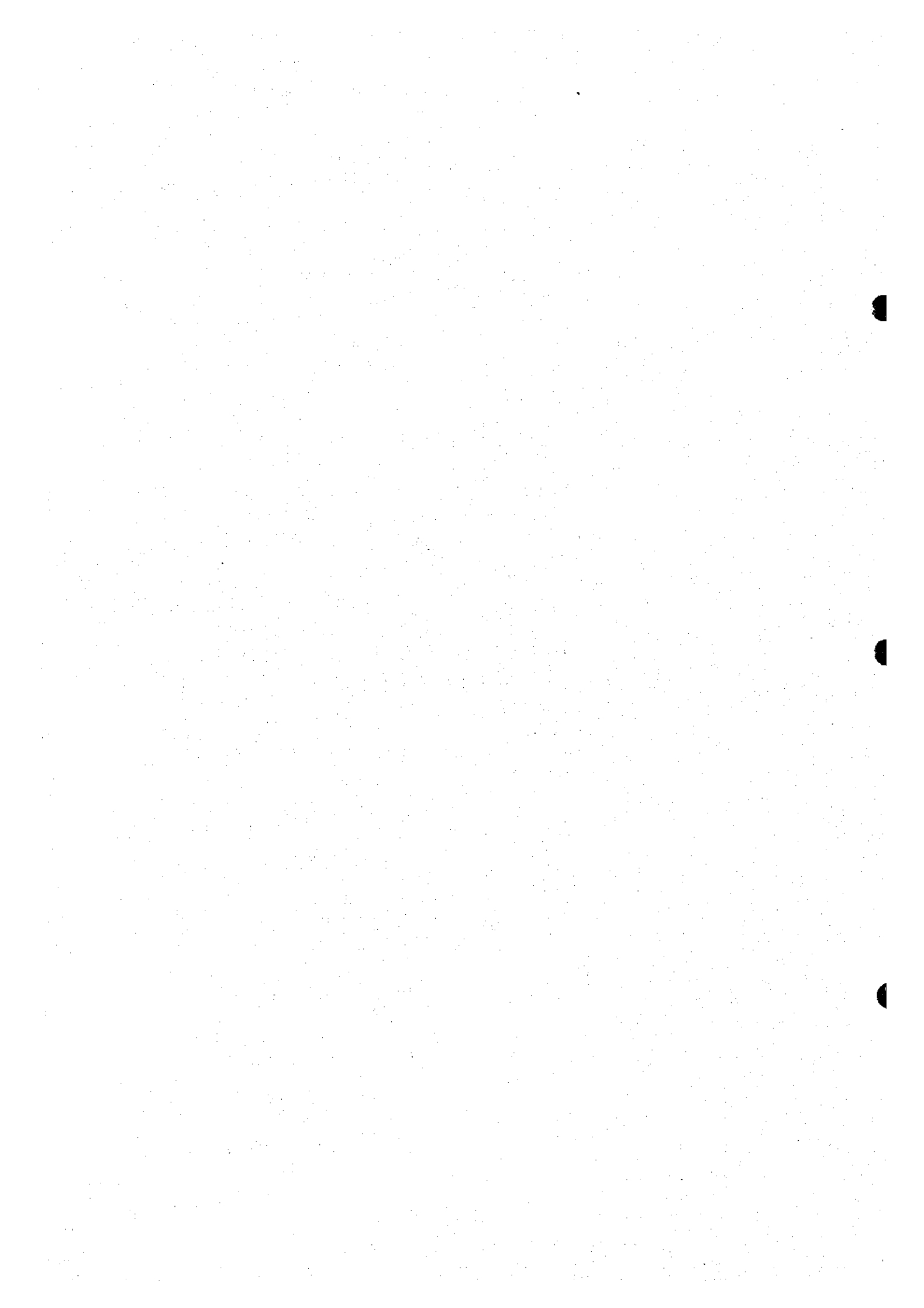
Some industrial wastes are of such hazardous nature that they are very likely to do harm to the living environment when they are used for land reclamation without any processing. Within this category is mentioned industrial wastes which contain mercury, cadmium, lead, hexavalent chromium, arsenic, etc., which should have a special treatment for disposal.

(f) Necessity of Cooperation from Enterprises

Enterprises such as manufacturers and distributors should make a self-assessment on product disposability, and should develop processes which would enable the treatment of industrial waste at generation source. It is necessary that enterprises examine the raw materials they use and take the necessary steps that would mitigate environmental pollution caused by their waste. Enterprises should make efforts to cooperate with the national government and NCC to ensure appropriate waste treatment.

CHAPTER 3

**PLANNING POLICY ON SOLID WASTE
MANAGEMENT IN NAIROBI AND
FRAMEWORK OF THE MASTER PLAN**



CHAPTER 3

PLANNING POLICY ON SOLID WASTE MANAGEMENT IN NAIROBI AND FRAMEWORK OF THE MASTER PLAN

3.1 Introduction

Clause 242, Article 11 of the Public Health Act, Rev. 1962, stipulates the duties of local governments in public health. As stated, every local authority shall take all lawful, necessary and reasonably practicable measures to maintain its district in clean and sanitary condition, preventing the occurrence therein or remedying or causing to be remedied or condition liable to be injurious or dangerous to health and to take proceedings at law against any person causing or responsible for the continuance of any such nuisance or condition. The Public Health Act, as well as the other laws and by-laws such as the Local Government Act do not state clearly the duty, authority, or policy of local governments in solid waste management.

The responsibility, duty, authority, regulation, etc., of local governments as mandated by legislation are thus the main issues to formulate a solid waste management (SWM) plan. Due to imperfections in currently existing relevant laws of Kenya, however, principles and guidelines are required to establish the framework of SWM in Nairobi City to support the formulation of the Master Plan and the execution of the following Feasibility Study.

In view of the need for a planning policy and framework of SWM, framework principles, guidelines, definition of municipal solid waste, roles of entities concerned, objectives, strategies, requirement of technical and institutional setup and other basic elements are proposed as discussed in the following sections.

3.2 Principles and Guidelines for the Establishment of SWM Framework

Through the series of discussions and the consensus reached between the Kenyan counterparts and the JICA Study Team, principles and guidelines for the solid waste management (SWM) by the Nairobi City Council (NCC) have been prepared as presented below. These principles and guidelines are the bases on which the planning policy on SWM by NCC and the framework of the Master Plan are formulated.

3.2.1 Categories of Waste

The following waste categories are as summarised in Table 3.2-1 below.

(i) Municipal Waste

Municipal waste is defined as solid waste that may be collected and disposed of by ordinary methods, which is the responsibility of the local government. The types of municipal waste are as enumerated below. NCC is responsible for the management of municipal waste.

- (a) Household waste
- (b) Business waste of small amount (less than 50 kg)

- (c) Waste generated from public institutions such as schools
- (d) Market waste
- (e) Hospital waste that does not require any treatment
- (f) Dead animals excluding domesticated animals (cattle and swine)
- (g) Street waste excluding demolition waste dumped on streets
- (h) Other wastes accepted by NCC as municipal waste

(2) Non-Municipal Waste

Non-municipal waste, i.e., designated waste is not NCC's responsibility but is the responsibility of waste generators.

Table 3.2-1 Waste Category and Management Responsibility

Category of Waste	Management Responsibility	Remarks
1. Municipal waste	NCC	NCC collects bulky waste upon receipt of requests from citizens by charging a special tariff.
2. Non-municipal waste 2-1 Non-hazardous industrial waste and commercial waste of large amount 2-2 Demolition waste 2-3 Discarded vehicles 2-4 Hazardous waste including infectious hospital waste	Generators of waste (NCC should monitor generators' management of non-municipal waste until they establish a proper management system for these waste.)	NCC may accept waste 2-1 and 2-2 at its disposal site on full cost recovery basis. The central government should establish hazardous waste management (treatment) facilities.

3.2.2 Objectives, Planning Policies and Strategies of Solid Waste Management

(1) Objectives of Solid Waste Management

(a) Primary Objectives

The primary objectives of solid waste management are to:

- protect public health,
- protect the environment, and
- maintain public cleanliness in order to keep public places aesthetically acceptable,

by means of proper storage, collection and safe treatment and disposal of municipal waste.

In addition, a further objective could be to conserve natural resources through waste reduction policies and recycling. This will depend on the government's environmental policy.

(b) Service Objectives

Additionally, local governments shall set the important service objectives of improving the quality of service, including:

- collection frequency;
- reliability;
- collection method;
- enhancing efficiency and reducing costs;
- extending service coverage to areas which may not be served or inadequately served; and
- upgrading environmental disposal standards and enforcement procedures.

In short, the key concept for the improvement of municipal solid waste management should be:

“Do more (better services) with less (money)”

(2) Planning Policies and Strategies

Planning policies and strategies to be set for each component of the SWM Master Plan shall be made based on the following:

- (a) be cost-effective and appropriate for the local government budget;
- (b) satisfy the protection of public health and environment; and
- (c) take account of the participation of NGOs in SWM.

The planning policies and strategies shall cover technical aspects such as collection and transportation, waste reduction and recycling, and final disposal. These policies and strategies shall also cover the institutional and financial aspects.

3.2.3 Responsibilities of the Central Government, NCC, Business Waste Generators and Residents

NCC must have the authority and responsibility for implementing solid waste management. As listed below, the other organisations involved in solid waste management are:

- the Central Government;
- the NCC;
- Contractors;
- Business (Industrial and Commercial) Waste Generators; and
- the Residents

The proposed principal responsibilities of the respective organisations are as summarised in Table 3.2-2 below.

Table 3.2-2 Parties Involved in Solid Waste Management and their Responsibilities

Parties Involved	Responsibilities
1. Central Government	(1) to formulate a national policy with respect to waste reduction, recycling and solid waste management. (2) to enact a national SWM law. (3) to set technical standards. (4) to research on solid waste management. (5) to ensure that laws and regulations are applied. (6) to provide guidance to local governments.
2. Nairobi City Council	(1) to formulate a local policy and prepare local strategies and plans (short and long term). (2) to finance SWM. (3) to levy waste tax. (4) to formulate regulations. (5) to formulate guidelines with respect to: (a) methods of discharging waste (types of containers to be used); (b) the waste reporting requirements of business waste generators; and, (c) recycling (types of waste to be recycled).
3. Contractors	(1) to provide waste collection, haulage and street sweeping services under contractual arrangements.
4. Business (Industrial and Commercial) Waste Generators	(1) to manage (collection, treatment and disposal) their waste except those accepted by the local government as municipal waste. (2) to submit reports on their waste (types, quantity, pretreatment and other information) as required by the municipal regulations.
5. Residents	(1) to reduce generation of waste. (2) to recycle waste. (3) to comply with the local government's waste collection procedure. (4) not to scatter waste. (5) to dispose of discarded vehicles by using commercial enterprises.

3.2.4 Basic Concept of SWM

Proper waste disposal is very important. However, to reduce the quantity of waste to be disposed is even more desirable from the environmental and economic points of view. There are two ways to achieve this: waste prevention (to reduce generation of waste) and waste utilisation (reuse, recycling and resources recovery). The preferred priority between waste reduction at source, utilisation and disposal is generally as follows:

Waste Reduction at Source
before
Waste Utilisation
before
Waste Disposal

(1) Waste Reduction at Source

The purpose of waste reduction is to reduce generation of waste materials by making procedures change their production processes and consumers change

their consumption patterns. Methods of waste prevention include the following:

- (a) Improving product design to minimise the amount and type of waste, e.g., increasing the number of components in products which can be recycled, simplifying packaging and making greater use of recyclable packaging materials;
- (b) Changing product design, materials and composition to reduce toxicity; and,
- (c) Consumers avoiding unnecessary consumption, e.g., using their own shopping bags rather than plastic carrier bags.

Effective waste prevention requires the establishment of a national law and enforcement systems. Waste prevention policies should be promoted firstly at central government level and then at municipal level.

(2) Waste Utilisation

Waste utilisation is promoted through reuse, recycling, and recovery of resources (material and energy) from waste. Laws and regulations should be passed and issued by the central government to promote waste utilisation, especially the recycling of packaging and energy recovery.

Reuse and recycling can best be promoted through waste separation at source. The Nairobi City Council (NCC) should take the initiative in promoting waste separation at source. Waste separation at source contributes not only to recovery of useful materials but also to the reduction of waste to be collected and disposed, with resultant reduction in cost.

(3) Waste Disposal

Waste that cannot be utilised has to be collected and properly disposed to minimise environmental impacts. In order to dispose of waste in a sanitary manner, disposal facilities must be constructed to comply with disposal standards.

3.2.5 Technical Standards and Choice of Appropriate Technology

(1) Necessity of Technical Standards

The provision of solid waste management services, even if imperfectly provided, directly contributes to securing the sanitation and comfort to those who received them. However, the provision of these services may cause secondary pollution in medium and long term. Technical and environmental standards are therefore necessary.

(2) Possible Environmental Risks Arising from the Provision of SWM Services and Preventive Measures

Possible environmental risks and preventative measures are as summarised in **Table 3.2-3** below:

Table 3.2-3 Possible Environmental Risks arising from the Provision of SWM Services and the Countermeasures

Types of SWM Services	Possible Environmental Risks	Countermeasures
1. Collection and transportation	(1) Public health risks associated with vermin and insects because of low frequency of collection	(1) Household waste collection with a frequency of once in a week or more
	(2) Pollution of streets and buildings with garbage and wastewater discharged from containers or vehicles	(2) Use of appropriate equipment or handling procedures
2. Disposal	(1) Pollution of surface or ground water with leachate generated from waste deposits in landfill site	1-1 Selection of appropriate sites 1-2 Non-acceptance of hazardous waste at municipal disposal site 1-3 Compliance with Agreements of Bazel Convention 1-4 Installation of sanitary landfill facilities
	(2) Waste scattering	(2) Installation of embankments and fences and application of cover soil
	(3) Generation of vermin	(3) Application of chemicals and cover soil
	(4) Generation of fire and smell	(4) Application of cover soil

(3) Choice of Appropriate Technology

Technology to be selected for SWM should:

- satisfy the environmental and technical standards; and
- be cost-effective and appropriate.

More specifically, it is desirable that the technology selected should satisfy the following criteria:

- (a) Effective for environmental pollution control;
- (b) Affordable in terms of both investment and operation and maintenance costs;
- (c) Expertise and spare parts for operation and maintenance are locally or easy available; and
- (d) Socially acceptable.

3.2.6 Institutional Framework of SWM

(1) Legal Arrangements

The central government should formulate a national solid waste management law which shall cover and/or satisfy the following:

- (a) Local governments shall have the primary duty of care and responsibility for municipal SWM;
- (b) Local governments shall have the authority and responsibility for setting by-laws and regulations with respect to municipal SWM which must comply with central government laws and requirements;
- (c) The central government shall have the responsibility to set environmental and technical standards with respect to solid waste management;
- (d) Private sector involvement - local governments shall have the right to contract-out SWM to the private sector and must implement appropriate arrangements to regulate the private sector;
- (e) Industrial waste management;
- (f) Hospital waste management; and,
- (g) Toxic and hazardous waste management.

(2) Effective Organisation and Management

(a) Why is effective management necessary?

Solid Waste Management may appear technically, economically and financially sound but may be poorly delivered because of institutional, organisational and management deficiencies.

(b) What is effective institutional arrangements?

There has to be clear demarcation and assignment of SWM responsibilities between the central government and NCC.

Ministries or agencies at central government level should have the responsibility for national policy and planning, legislation and setting standards concerning SWM. National policy on privatisation should also be formulated at this level. An important role of the central government is to give guidance to local governments, i.e., NCC. This is particularly relevant for privatisation.

NCC has the primary duty of care for SWM including planning, financing and management of services, formulation of regulations, etc.

Responsibilities and obligations should not be fragmented or overlapping among institutions at either level. Linkages and coordination arrangements between different institutions should be efficient and effective.

(c) What is effective organisation and management?

The provider of SWM services at the local level, whether government or private company, needs to develop effective organisational and management capabilities. These should include:

- An efficient organisational structure with clear reporting lines, rational departmentalisation, reasonable spans of control and number of levels of managers/supervisors, and appropriate senior management structure.
- A clear assignment and delegation of responsibilities and adequate authority to managers and supervisors with accountability for individual performance.
- Procedures to clearly set and monitor objectives from the strategic level down to middle management and supervisors: Managers must have a clear understanding of their objectives.
- Effective planning and policy formulation: These should include preparation of medium/long term strategic plans as well as annual operational plans.
- Effective financial management: This should include integration of financial planning into the planning process, implementing budgetary planning and control and appropriate accounting systems.
- Effective decision making by managers (the right decisions made in the shortest time).
- Effective and appropriate systems: These should include management information systems and other procedures, e.g., work flows and communication patterns. Managers need appropriate and regular information to enable them to make effective decisions and to efficiently carry out their responsibilities.
- Periodic assessment of managers' performance against agreed performance targets and criteria.
- Well trained and committed managers.

(3) Financing and Financially Managing SWM

(a) Financing SWM

Local governments are very often constrained in their ability to generate revenue to finance SWM and often rely on the central government for their capital investment financing needs. Access to non-governmental financing may be limited. Additionally, it is not uncommon for deficits on SWM operating expenditures to be subsidised by the central government.

In principle, it is preferable that operating costs are recovered wherever possible through a waste tax or charge rather than through general taxation, because cost recovery under a charge or tax encourages financial discipline and cost efficiencies, and facilitates financial planning.

The cost of financing capital investment, e.g., facility and equipment, should also be recovered, where possible, through a waste tax or charge.

If NCC is unable to finance capital investment, alternative sources of financing should be considered. These could be the central government, international donor agencies, or the private sector.

If SWM is financed from a solid waste tax or charge, then NCC needs to design an appropriate charging structure and to set affordable charges.

If SWM is financed from general taxation, budgetary constraints and service priorities will determine the amount of available financing.

(b) Financial Management

SWM services must have effective financial management to ensure that financial resources are effectively, efficiently and properly used.

(i) Financial Planning and Tariff Forecasting

This should include preparation of annual financial plans as well as tariff and financial forecasts over the medium term.

Least cost investment planning should be used for capital investment, if appropriate.

(ii) Financial Systems

The financial planning system must be supported by a budgetary planning and control system and good financial accounting systems.

(4) Private Sector Involvement (PSI)

(a) The Decision to Involve the Private Sector

Why should NCC involve the private sector in solid waste management (SWM)? What activities can it privatise? How does it decide whether to privatise or not? If it decides to involve the private sector, what method of privatisation is most suitable?

These are questions which NCC must answer when it is considering private sector involvement (PSI). Taken together they outline a decision framework on PSI.

(b) Why and what to privatise

PSI may provide a solution to improve the delivery of solid waste services which are either too costly or of poor quality. Worldwide experience has demonstrated this. In this context, privatisation should be considered as a means:

- to improve the quality of service;
- to enhance efficiency and reduce costs; and,
- to mobilise private sector capital for capital investment.

Theoretically, any component of SWM can involve the private sector. In practice, collection, transportation and street cleansing are usually the first to be considered, rather than disposal including operation of transfer stations. This is because the former components are much less risky to privatise than disposal. Disposal including operation of a transfer station is risky because:

Firstly, the private sector is largely motivated by market forces to make profit, rather than to comply with public health or environmental standards. Disposal and operation of a transfer station might have a greater chance to directly affect public health and the surrounding environmental conditions and might be required in compliance with the standards. Compliance adds cost.

PSI should only be considered if NCC can effectively regulate private operators to ensure that public health and environmental standards are complied with.

Secondly, the private sector may lack technical as well as administrative experience of waste disposal including operation of a transfer station. NCC needs to carefully screen and assess the private sectors' technical and management capabilities before involving them.

Thirdly, often the local government has insufficient experience in the management of disposal services. Since it has a primary duty of care for SWM services it should not execute disposal until it has demonstrated competent management and technical capabilities in delivering disposal services.

(c) How to decide whether or not to privatise

A number of contextual issues have to be considered when evaluating the case for PSI. The following criteria should be considered on whether or not to involve the private sector:

(i) Government's Contract Management Capability and its Public Accountability

NCC must ensure that its responsibilities for SWM services which are delivered through a private sector operator are properly discharged. To ensure this, the government must have an effective capability:

- to manage the contracting process, i.e., contract design, setting performance measures, tendering and bid evaluation, and contract award and negotiation;
- to monitor contract performance;
- to enforce contracts and licenses; and,
- to carry out economic regulation, e.g., annual tariff setting and financial planning and tariff forecasting.

Good regulatory and contract management capability is essential to ensure that a capable private operator is selected, risks are minimised on both sides through good contract design, and contract performance is properly monitored.

Good economic regulation ensures that the private operator can finance its functions, that NCC is paying an economical price for SWM services and that efficiency gains can be realised.

If contract management is weak, there is a real risk that SWM services may be poorly delivered by the private sector and the government will be unable to discharge its primary duty of care for SWM.

(ii) Private Sector Capabilities

Does the private sector have the necessary technical and management capabilities and the financial resources to provide a more efficient, less costly and higher quality service than that provided by NCC?

Usually private sector management brings a number of benefits including:

- a more committed and innovative management;
- better management skills and more effective decision making;
- better planning;
- better financial management;
- improved resource management of assets and human resources;
- more efficient financing and management of capital investment; and,
- a motivated work-force.

NCC should carefully screen and assess whether private sector operators have these capabilities. In particular, the government should consider whether the private sector can improve efficiency and reduce costs through:

- higher labour productivity;
- more efficient operational procedures;
- better financial discipline, e.g., through tight budgetary controls; and,
- better systems.

At the same time NCC should identify what impedes it from providing an efficient service itself, e.g., inefficient work arrangements, restrictive labour practices and bureaucratic management. Can these constraints be removed or is private sector involvement (PSI) a better solution?

(iii) Market Competition

The extent to which the private sector can bring benefits is reflected by the level of competition in the sector. Generally, competition among companies improves the quality and the economy of services.

Are there enough companies in the market to foster and stimulate competition? Are there barriers to entry? If the market is still undeveloped, are economic incentives required to stimulate private participation?

(iv) Legal Sufficiency and Enforcement

Are laws and regulations sufficient to:

- enable and empower NCC to contract, license and effectively regulate SWM services;
- enable NCC to effectively monitor and enforce laws and regulations; and,
- allow private companies to compete fairly and with minimal risk?

Is the judicial system effective enough to enable NCC to enforce contracts and SWM laws?

(v) Can NCC afford to pay for private sector services?

NCC needs to determine whether it can afford to pay for private sector SWM services. Usually, SWM is financed either from a solid waste tax or charge or from general taxation. In either case NCC needs to prepare good tariff and financial forecasts to determine the revenue available for procuring private sector services.

(vi) Regulatory Costs of PSI

Will PSI reduce the overall costs of SWM? NCC should determine whether the administrative and regulatory costs will be less than the savings generated from PSI. If PSI reduces overall costs, then PSI is more economical.

(d) What is the appropriate method of privatisation?

Once involvement of the private sector is decided, the appropriate type of PSI and contracting arrangements have to be selected. This will depend on the type of service to be privatised, i.e., collection, street cleansing or disposal and also on whether the private sector is going to finance and manage capital investment.

Generally, the operation of **collection and transportation** or **street cleansing** is contracted out under a management contract or operating contract. Once PSI is decided, the appropriate type of PSI and contracting arrangements have to be selected.

There are a number of different contracting methods but, essentially, there are three types of contracting for PSI in collection services. These are (1) Open Competition, (2) Operating Contract, sometimes called "contracting", and (3) Franchise.

Full privatisation is the last option for SWM.

Open Competition

At the moment there is "open" and completely unregulated competition of private collection services in Nairobi. Companies are free to provide collection services to whom and where they like and collect tariffs directly from customers. Generally, open competition is not the best arrangement for PSI even if it is regulated. However, where the level of public collection is low, it may be, as it is in Nairobi, a vital necessity.

Operating Contract

The most usual contracting method is a simple operating contract under which a finite term contract is awarded, usually for a fixed price as a zonal monopoly, i.e., the contractor has the exclusive right to provide services in a designated area. Typically, it is re-tendered every 3 to 5 years.

Franchise

Under a franchise the local authority gives a contractor the sole right to provide services in a designated area, i.e., a zonal monopoly. In return the contractor pays the local authority a fee for the right to operate in that area and to levy charges on customers and collect revenue from them. The local authority regulates the contractor's tariffs, as well as service performance, through the franchise agreement.

The disadvantages of a franchise are:

- Contractors bear the cost billing and collection from customers which adds considerable cost;
- Economic regulation adds cost; and

- Contractors can only work where everyone in the franchised zone can afford to pay the contractor's tariff. This implies that all households, as well as business establishments, can afford the tariff and will cooperate with the franchiser. If there are substantial income differentials, this method may be unworkable.

Operating contracts are therefore generally preferable to franchises. However, at the moment, NCC cannot afford to contract out SWM services because of its weak financial situation. This is currently the overriding constraint to PSI in Nairobi.

Full Privatisation

Here NCC sells its SWM assets to the private sector which is free to provide services to whom and wherever it wants. Consumers are given the choice of who they want to contract with. There is free competition between private sector companies who are fully responsible for revenue collection and investment.

The role of NCC is reduced to licensing and regulating the private sector including enforcement of solid waste laws. Regulatory arrangements will have to be rigorous particularly for economic regulation, and will require an independent regulatory body at local or national level, and the development of complex regulatory methodologies.

Full privatisation is very rare and is not recommended if PSI and government's regulatory capacity are not well established. There are substantial risks for both NCC and private sector providers if this method is prematurely adopted.

3.3 Formulation of SWM Policy

3.3.1 The Role of Each Party Concerned

To determine the policy on SWM, the role of each party concerned shall be clarified; namely, (1) The government shall be responsible for the provision of financial sources, technology development and legislative setup; (2) The local authority shall be responsible for the provision of sufficient facilities and regulations of SWM services; and, (3) The beneficiaries shall be responsible for cooperating with the local authority on the discharge of waste and on bearing the charges.

Especially, the role of the local authority is the most important to establish an efficient municipal solid waste management system for the city. Its duty is defined in the following statement:

"NCC has the primary duty of care for SWM in Nairobi City through regulation and services."

Based on the role of each party mentioned above, the policy on SWM by NCC is proposed by the JICA Study Team to be used provisionally for the formulation of the Master Plan. Probably, it may be used as a statutory provision in the law or by-law on solid waste management in the future.

3.3.2 Primary Objectives of Solid Waste Management

The primary objectives of the solid waste management by NCC are proposed to be applied commonly in every municipality to achieve the goals of better living environment such as the following three items:

- (1) Improvement of Public Cleanliness;
- (2) Improvement of Public Health; and
- (3) Protection of the Environment.

3.3.3 Policy or Goals of the Future SWM Plan

The planning policy to establish an integrated solid waste management system is defined with a future target based on a consideration of source reduction, resource recovery, waste collection in entire service area, waste treatment and disposal supported by rational institutional and legal arrangements and financial viability. The goals of the future SWM Plan are as summarised below.

- (1) **Reduction of Waste at Source**
 - (a) Reduction of Waste by 10% at the Generation Source
 - (b) Full Participation of the Government, NCC, Residents and Enterprises
- (2) **Collection and Transportation**
 - (a) Privatisation Covering Whole Collection Service Area
 - (b) Introduction of Separate Collection System
- (3) **Resource Recovery and Intermediate Treatment**
 - (a) Resource Recovery of 10% by Community Groups and NGOs
 - (b) Resource Recovery of 10% by Scavengers
 - (c) Control and Assistance by NCC on Resource Recovery
 - (d) Involvement of Recycling Company in Resource Recovery
 - (e) Treatment of waste in combination with composting, incineration, etc., for material recycling, biological and chemical recycling, and thermal recycling to minimise and treat residue into a state of harmless and stabilised material.
- (4) **Final Disposal**
 - (a) Operation of Complete Sanitary Landfill
 - (b) Reuse of Closed Landfill Site(s)

3.4 Planning Strategies

3.4.1 Problem Identification for SWM in Nairobi

As stated in Chapter 2, due to poor waste collection services of the city authority, residents of Nairobi are suffering environmental deterioration around their living

quarters and, consequently, lodge complaints to NCC for fear of degradation of public health.

There are many causes preventing NCC from conducting better services of waste collection and disposal. The major problems, which are considered to be the key issues for the Master Plan formulation, are as enumerated below.

- (1) Low level of waste collection rate
- (2) Lack of spare parts and long procedure for procurement of parts
- (3) No involvement of NCC on waste reduction and resource recovery
- (4) Illegal and uncontrolled disposal
- (5) Open dumping and no ample space available at Dandora disposal site
- (6) No comprehensive national law on SWM
- (7) Inefficient institutional and organisational arrangements of NCC
- (8) Uncontrolled private sector involvement on waste collection services
- (9) Lack of financial sources for investment and operation
- (10) Improper budgetary system failing to secure financially sound operation
- (11) Lack of public awareness about SWM problems facing the city

3.4.2 Trend of Future SWM

Community needs are gradually changing for a better quality of life. Thus, the conditions for formulation and implementation of the SWM plan must match the trends in future. Planning strategies are thus worked out based on the future trend prospected in the following:

- (1) Increase of cost of SWM services
- (2) Application of more restrictive regulations for SWM
- (3) Increase of public awareness and requests for administrative operation

3.4.3 Planning Strategy

To achieve the primary objectives, the strategic approach to formulate the SWM Master Plan for NCC are proposed with the following six (6) items in consideration of solving the implicated constraints of the city towards improvement of technical and institutional deficiencies:

- (1) Financial strengthening of SWM
- (2) Institutional capacity building
- (3) Improvement of SWM operational capacity
- (4) Private sector involvement (PSI) in SWM
- (5) Public awareness and participation of communities and NGOs
- (6) Promotion of waste reduction at source and resource recovery

3.5 Planning Directions of the Master Plan

3.5.1 Components of the Master Plan

The Master Plan for improvement of SWM in Nairobi is formulated in three stages of action plans; namely, the first implementation stage (ended in the 2nd-3rd year), the second implementation stage (ended in the 5th year) and the third implementation

stage (ended in the target year, i.e., 10th year). The action plans are formulated through two approaches: (1) technical approach, and (2) institutional and financial approach. The major planning items of the Master Plan are summarised below.

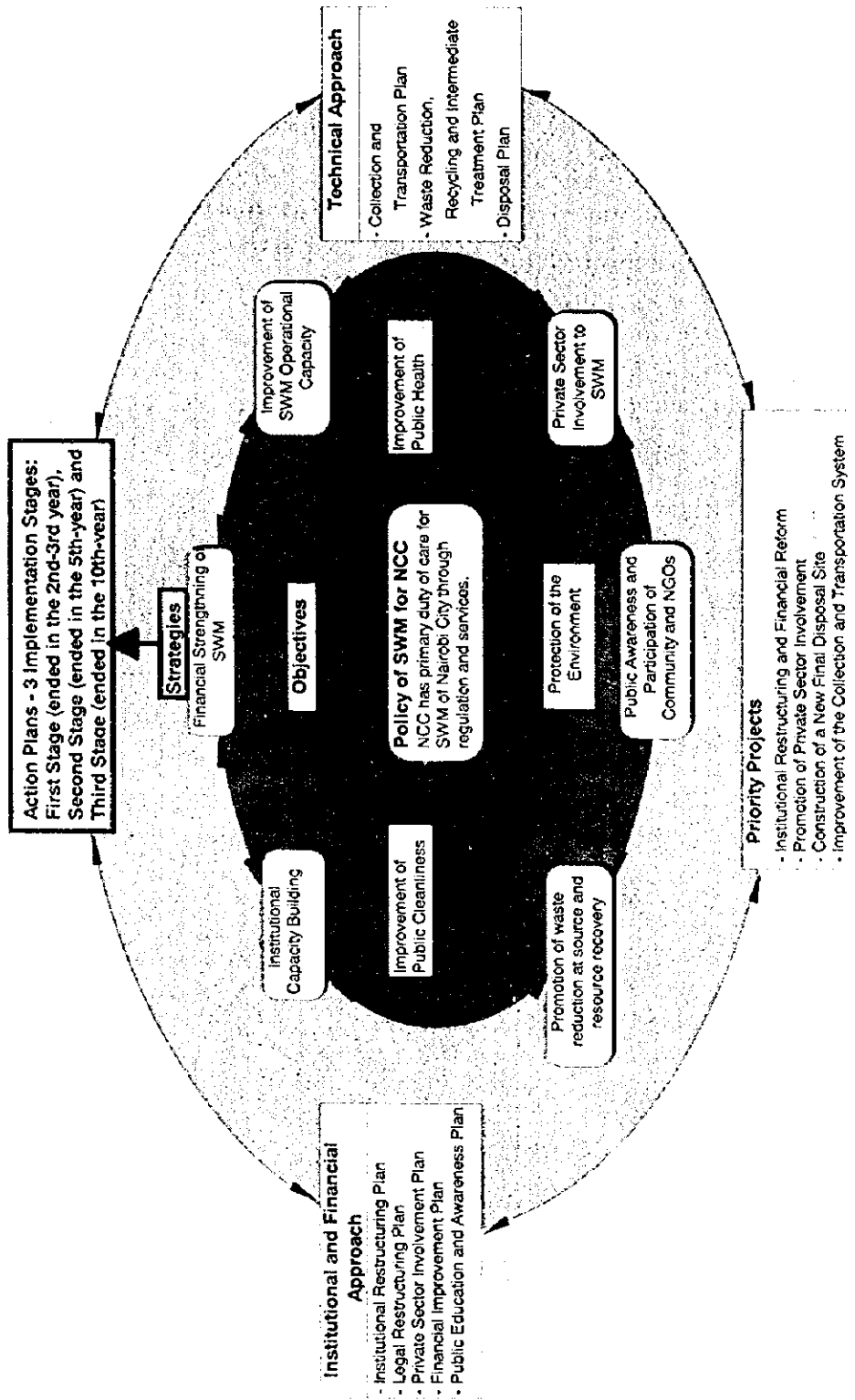
(1) Technical Approach for the Master Plan

- Collection and Transportation Plan
- Waste Reduction, Recycling and Intermediate Treatment Plan
- Final Disposal Plan

(2) Institutional and Financial Approach for the Master Plan

- Institutional Restructuring Plan
- Legal Restructuring Plan
- Private Sector Involvement Plan
- Financial Improvement Plan
- Public Education and Awareness Plan

The interrelation of objectives, strategies and planning directions is illustrated in **Figure 3.5-1**.



Solid Waste - A Consequence of Human Activities

Figure 3.5-1 Framework of the Solid Waste Management Master Plan for Nairobi City

3.5.2 Objectives, Planning Policies and Strategies of Each Component of the Master Plan

The objectives, planning policies and strategies of each component of the Master Plan are clarified, as follows:

(1) Collection and Transportation Plan

(a) Objective

The primary objective of the Collection and Transportation Plan is to increase the collection service coverage in order to maintain public health and cleanliness, and to protect the City's environment.

(b) Planning Policy

The NCC is firstly to provide a minimum level of service throughout Nairobi. Minimum level of service is defined as collection service to be conducted once a week from communal collection points.

(c) Strategy

- (i) A collection and transportation system which is the most economical and efficient as well as the least socially and environmentally harmful, shall be adopted, in comparison with possible technical options such as station type and door-to-door type collection as well as direct and indirect transport methods.
- (ii) Apart from contracting-out areas of collection to private companies, NCC shall provide collection services equally to residents.
- (iii) NCC shall promote and make the greatest use of private sector involvement in terms of collection services with full control by the private sector.
- (iv) Community based waste management in the informal settlements shall be considered to enhance collection and transportation operations by using communal collection points.
- (v) Improvement of the existing vehicle operation and maintenance system in the Department of Environment of NCC shall be carried out to increase the availability of collection vehicles.

(2) Waste Reduction, Recycling and Intermediate Treatment Plan

(a) Objective

The objective of the Waste Reduction Plan is to lighten the cost burden to NCC through reduction of solid waste amount for collection and disposal.

The objective of the Recycling Plan is to save finite resources and minimise landfill space as a result.

The objective of the Intermediate Treatment Plan is stabilisation and reduction of residuals in addition to resource recovery through waste conversion.

(b) Planning Policy

- (i) The Waste Reduction Plan shall be formulated under the condition to perform a role of each party, i.e., the role of the Government, local authority and the beneficiaries.
- (ii) Solid waste recycling shall make use of the existing functions of the community based organisations and the recycling industries to the maximum extent.
- (iii) The Intermediate Treatment Plan shall be formulated by means of the applicable technology in Kenya so as not to cause a financial burden on SWM.

(c) Strategy

- (i) Waste reduction shall be carried out for domestic, commercial and other business wastes.
- (ii) Formulation of the Waste Reduction Plan shall take public participation into consideration.
- (iii) NCC shall have the primary responsibility for promotion, guidance and assistance to the community groups, enterprises, recycling companies, etc., for organising the recycling groups and operations.
- (iv) Initial solid waste recycling shall be carried out mainly by materials recovery by the generators at sources and by the scavengers at the disposal site(s).
- (v) Intermediate treatment or waste conversion through composting shall be introduced in the future.

(3) Final Disposal Plan

(a) Objective

In the concept of final process of solid waste management (SWM) system, the objective of the Final Disposal Plan is to have the solid waste stabilised and be hygienic to prevent secondary pollution.

(b) Planning Policy

The sanitary landfill is evaluated to be the most appropriate disposal method from both economic and environmental viewpoints. Therefore,

the final disposal plan shall be formulated for the construction and operation of a sanitary landfill.

(c) Strategy

The scale of sanitary landfill facilities and their operation shall take financial availability into consideration. Although it is preferable to provide two (2) disposal sites for Nairobi City, considering the size of the collection area and its efficiency, the design should be examined also from the environmental and social points of view. Due to financial constraints concerning SWM financing, a phased construction of the disposal site shall also be considered.

(4) Institutional Restructuring Plan

(a) Objective

The Institutional Restructuring Plan (IRP) has three objectives, as follows:

- (i) To strengthen NCC's Department of Environment (DoE) so that it can effectively and efficiently manage its SWM responsibilities and services.
- (ii) To strengthen the Department of Environment so that it has the institutional capacity to manage and sustain the Priority SWM Projects proposed under the Master Plan.
- (iii) To propose a strategy for the future role and structure of the DoE as a whole.

(b) Planning Policy

- (i) Some portions of IRP shall be implemented fully or partially by NCC itself (Preparatory Actions).
- (ii) The IRP's actions are to be implemented under the Capacity Building Assistance Program (CBAP).
- (iii) The CBAP will comprise a mixture of direct implementation assistance combined with training provided in classes or workshops, covering a number of organisational areas.

(c) Strategy

- (i) The IRP shall be made based on restructuring the existing organisational structure of the DoE's SWM functions.
- (ii) The IRP will establish a number of new functions, including the appointment of new managers and staff.
- (iii) The IRP will develop key management capabilities.

(5) Legal Restructuring Plan

(a) Objective

The objective of the Legal Restructuring Plan (LRP) is to propose the most suitable legal arrangements which will enable NCC to effectively and efficiently regulate solid waste management activities in Nairobi City.

(b) Planning Policy

- (i) NCC should move quickly to enact new SWM By-laws.
- (ii) The SWM By-laws should be formulated in consideration of other international SWM legislations to ensure that Kenya complies with the international standards.

(c) Strategy

- (i) A new Environmental Planning and Management Division is to be established in the DoE which, in conjunction with the Town Clerks Department, will formulate the new SWM By-laws.
- (ii) NCC will receive assistance from an international Legal Consultant to formulate and draft the SWM By-laws.

(6) Private Sector Involvement Plan

(a) Objective

The objective of the Private Sector Involvement (PSI) Plan is to improve the quality of NCC's SWM services in a manner to increase efficiency and effectiveness and reduce the cost of the services through capital investment by private sectors.

(b) Planning Policy

- (i) Implementation of PSI shall be regulated properly to have efficient contract management in addition to encouraging participation of the private sectors in cleansing services.
- (ii) PSI in SWM services shall be initiated with collection and transportation services of municipal wastes by means of contracting out the service areas.
- (iii) PSI shall be practiced positively taking into consideration the financial affordability of NCC for the cleansing services.

(c) Strategy

- (i) Every existing private sector involved in waste collection should be licensed, levied/charged, monitored and controlled by NCC.
- (ii) Services provided by the contractor(s) shall be firstly limited to operation of collection/transportation and street cleansing,

including street sweeping, litter picking, gully cleaning, dustbin emptying, dumping removal and grass cutting.

- (iii) In addition to the existing contracted-out area, i.e., the Central Business District (CBD), NCC shall implement the plan to expand the privatisation area(s) without delay to improve the services.
- (iv) The privatisation area(s) shall be expanded gradually based on the priority made principally by distance from the city centre, residents' income level and financial affordability of NCC.
- (v) The private contractor(s) shall have the sole and exclusive right to provide services in a designated area on the condition that he(they) will bear the responsibility of collecting and transporting of all municipal wastes to maintain cleanliness of the area.
- (vi) The waste charge rate in the privatised area(s) shall be determined by the level of services and the financial affordability of the beneficiaries and NCC.

(7) Financial Improvement Plan

(a) Objective

The objective of the Financial Improvement Plan is to improve and strengthen the financial conditions of SWM services and to support sound or sustainable operations.

(b) Planning Policy

- (i) Enough revenue should be secured for the proper operation of SWM services.
- (ii) Cost effectiveness should be improved in the operation of SWM services.
- (iii) Financial planning for SWM services should be improved.

(c) Strategy

(i) Establishing Financial Autonomy of SWM

Since the generation of general tax revenue by NCC is severely constrained and is likely to remain for a considerable time, the Department of Environment must secure its own revenue for the operation of SWM services by establishing a special account whose revenue is restricted to expenditures for SWM activities only.

(ii) Increasing Revenue through Charges

The existing billing system which utilises the water billing system should be continued. In addition, a step-up tariff system which

changes rates in accordance with income should be introduced for increasing revenue.

(iii) Improving the Budgetary System

Simplifying the budgeting process and clarifying the accounting procedure will help to grasp the financial conditions accurately and to make a proper financial planning of SWM services.

(iv) Private Sector Involvement

Contracting-out a part of SWM services to private companies is expected to improve cost efficiency of the services as a whole.

(8) Public Education and Awareness Plan

(a) Objective

The objective of the Public Education and Awareness Plan is to raise awareness of citizens for cooperation to solid waste management.

(b) Planning Policy

The Plan shall be formulated to promote a better understanding of citizens through public and school education by establishing a workable implementation system within NCC.

(c) Strategy

(i) Raising Awareness within the NCC

The NCC's own awareness of the requirements of a new solid waste management strategy is to be raised through a programme of seminars and workshops directed at council officials. This should be made prior to a public announcement by NCC on the implementation of the new strategy.

(ii) Communications Strategy

Following its decision to implement the new strategy, the NCC has to inform the public of the measures it proposes taking to improve SWM services in the city and of its proposals to increase the existing charge levels to pay for the services. A properly structured communications strategy is to be proposed.

(iii) Public Education

A public education and awareness programme should accompany the NCC's announcement of the new strategy. Any attempt to introduce such a programme before the NCC has spelt out the steps

it is to take to improve solid waste management conditions in the city would be futile.

(iv) Primary Education

A children's charter is proposed to make school children more aware of solid waste issues. It involves a commitment by the NCC to provide high quality collection services to all schools and children to keep their school compounds free from waste. It is to be reflected in a signed Charter prominently displayed in all schools.

A highly visible public commitment such as this will heighten children's awareness of the issues involved and place a duty on the NCC to meet its publicly stated obligations.

3.6 Goals of the Master Plan

The goals of the action plans of each sector of the master plan are as outlined below with prospective target levels to be achieved by the year 2008.

(1) Collection and Transportation Plan

- To increase the collection efficiency and capacity with the collection ratio targeted at 100% for NCC and private companies at the ratio of 80% and 20%, respectively.
- To encourage more participation of private companies in the collection services.
- To attain full control of collection services by NCC.

(2) Waste Reduction, Recycling and Intermediate Treatment Plan

- To reduce waste by 5% at generation sources.
- To encourage participation of the central government, NCC, residents and enterprises.
- To attain resource recovery of 5% through participation of community based groups and NGOs.
- To attain resource recovery of 5-10% by scavengers.
- To encourage promotion, control and assistance by NCC on resource recovery activities.
- To encourage promotion, encouragement and assistance to recycling companies.
- To prepare a development plan for a pilot scale compost plant with the capacity of 50 tons per day for materials recycling and biological conversion processes.

(3) Final Disposal Plan

- To operate an effective sanitary landfill.
- To prepare a post-closure plan.
- To minimise secondary pollution.

(4) Institutional Restructuring Plan

- To establish an effective organisation structure.
- To formulate and implement an effective policy and planning.
- To develop good human resources.
- To appoint effective managers and supervisors.

(5) Legal Restructuring Plan

- To enact a SWM By-laws.

(6) Private Sector Involvement Plan

- To increase the amount of solid waste collected by private companies.
- To encourage and provide assistance to recycling companies.

(7) Financial Improvement Plan

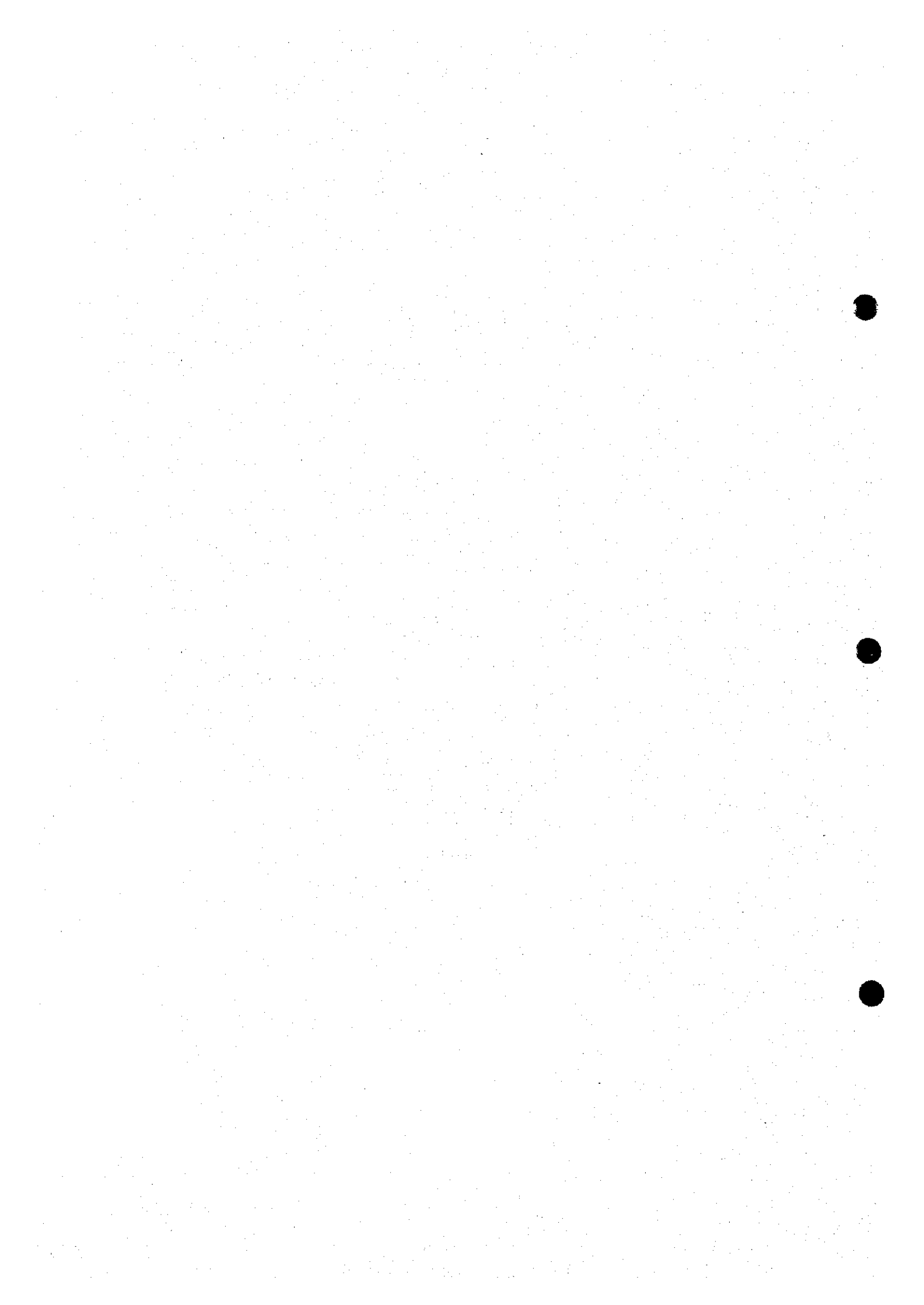
- To attain financial autonomy.
- To increase revenue from solid waste charges.
- To increase solid waste tariff to an appropriate level.
- To maintain the viability of budgeting.

(8) Public Education and Awareness Plan

- To continue public awareness campaign and educational programme through the media.
- To implement regular education on SWM for students at schools.
- To implement regular education on SWM for adults at churches.
- To increase public awareness on the reduction and recovery of solid waste.

CHAPTER 4

**FORMULATION OF
THE MASTER PLAN**



CHAPTER 4

FORMULATION OF THE MASTER PLAN

4.1 Introduction

This Chapter describes the formulation of the Master Plan in a combination of technical options and institutional and financial arrangements. The first two sections, namely **Section 4.2** and **Section 4.3**, present the socioeconomic aspects such as population and economic projection and social conditions and the future waste generation and composition from the present to the target year 2008, respectively. Based on these basic conditions, technical approaches are analysed to establish the three (3) strategic components of the Master Plan; namely, (1) the collection and transportation plan; (2) the waste reduction, recycling and intermediate treatment plan; and (3) the final disposal plan, as discussed in **Section 4.4**. The technical alternative plans are then identified and evaluated in **Section 4.5**, and the selected alternative plan is amplified by institutional, financial and legal restructuring plans including private sector involvement and public education plans, as explained in **Section 4.6** to **Section 4.10**. The phased implementation plan is presented in **Section 4.11**, to clarify the timing and scale of the proposed plans and to identify priority projects for the Feasibility Study. **Section 4.12** compiles the preparatory actions that should be carried out by the Nairobi City Council (NCC) to facilitate the implementation of the Master Plan, and this section also presents the Urgent Improvement Plan. Finally, **Section 4.13** describes the evaluation of the Master Plan in terms of technical, environmental, social and economic and financial points of view.

All the detailed data and analysis relevant to each Section are given in **Volume 4, Supporting Report; Volume 5, Data Book (1); and Volume 6, Data Book (6)**.

4.2 Socioeconomic Aspects

4.2.1 Population Projection

(1) Projection of Total Population in Nairobi Province

The latest national census was carried out in 1989, so that there was no data on actual population in Nairobi in 1997. The population projection for Nairobi City prepared by the Ministry of Local Government (MOLG) is thus employed. **Figure 4.2-1** shows the projection results.

The projection shows a growth rate of 4.70% per annum (p.a.) from 1998 to 2008. Accordingly, the projected population will increase by more than one million during the years covered by the study.

Table 4.2-1 Projected Total Population in Nairobi Province

Unit: 1,000

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Kenya	29,010	2,746	30,473	31,189	31,896	32,588	33,264	33,922	34,561	36,178	35,773	36,344
Nairobi	2,191	2,294	2,397	2,500	2,616	2,737	2,867	3,012	3,148	3,300	3,461	3,630
Share*	7.55%	7.71%	7.87%	8.02%	8.20%	8.40%	8.62%	8.88%	9.11%	9.12%	9.67%	9.99%

* "Share" indicates proportion of the population of Nairobi to the total population of Kenya.

Source: Economic Survey 1996, MOLG and JICA Study Team

(2) Population Projection of Sub-Areas in Nairobi Province

Locational distribution of population is essential for the formulation of the solid waste management plan, especially, the collection and transportation plan. Populations in locations are shown in the estimation gained above. (See Table 4.2-2.)

Table 4.2-2 Population Projection of Sub-Areas in Nairobi Province

(Unit: 1,000)

Location	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Makadara	64	64	65	65	65	65	65	65	65	65	65	65
Kaloleni/Makongeni	1	1	1	1	1	1	1	1	1	1	1	1
Maringo/Mbotela	27	27	27	27	27	27	27	27	27	27	27	27
Viwanda	28	28	28	29	29	29	29	29	29	30	30	30
Bahati	32	32	32	33	33	33	33	33	33	33	33	33
Pumwani	9	9	9	9	10	10	11	11	12	12	13	14
Eastleigh	122	122	123	124	125	126	127	129	130	131	133	134
Kamukunji	22	23	23	23	23	23	23	23	23	23	23	23
Ngara	51	52	52	52	55	57	60	63	66	70	73	77
Starehe	84	84	84	85	87	90	93	96	99	102	106	109
Kibera/Woodley	49	49	50	51	53	56	59	62	65	68	71	75
Karen/Langata	82	89	95	102	10	115	121	129	136	145	153	16
Kenyatta/Golf Course	17	17	17	18	19	20	20	22	23	24	25	26
Mugumoini	129	133	138	142	150	157	165	173	182	191	200	210
Waiihaka	46	48	51	54	57	61	65	68	72	77	81	86
Kangemi	110	117	124	131	138	147	156	165	175	185	196	208
Riruta	56	60	63	67	71	75	79	84	89	94	100	106
Kawangware	35	37	40	42	44	47	50	53	56	59	63	67
Mutuini	41	44	46	49	52	55	58	62	65	69	73	78
Parklands*	210	218	226	234	246	258	271	285	299	314	330	347
Muthaiga	25	27	30	32	33	35	37	39	41	43	45	47
Kilimani	59	60	60	61	64	67	71	74	78	82	86	90
Mathare	54	55	55	55	55	55	55	55	55	55	55	55
Kariobangi	10	10	11	12	12	13	14	15	15	16	17	18
Kahawa	98	105	113	120	126	132	139	146	153	161	169	177
Kasarani (Ruaraka)	110	115	120	125	129	134	139	145	150	156	163	170
Raysambu	93	96	99	102	108	113	119	125	131	137	144	151
Embakasi	155	164	17	183	194	205	217	229	242	256	271	286
Njiru	349	381	413	445	471	500	530	570	595	631	669	709
Dandora	24	26	27	29	31	32	34	37	39	41	43	46
Total	2,191	2,294	2,397	2,500	2,616	2,737	2,867	3,012	3,148	3,300	3,461	3,630

* Population of Muthaiga is not included in Parklands.

Source: MOLG and JICA Study Team

In addition, each sub-area (location) is classified by income level, namely high, middle and low, using the identification by the report entitled "A Strategic Health Plan for the Nairobi Area, Final Report, 1992."

4.2.2 Economic Projection

(1) Economic Growth

"A Road Network Development Master Plan, Final Report, 1995" made a forecast of gross domestic product (GDP) per capita growth rates up to 2010. This depicts the growth rates as growing gradually to 3.48% over the years 1995-2005 and dropping slightly to about 3.32% p.a. during 2010. With consideration of recent actual figures, they are adjusted to be lower, as shown in Table 4.2-3:

Table 4.2-3 Projected GDP Per Capita Growth Rate

Year	GDP Per Capita Growth Rate (%, p.a.)
1997	2.19
1998	2.34
2000	2.65
2004	2.99
2008	2.98

Source: A Road Network Development Master Plan, Final Report, 1995 and JICA Study Team

(2) Household Income

"Welfare Monitoring Survey II, Basic Report, 1996" presents the percentage distribution of households in Nairobi Province by yearly expenditure in 1994 and the distribution of annual per capita income and expenditure by quintiles in 1994. This report also presents mean monthly household expenditure, Kshs 15,075.8 and income, Kshs 16,789.4 in 1994. From these data on households, each class of household monthly income is estimated, as shown in Table 4.2-4:

Table 4.2-4 Projected Monthly Household Income by Levels
Unit: Kshs/month; 1997 Price

Levels	1997	1998	2000	2004	2008
Top 45% Level	14,499	14,817	15,542	17,343	19,546
Top 30% Level	18,830	19,242	20,184	22,523	25,384
Top 15% Level	23,161	23,667	24,826	27,703	31,222

Source: Welfare Monitoring Survey II, Basic Report, 1996 and JICA Study Team

Since the population in informal settlements are estimated at 55% of the total (The Nairobi Informal Settlements Coordination Committee, "A Development Strategy for Nairobi's Informal Settlement," October 1997), the remaining population can be divided into three same size income classes at the Top 45%, 30% and 15% Levels.

The Study assumes that the affordability for solid waste management by households is 1% of income, considering those in other developing countries including Penang City, Malaysia (0.67%), Bangkok, Thailand (0.62%), Surabaya, Indonesia (0.5%) (Note: these figures are shares of per capita GDP).

Thus, affordability for solid waste management by households in the planning years is estimated as follows:

Table 4.2-5 Estimated Affordable Limit for Households
Unit: Kshs/month; 1997 Price

Levels	1997	1998	2000	2004	2008
Top 45% Level	145	148	155	173	195
Top 30% Level	188	192	202	225	254
Top 15% Level	232	237	248	277	312

Source: JICA Study Team

According to the Public Awareness Survey conducted as a part of the Study, willingness-to-pay for SWM services is 212 Kshs for High Income, 207 Kshs for Middle Income and 61 Kshs for Low Income, after adjustment of the factor on those who are not willing to pay. Thus, the estimated figures are used as references for affordability.

4.2.3 Social Considerations

(1) Overview of Findings

Significant findings of the analysis are:

- (a) It is necessary to distinguish between formal and informal areas in planning SWM strategies for Nairobi.
- (b) A minimum level service based on communal collection points is likely to be the most appropriate collection strategy for the formal areas of Nairobi.
- (c) Strategies for the informal areas need to be formulated in close collaboration with non-governmental organisations (NGOs) and community-based organisations (CBOs) working in these areas.
- (d) Scavenging is a response to poverty, a fundamental component of the Kenyan recycling industry, a major generator of income for poorer households, and a key factor in reducing the amount of waste to be disposed of by society.

(2) Strategic Implications

The strategic implications of these points are summarised below.

(a) Waste Collection in the Formal Areas

A strategic objective should be to provide a minimum level of service to the formal areas of Nairobi. Advantages are:

- (i) The NCC can focus on providing basic services throughout Nairobi.

- (ii) Charge levels can be kept to a minimum; a single basic charge can be levied on all users; existing charging arrangements can be maintained.
- (iii) The private sector can be contracted by the NCC to provide (minimum level) secondary collection services in discrete collection areas.
- (iv) Householders can contract independently with the private sector for the provision of primary collection services. Two ways are:
 - private firms providing door-to-door collection services as currently done in the more affluent areas of Nairobi; and
 - local residents' associations providing locally-based primary collection services in less affluent areas.

(b) Waste Management in the Informal Areas

Significant points are:

- (i) Single-issue objectives (such as improved waste management) combined with centralised solutions are often inappropriate; integrated approaches involving the communities themselves are more appropriate.
- (ii) The starting point for strategy planning is an understanding of the existing programmes and activities of NGOs and CBOs, and for strategies to be developed in collaboration with these groups.
- (iii) Since waste is a principal source of income for people living in informal areas, the role of government should be to facilitate the creation of community-based schemes rather than to support centralised projects in direct competition with them.
- (iv) Micro-enterprises offer an important opportunity for improving the effectiveness of community-based initiatives.

(c) Management and Control of Scavengers

Policy responses to scavenging can be addressed specifically towards door-to-door collectors, city site scavengers and Dandora disposal site scavengers.

- (i) Door-to-door collectors are not perceived to be a problem, and no policy actions are proposed.
- (ii) City site scavengers are perceived to be a nuisance, but effective collection services should considerably reduce the problem. Their forcible removal is not recommended as this will merely cause social tensions elsewhere.
- (iii) Closure of the Dandora site will remove the sole source of income for some 2,000 site-based scavengers, most of whom will want to shift to the new landfill site. Denying scavengers access to the new

site is likely to be expensive and socially undesirable. Policy should be directed towards managing the activities of scavengers on the site.

- (iv) The Study recommends that scavengers should not be permitted to reside at the new site.
- (v) The Mukura Recycling Project should be encouraged to relocate to the new site, and the opportunity to create a cooperative society of scavengers out of the project should be examined in detail.

4.3 Future Waste Generation and Composition Analysis

4.3.1 General

Future solid waste amount and composition by the year 2008 is forecast on the basis of results obtained in the field survey. The forecast model includes interim estimates for the year 1998, 2000, 2004 and 2008.

The following factors have an influence on the future waste amount and composition:

- (1) Population;
- (2) Social welfare and the financial capacity of single consumers/families;
- (3) Industrial technology; and
- (4) Import of goods.

4.3.2 Forecast on Future Population in Nairobi

The most direct influence on waste generation is the change in population. As described in Subsection 4.2.1, the annual population in Nairobi City for the planning period has been estimated, as shown in Table 4.3-1

Table 4.3-1 Forecast on Future Population in Nairobi

(Unit: 10³ person)

	1997	1998	2000	2004	2008
High income	511	532	574	703	862
Middle income	585	614	674	820	992
Low income	1095	1,147	1,252	1,489	1,776
Total	2,191	2,294	2,500	3,012	3,630

Source: A Strategic Health Plan for the Nairobi Area, Final Report, 1992 and MOLG

4.3.3 Relationship between Gross Domestic Product (GDP) and Waste Discharge

GDP is one of the important indicators which may represent levels of social welfare, industrial technology and import of goods. Growth rate in GDP is thus expected to have a larger impact on the waste amount per capita of developing countries than the developed countries and it will also remarkably result in changes in the composition of waste at a certain welfare level.

The statistics of Tokyo Metropolitan Area and Bangkok, Thailand in the past show that there is a correlation between the waste increase rate per capita and growth rate in GDP per capita. The rate of waste increase rate per capita to growth rate in GDP per capita in Tokyo Metropolitan Area between 1956 and 1968 is 0.51. Another study in Bangkok between 1990 and 1995 shows the rate of 0.52. Based on these figures, it is assumed that the waste increase rate per capita is 0.5 of growth rate in GDP per capita in percent.

4.3.4 Methodology for Selecting the Forecast Model

For the types of waste to be forecast, the conditions for estimation are as set out below.

(1) Commercial Waste (Restaurant, Others)

Commercial waste generation is forecast based on the number of shops which will increase in proportion to the increase in population.

(2) Household Waste

The data of waste generation amount per capita was obtained in the field survey. Waste discharge amount is calculated by subtracting self-disposal amount from generation amount. The self disposal amount is estimated on the basis of the result of socioeconomic and public awareness survey on households in Nairobi City by the JICA Study Team in May, 1997, which covered 504 households of each income level. As described before, the waste discharge amount per capita will increase according to 0.5 of growth rate in GDP per capita in percent.

(3) Market Waste

Market waste generation is also forecast based on the number of hawkers in the market which will increase in proportion to the increase in population.

(4) Road Sweepings

Waste generation ratio of road waste will not change and it is projected based on the length of road for sweeping service which will increase in accordance with the GDP growth. Therefore, road waste generation is assumed to increase in proportion to the GDP growth.

4.3.5 Forecast on Waste Amount in Nairobi

Based on the assumptions above, the forecast on waste amount in Nairobi is made and the results are as shown in Table 4.3-2 and Figure 4.3-1 below.

Table 4.3-2 Forecast on Waste Amount in Nairobi

(Unit: t/day)

	1997	1998	2000	2004	2008
Household	1181.1	1251.1	1398.9	1784.1	2283.3
Commerce	93.5	97.9	106.7	128.5	154.9
Market	82.5	86.3	94.1	113.4	136.6
Road	69.0	73.9	84.8	114.4	155.3
Total	1,426	1,509	1,684	2,140	2,730

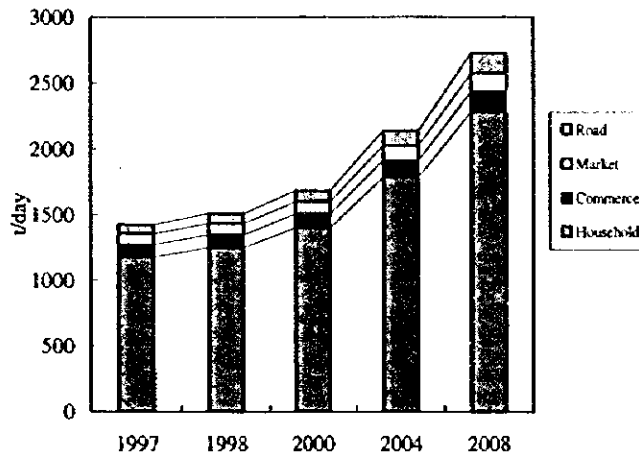


Figure 4.3-1 Forecast on Waste Amount in Nairobi

4.3.6 Forecast on Future Waste Composition

Waste characteristics are forecast based on the results of the field study because there are no data available regarding consumption pattern, improvement of the standard of living, change in lifestyle, degree of urbanisation and so on, which are among the important factors to forecast the future changes.

Figure 4.3-2 and Table 4.3-3 show the forecast on waste composition. The frame of the waste composition in 2008 is set as follows:

- (1) Combustibles ratio is decreasing to 85%, and incombustible ratio is increasing to 15%.
- (2) Each composition ratio in combustibles (food waste, paper, textile, etc.) and non-combustibles (glass, metals, any other) is constant.

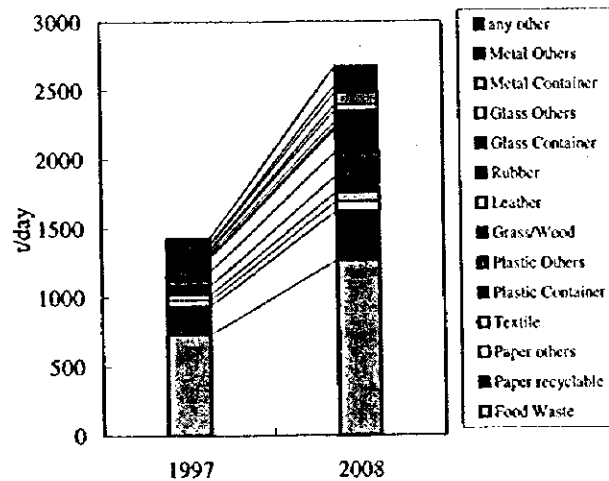


Figure 4.3-2 Forecast on Waste Composition in Nairobi

Table 4.3-3 Forecast on Waste Composition in Nairobi

Constituent	1997		2008		
	Total (t/day)	Rate (%)	Total (t/day)	Rate (%)	
Food Waste	734	51.5	1239	47.4	
Paper	Recyclable	206	14.5	363	13.3
	Others	41	2.8	71	2.6
Textile	38	2.7	67	2.5	
Plastic	Container	67	4.7	118	4.3
	Others	102	7.1	179	6.6
Grass/Wood	96	6.7	168	6.2	
Leather	13	0.9	23	0.8	
Rubber	21	1.5	37	1.3	
Combustible-subtotal	1,317	92.4	2,321	85.0	
Glass	Container	21	1.5	81	3.0
	Others	11	0.8	43	1.6
Metal	Container	25	1.7	93	3.4
	Others	13	0.9	49	1.8
Any others	38	2.7	143	5.2	
Non-combustible-subtotal	109	7.6	410	15.0	
Total	1,426	100.0	2,730	100.0	

4.4 Development of Technical Options

In this Section, alternative plans are developed for the sector plans, particularly focusing on the technical approaches which include collection and transportation; waste reduction, recycling and intermediate treatment; and final disposal. The alternative plans for each sector are compared in Section 4.5, Selection of Alternative Technical Plans, to evaluate and select the optimum plan and to further assess the financial viability of the proposed components of the Master Plan.

4.4.1 Collection and Transportation Plan

(1) Overview of the Planning Concept

As analysed in Chapter 2, the present collection and transportation services for solid waste in Nairobi is extremely low. The solid waste amount survey shows that only about 25% of the total solid waste generated is collected by both the Nairobi City Council (NCC) and the private companies. The remaining uncollected wastes are dumped on vacant lands and on roads. This serves not only as an eyesore but also causes a serious deterioration of the city's sanitary environment and public health.

The primary objective of the Collection and Transportation Plan is, therefore, to increase the coverage of collection services to maintain public health and sanitary conditions and to protect the city's environment. To achieve this objective, the collection coverage ratio or waste collection rate of NCC and the private sector should be 100% in 2008, the target year of the Master Plan. Apart from this target, the improvement plan for the years 1998 and 1999 is urgently required to cope with the increase of generated waste in the city. The main activity of the improvement plan is the renewal of collection vehicles. The details of this plan are described in Section 4.12.

For planning purposes, NCC should provide the minimum level of service throughout Nairobi and to collect all the solid wastes generated in the city. The minimum level of service is defined as collection services conducted once a week from communal collection points.

NCC should also promote private sector involvement (PSI) with full control in terms of collection services. Aside from subcontracting collection areas to private companies, NCC should provide an equally satisfactory service to the communities.

For the purpose of increasing the collection coverage ratio or waste collection rate, the most economical and efficient collection and transportation system should be adopted in consideration of possible technical options such as station type and door-to-door type collection, as well as direct and indirect transportation methods.

Community based waste management in the informal settlements shall be considered to enhance the collection and transportation operations by using communal collection points. Improvement of the existing vehicle operation and maintenance system in the Department of Environment of NCC shall also be carried out to increase the availability of collection vehicles.

(2) Possible Technical Options

Although a wide variety of systems and equipment have been used for collection and transportation of solid waste, collection and transportation services in almost all developing countries still depend on a combination of manpower and vehicles. Technical options for collection and transportation

are thus primarily considered in these two system components in the Master Plan. In addition, the collection system options are basically established assuming that household collection is dominant because the target waste amount to be collected is mainly composed of household waste.

(a) Collection System Options

As far as the current NCC collection system is concerned, approximately 90% of the collection service is the station type of collection. This system is understandable since many heaps of garbage could be seen anywhere in Nairobi and NCC has to remove the waste day by day under the "crisis management" circumstances, i.e., too few vehicles and equipment for operations. There seems to be little room for conducting a door-to-door type collection throughout the city at present.

In the Master Plan, however, since the increase in number of vehicles and equipment is thought to be one of the options, the station and the door-to-door types of collection are the collection system options.

(i) Station Type of Collection

To improve the efficiency of waste loading work, the communal container system is generally applied for the storing and hauling of waste. This hauled container system has the advantage of requiring only one truck and a driver to accomplish the collection cycle, and each container picked up requires a round trip to the disposal site or other transfer point. Detachable-container trucks are recommendable for this system. Alternatively, dump trucks (or tippers) with a wheel loader or with manual loading can also be applied.

(ii) Door-to-Door Type of Collection

In this option, collection trucks drop by each household to pick up the waste. This system has already widely prevailed particularly in the high income residential areas of Nairobi, and the main collectors are private entities. This requires a much higher capital and O&M cost than the station type of collection, in general, but the system can fully cover the target area if collection vehicles with loaders are sufficiently provided. Compaction-type vehicles (or compactor trucks), open trucks (or side-loaders) or dump trucks (or tippers) are usually employed for this system.

In consideration of the merits and demerits of the two options mentioned above, it seems that a combination of the station and door-to-door types of collection are the most applicable in Nairobi City because of the many types of housing and the different methods of discharging waste which could not fit into only one system of collection. In terms of collection vehicles to be used, the following four (4) options are considered for the most appropriate collection system in Nairobi.

Table 4.4-1 Collection System Options

Option	Kind of Collection Vehicles	
	Main System	Subsystem
A-1	Container trucks (8 m ³)	Side loaders (6t), Dump trucks (or Tippers, 6t) and Wheel loaders (2 m ³ bucket capacity)
A-2	Dump trucks (or Tippers, 6t) and Wheel loaders (2 m ³ bucket capacity)	Side loaders (6 t)
A-3	Dump trucks (or Tippers, 6t) and Manual loading	Side loaders (6t) and Wheel loaders (2 m ³ bucket capacity)
A-4	Compactor trucks (6t)	Side loaders (6t), Dump trucks (or Tippers, 6t) and Wheel loaders (2 m ³ bucket capacity)

(b) Transportation System Options**(i) Indirect Transport**

Transfer operations can be used successfully when the locations of disposal sites are relatively far from collection routes. In this case, transfer stations are required to accomplish the transfer of solid waste from collection vehicles to a larger transport equipment.

(ii) Direct Transport

Direct transport can also be chosen to avoid excessive initial investment for the construction of a transfer station or when unable to secure land for transfer stations.

Two areas, namely, the Ruai and Ngong Road Forest areas as mentioned later in Subsection 4.4.3, are proposed for final disposal site in this Study. The Ruai Area is located in the eastern part of Nairobi and further from the existing dumping site at Dandora, but the Ngong Road Forest Area does not have enough land for a 10-year disposal of waste if the disposal site is constructed only in that area. Therefore, in consideration of a combination of direct transport and indirect transport, as well as the number of disposal sites to be constructed, three (3) options are applied to the Master Plan as tabulated below. The decision on which collection or transportation system is better depends mostly on the economical consideration.

Table 4.4-2 Transportation System Options

Option	Final Disposal Site	Transfer Station
B-1	Ruai and Ngong Road Forest	Not applicable
B-2	Ruai only	Madaraka or Kariobangi area
B-3	Ruai only	Not applicable

(3) Selection Procedure

The selection of a collection system option does not depend on how many or how far disposal sites are to be constructed. In other words, the best collection system can be selected independently from the transportation system.

Based on this concept, **Item (4)** below describes the evaluation of each collection system option, assuming that the final disposal site is constructed at the Ruai Area only without any transfer station so as to compare the options under the same conditions. The transportation system is then developed accordingly in **Item (5)** and evaluated based on the best collection system option in consideration of cost for disposal.

Details of each option such as presumptions and estimation of the required quantities are explained in **Chapter 6 of Supporting Report Section E.**

(4) Evaluation of the Collection System Options

(a) Technical Evaluation

From the operation and maintenance point of view, dump trucks (or tipper) are the easiest vehicles to be operated and maintained by the local personnel. However, the Nairobi City Council (NCC) still uses container trucks and compaction-type trucks (compactors) even if both types of vehicles were procured more than eight years ago. According to their experience, the staff of the Cleansing Section, Department of Environment stated that compactors are more difficult to operate and maintain than container trucks. Moreover, due to many bumps and dents in the roads of Nairobi, compactors jolt so badly that their rear portions with the waste inlet opening get in contact with the road, causing the vehicles to break down.

In conclusion, dump trucks (**Options A-2 and A-3**) are technically the best. However, there is not so much difference among these two options and the container trucks (**Option A-1**) because the mechanism of their hydraulically operated arm is exactly the same.

(b) Environmental Evaluation

Option A-1 essentially envisions the abolition of the existing unauthorized dumping of waste on roads or in open derelict spaces and their replacement by a container system. The decrease of solid waste left in the city will consequently improve the appearance of city streets and residential areas and the environmental conditions of the city. Although the other options, namely **Options A-2, A-3 and A-4** also intend to reduce dumping, the substitution of the present manual labor throwing waste into dump trucks with mechanization by a container system proposed in **Option A-1** will greatly contribute to the improvement of sanitation conditions of workers involved in the loading of waste.

Therefore, **Option A-1** is superior to the other options in view of contribution of improving not only the city's environment but also the worker's sanitary conditions.

(c) Social Evaluation

If the containers installed in the city make themselves conspicuous, e.g., bright coloured containers, it will be easy for residents to notice that the new collection system has started. The introduction of containerization will therefore result in arousing people's awareness toward the importance of solid waste management, and it will accordingly enhance people's cooperation with the new system.

In short, **Option A-1** is thought to have a positive social impact to a greater extent than the other options because people in Nairobi are used to seeing dump trucks and compactors.

(d) Economic and Financial Evaluation

The unit cost spent for collecting and transporting one (1) ton of waste is used as an indicator to economically evaluate the above developed options. Details of the estimation such as methodologies and assumptions are described in **Supporting Report Section J**, and the comparison of the estimated costs is shown in **Table 4.4-3** below.

From this table, the unit cost of **Option A-1** (Container) is the lowest. While **Option A-3** (Dump + Manual loading) has almost the same unit cost as **Option A-1**, the operating cost of **Option A-3** is higher than that of **Option A-1**. The lower operating cost means a lower burden on the financial situation of NCC. In conclusion, **Option A-1** is economically and financially the best option among them.

Table 4.4-3 Comparison of Estimated Cost of Collection Options

Items of Comparison	Option			
	A-1 (Container)	A-2 (Dump + Wheel loader)	A-3 (Dump + Manual loading)	A-4 (Compactor)
Operating Cost* ¹	15,970	16,736	19,031	19,133
Depreciation Cost* ¹	3,383	3,161	1,985	2,237
Capital Cost* ¹	3,428	3,207	2,031	2,283
Engineering Cost* ¹	189	177	113	127
Total Cost* ¹	22,970	23,281	23,160	23,779
Unit Cost* ²	46.25	46.87	46.63	47.88

*¹: All costs are indicated in 1,000 US dollars converting them into annual expenditures.

*²: The unit cost is described in US dollar per ton of solid waste.

(f) Selection of the Optimum Collection System

The preceding evaluation demonstrates that the optimum collection system is **Option A-1**. Based on this collection system, the optimum transportation system is selected in the following **Item (5)**.

(5) Evaluation of the Transportation System Options**(a) Economic Cost of Each Option**

The unit cost spent for collecting and transporting one (1) ton of waste has been calculated, as shown in **Table 4.4-6** below. Details of the estimation are described in **Supporting Report Section J**.

Option B-1 which proposes two disposal sites in the city has the lowest unit cost. In comparison with **Options B-2** and **B-3**, both operation and unit costs of **Option B-2** are lower than those of **Option B-3** while the capital cost of **Option B-2** is higher than that of **Option B-3**. Final evaluation from the economic, financial as well as other aspects such as technical, social and environmental, has been made in consideration of cost for final disposal, as described later in **Section 4.5**.

Table 4.4-4 Comparison of Estimated Cost of Transportation Options

Items of Comparison	Option		
	B-1 (Ruai and Ngong Road Forest)	B-2 (Ruai + Transfer Station)	B-3 (Ruai only)
Operating Cost* ¹	10,027	13,934	15,970
Depreciation Cost* ¹	3,018	4,085	3,383
Capital Cost* ¹	3,064	4,583	3,428
Engineering Cost* ¹	169	304	189
Total Cost* ¹	16,278	22,906	22,970
Unit Cost* ²	32.78	46.12	46.25

*¹ All costs are indicated in 1,000 US dollars converting them into annual expenditures.

*² The unit cost is described in US dollar per ton of solid waste.

(b) Selection of the Optimum Transportation System

The prescribed transportation options have been evaluated in combination with technical options for the final disposal site. The best selection is **Option B-2** (one disposal site at Ruai with a transfer station), and the required quantities of this option are as shown in **Table 4.4-5** below. The final evaluation is described in **Section 4.5**.

**Table 4.4-5 Vehicles, Equipment and Manpower Required for Option B-2
(Waste Collection Rate: 100%)**

No	Items	Quantity										
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	Detachable-container truck	82	86	91	96	101	106	112	118	125	132	139
2	Container	1853	1947	2042	2151	2267	2390	2531	2665	2815	2974	3143
3	Trailer truck	23	24	25	27	28	30	32	34	36	38	40
4	Side loader	40	42	44	46	49	51	54	57	60	64	67
5	Dump truck	19	20	21	22	23	24	26	27	28	30	32
6	Wheel loader	19	20	21	22	23	24	26	27	28	30	32
7	Water sprinkler	4	4	4	4	5	5	5	5	6	6	6
8	Inspection car	22	22	22	22	22	22	22	22	22	22	22
9	Tow truck	1	1	1	1	1	1	2	2	2	2	2
10	Parking lots	6	6	6	6	6	6	6	6	6	6	6
11	Driver	212	221	231	242	253	265	279	292	307	322	339
12	Loader	413	433	454	478	505	533	564	595	629	665	703
13	Sweeper	1239	1300	1361	1435	1514	1599	1693	1785	1886	1995	2110
14	Supervisor	182	191	200	211	222	233	247	260	274	289	306
15	Headman	83	87	91	96	101	107	113	119	126	133	141

(6) Collection and Transportation Plan for Informal Settlements

The experimental collection work in Kayaba clearly shows that a community based organisation in informal settlements or slum areas will engage enthusiastically in primary waste collection and this will greatly help in improving solid waste management in these area. The community was encouraged to collect refuse and place them in the collection points designed for the experimental work. The only problem regarding the collection of solid waste in Kayaba was the inability of NCC to clear the collection points on a regular basis because of the insufficient number of vehicles.

The collection and transportation plans mentioned above, i.e., Options A-1 to A-3 and B-1 to B-3 consider the collection of waste from communal collection points normally designed just outside of the slum entrance or exit by using the planned collection vehicles. The collection and transportation plan for informal settlements, therefore, concentrates on primary collection; in other words, collection of waste inside the slum area.

As the experimental collection work in Kayaba showed, the collaboration of community based organisations (CBOs) is imperative to expand the residents' involvement in primary collection. To organise the community group, if there is no organisation in the projected area, the strong leadership and guidance of a new NCC Community Development Section (CDS), as well as the cooperation of non-governmental organisations (NGOs), is required. Even if a community group exists, NGOs shall have to carry out the appropriate public education and residents awareness arousal programme before the actual operation work starts. The Society for Protection of Environment in Kenya (SPEK), which is one of the NGOs, showed good performance in implementing the residents' awareness programme in the experimental collection work. Additionally, the minimum number of equipment for waste collection such as wheelborrow, broom, rake, etc., shall also be provided to support the operation and add direct incentive to the participants.

The Community Waste Management Project (CWMP) initiative by NGOs for the primary collection inside the slum area including public education and awareness programme is thus proposed to be implemented in parallel with the collection and transportation services in formal areas. The CWMP will be extended to cover nine (9) additional slum areas in Nairobi in the first three years from 1999 to 2001. Every year from 2002 to 2004, four (4) slum areas will be developed. Finally, five (5) areas will be selected every year from 2005 to 2008 to finish covering all 37 informal settlements. The project in the designated slums is composed of five (5) activities: organisation of waste management groups, establishment of central disposal areas or collection points, collection operation, introduction of reuse/recycling of waste, and public education and awareness. The project schedule and cost are summarised in Table 4.4-6 below.

Table 4.4-6 Schedule and Cost of the Community Waste Management Project (CWMP)

Item	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Number of Slums for the Project	3	3	3	3	3	4	4	4	5	5	37
Project Cost of CWMP*	2,400	2,400	2,400	2,400	2,400	3,200	3,200	3,200	4,000	4,000	29,600

* All costs are indicated in 1,000 Kenyan shillings.

(7) Vehicle Operation and Maintenance Plan

The review on daily operation and maintenance records shows that the inappropriate vehicle maintenance, in particular, causes the extremely low level of vehicle availability. In addition, the main causes of failure such as brake, wheel and gear, require long duration in the workshop due not only to lack of spare parts but also the long procedure for the procurement of spare parts.

As it is, all the required spare parts, tools or equipment have to be purchased through the City Treasurer's Department. The Department of Environment (DoE) cannot deal autonomously with the procurement of spare parts and other required physical materials. This bureaucratic system actually interrupts immediate supply for replacement and repair in most cases.

To solve the situation, a small workshop which will be fully managed by the DoE should be constructed. The workshop will cover only preventive maintenance of the collection vehicles on a daily basis, minor repair of tire punctures, brakes, steering systems, etc., and procurement of spare parts for their repair. The new workshop should be located in the Kaloleni Cleansing Depot which is one of the largest depots in the DoE and has enough space for the construction of the workshop. A new Logistics Section under the Administration Division of the DoE will manage this workshop. The construction cost including installation of tools and equipment is estimated to be 15 million Kshs.

(8) Operational Organisation of the New Collection/Transportation System

Daily collection and transportation work should be operated based on the existing six (6) districts, since the management of daily operations is done regularly in each district. It seems to be very difficult to reorganise this district-wise system on a different type of locational boundaries like boroughs.

The organisation of a new collection and transportation system for each District, therefore, will be basically established under the District Inspector, and comprising a senior foreman, a senior headman, a headman or supervisor, drivers and loaders or sweepers. The typical staffing and composition of the organisational unit for daily operations is illustrated as follows, and the responsibility of each staff is as described in Subsection 4.6.4.

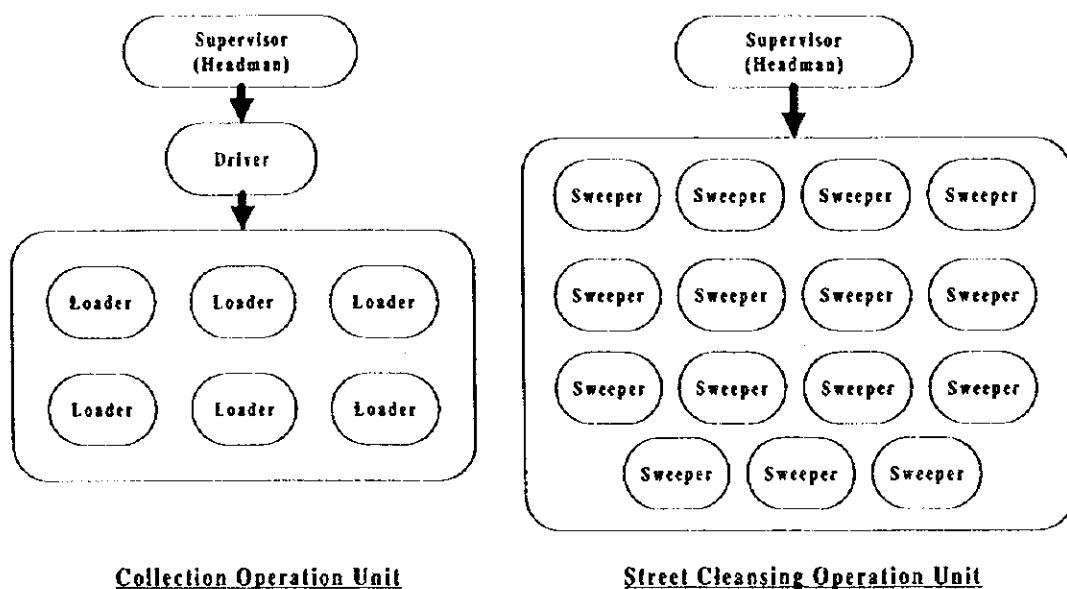


Figure 4.4-1 Typical Organisational Units for Daily Operations
 (Note: The number of loaders depend on the collection type.)

4.4.2 Waste Reduction, Recycling and Intermediate Treatment Plan

(1) The Role of NCC in Waste Reduction and Recycling

A Special Task Team shall be organised under the proposed Community Development Section (CDS) in DoE. The Team shall also be responsible for public campaign and education, encouragement, assistance, and co-ordination to form a link among the community groups and recycling companies in carrying out the waste reduction, recycling and intermediate treatment services.

In order to organise the activities of the community based groups, the CDS shall collect and publish a database on community groups, list of recycling companies, trading sites of the recovered materials (buy-back centres), etc., and control/co-ordinate the standard price for maintaining a stable market for the recycled materials.

Regarding the resource recovery at the disposal site, it would not be a wise way to ban materials recovery by the scavengers, although NCC's control and/or systemisation is needed to give a position to scavengers in forming a better recycling system for the NCC.

(2) Waste Reduction and Recycling Plan

(a) Waste Reduction

The target level of solid waste reduction ratio at the generation sources shall be 5% by the year 2008. The explanation on the target level is in Item (4) below.

For the implementation of a "trial program" called as waste generation source management, the more practical and promising methods are proposed to carry out the plan by means of programs, as follows:

- (i) Control of waste generation, including production control, distribution/sale control, consumer control, waste charge control and business waste control; and
- (ii) Discharge control, including promotion of self-disposal/recovery.

The CDS shall execute public campaign and education with the most effective measures to encourage the people to change their previous habits on generation, discharge and recycling of wastes and to promote the participation of the public.

(b) Recycling and Resource Recovery

The target level of waste recycling and resource recovery is set at 5% by 2008 by means of materials recovery, reproduction and reuse through participation of the residents, community groups, institutions and business establishments. The explanation on the target level is in Item (4) below.

The CDS officials dispatched to the six collection district offices shall implement the waste reduction and recycling activities. The CDS shall initiate the programs to establish the system for waste separation, collection, transportation, safe routes through the educational campaign to encourage participation of the public.

The public campaign, guidance and assistance shall be made continuously to develop the recycling activities.

(3) Intermediate Treatment Plan

In view of the financial circumstances of NCC, there is no option to propose the installation of intermediate treatment facilities at this stage of study. However, it should be noted that the intermediate treatment facilities are indispensable for the establishment of an integrated solid waste management

system for Nairobi in the future. Accordingly, considering the result of the waste composition analysis indicating the commingled ratio of food waste of about 50%, it is proposed to initiate a plan to establish the link with community based composting groups so as to support their activities, and to direct the plan toward the installation of a compost plant(s) at an early stage in combination with the incineration plant(s) which will be required in a later stage.

(4) Proposed Target Levels and Prospects

(a) Proposed Target Level

It is suggested that implementation of the Waste Reduction, Recycling and Intermediate Treatment Plan shall be initiated with the accumulation of database including waste amount, component, recycling activities, etc., to analyse the installation of appropriate facilities reflecting the needs of the society for recycling and intermediate treatment facilities. These data will be available through implementation of the improved solid waste management services proposed in the Master Plan and the priority projects within the coming 10 years.

The target level of waste reduction is proposed to realise the rate of 5% by 2008 and 10% by 2018 or later period by the reduction of waste amounts at the generation sources.

The target level of materials recycling and recovery is proposed at 5% by 2008 and 10% by 2018 or later period based on the waste amount counted from the amount after waste reduction at the generation sources.

The target level of waste reduction and materials recycling/recovery is proposed based on the experiences on solid waste management of many countries. In Japan, especially, there are many municipalities wasting lots of consumables without even achieving 5% of reduction and recycling after years of operating the trial program.

The actions for developing the intermediate treatment facilities shall begin by keeping a good link with the community based composting groups so as to encourage, support and assist their activities for the development of a compost market in the future.

(b) Estimated Amount of Waste Reduction and Resource Recovery

The estimated amounts of waste reduction and resource recovery are expected to be realised through the following activities:

- (i) The first action is public educational campaign by the NCC/MOLG to develop a social response to waste reduction through the participation of residents, community based organisations (CBOs), offices, factories and other business establishments. The waste reduction plan is expected to bring

about waste reduction of 137 tons per day by setting the target ratio of 5% in 2008.

- (ii) The second action is the separation of recyclable materials and recovery at the generation sources by actively campaigning for the participation of the CBOs under the preparatory co-ordination by NCC/MOLG for securing market for the recycling materials through installation of buy-back centres and co-operation by the recycling industries. Recycling is expected to have a resource recovery of 125 tons per day by setting the target ratio of 5% in 2008.

4.4.3 Final Disposal and Facility Plan

(1) Final Disposal Plan

The major targets of the Final Disposal Plan are: (1) to improve the existing dumping site; (2) to construct a new sanitary landfill site(s); and (3) to introduce a suitable maintenance and operation system at the new site(s) so as to establish the final disposal system for NCC.

The improvement plan for the existing dumping site (1998-1999) is described in Section 4.12. The main activities of the improvement plan are: (1) the introduction of a minimum number of heavy machines; and (2) the strengthening of operational management of the site.

The new final disposal system will start with the preparation and construction of a new sanitary landfill site(s). The major contents and schedule of the final disposal plan is as shown in Table 4.4-7.

Table 4.4-7 Major Contents and Schedule of the Final Disposal Plan

Year	Activities
1989-1999	<ul style="list-style-type: none"> • (improvement and sustenance of conditions at the existing dumping site) • preparation work for new site(s)
1999	<ul style="list-style-type: none"> • basic design and detail design for new site(s)
2000	<ul style="list-style-type: none"> • construction of new site(s) - first area
2001	<ul style="list-style-type: none"> • construction of new site(s) - second area • land-filling at the first area • suitable maintenance and operation of new site(s) • closure work of the existing Dandora site
2002-2003	<ul style="list-style-type: none"> • (construction of new site(s) - third area • suitable maintenance and operation of new site(s)
2004-2008	<ul style="list-style-type: none"> • suitable maintenance and operation of new site(s)

(2) Alternative Plan

There are two candidate final disposal sites, the Ruai Area and the Ngong Road Forest Area. Therefore, the following alternative plans for the final disposal system are considered:

Case A: Two (2) sites (Ruai, 20 ha; and Ngong Forest Area, 27 ha)

Case B: One (1) site (Ruai, 40 ha)

(3) Suitable Sanitary Level of Landfill System in Nairobi City

The sanitary level of landfill system can be classified into four (4) levels. The sanitary level of landfill system, its target, etc., are further described in **Supporting Report Section H**.

The primary target of the construction of the new site(s) plan should be Level 4 (Level 3 plus simple leachate treatment ponds), according to the Environmental Impact Assessment (EIA).

(4) Facility Plan of New Landfill Site

(a) Geological Investigation Result

The geological conditions of the candidate site are essential to the design of the final disposal site. The details of information on the investigation results are given in **Supporting Report Section H** and in **Section 8.2 of Data Book (I)**.

According to the Geological Survey Report, both sites do not require artificial liners to prevent seepage of leachate to the groundwater, because the bed layer of both candidate sites has low permeability ($>1 \times 10^{-8}$ m/sec).

(b) Facility Plan

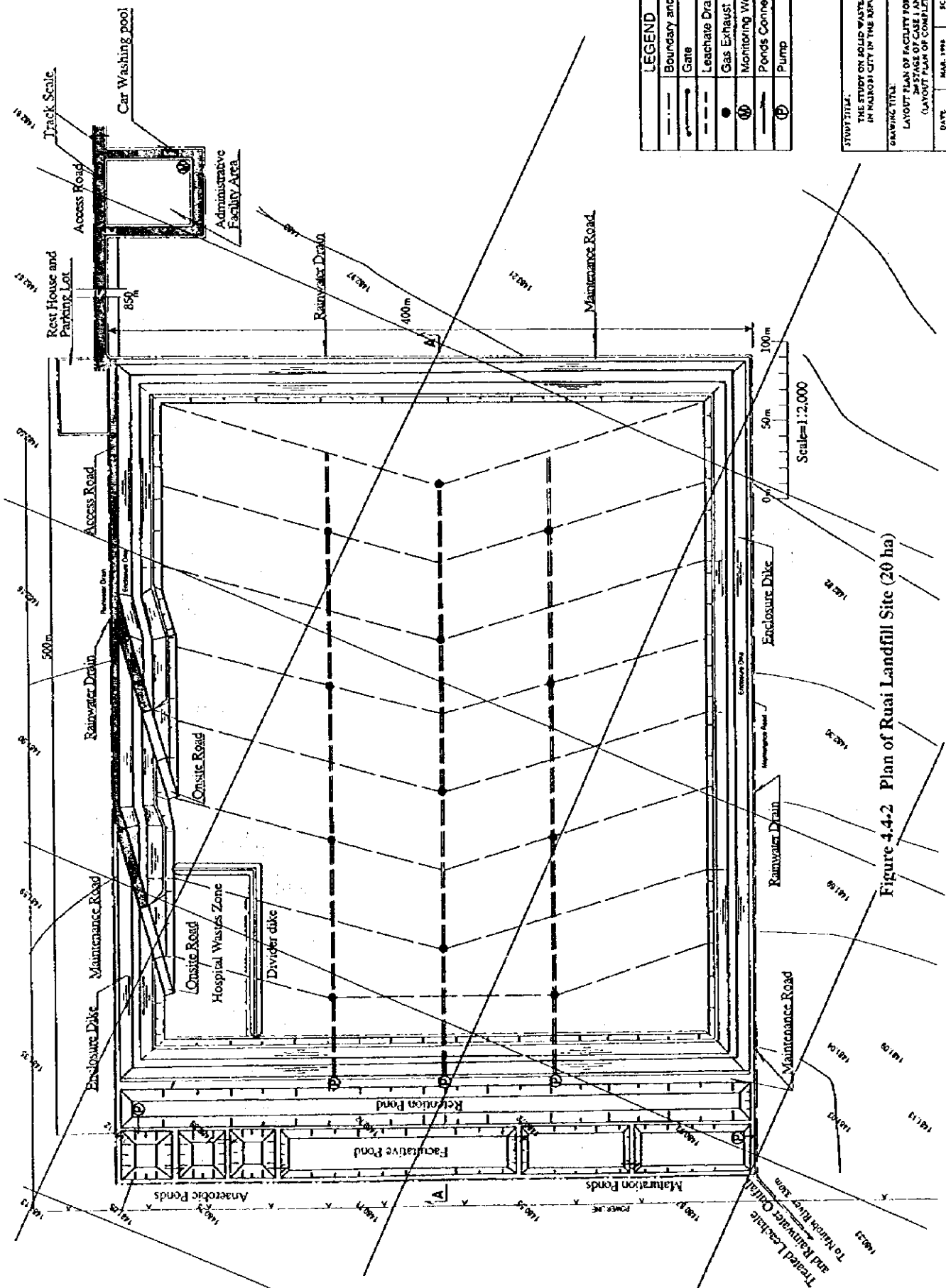
The major components of the designed sanitary landfill site are as shown in **Table 4.4-8**. Details of facility components and design calculations are described in **Supporting Report Section H**.

Table 4.4-8 Major Components of Landfill System

Components
1. Access Road
2. Structure for solid waste retention
2-1 Enclosure Dike
2-2 Divider Dike
2-3 Landfill Area
3. Leachate Control Facility
4. Leachate Treatment Facility
5. Rainwater Drainage
6. Gas Vent
7. Monitoring Facility
8. Administrative Facility

(c) Design of New Landfill Site

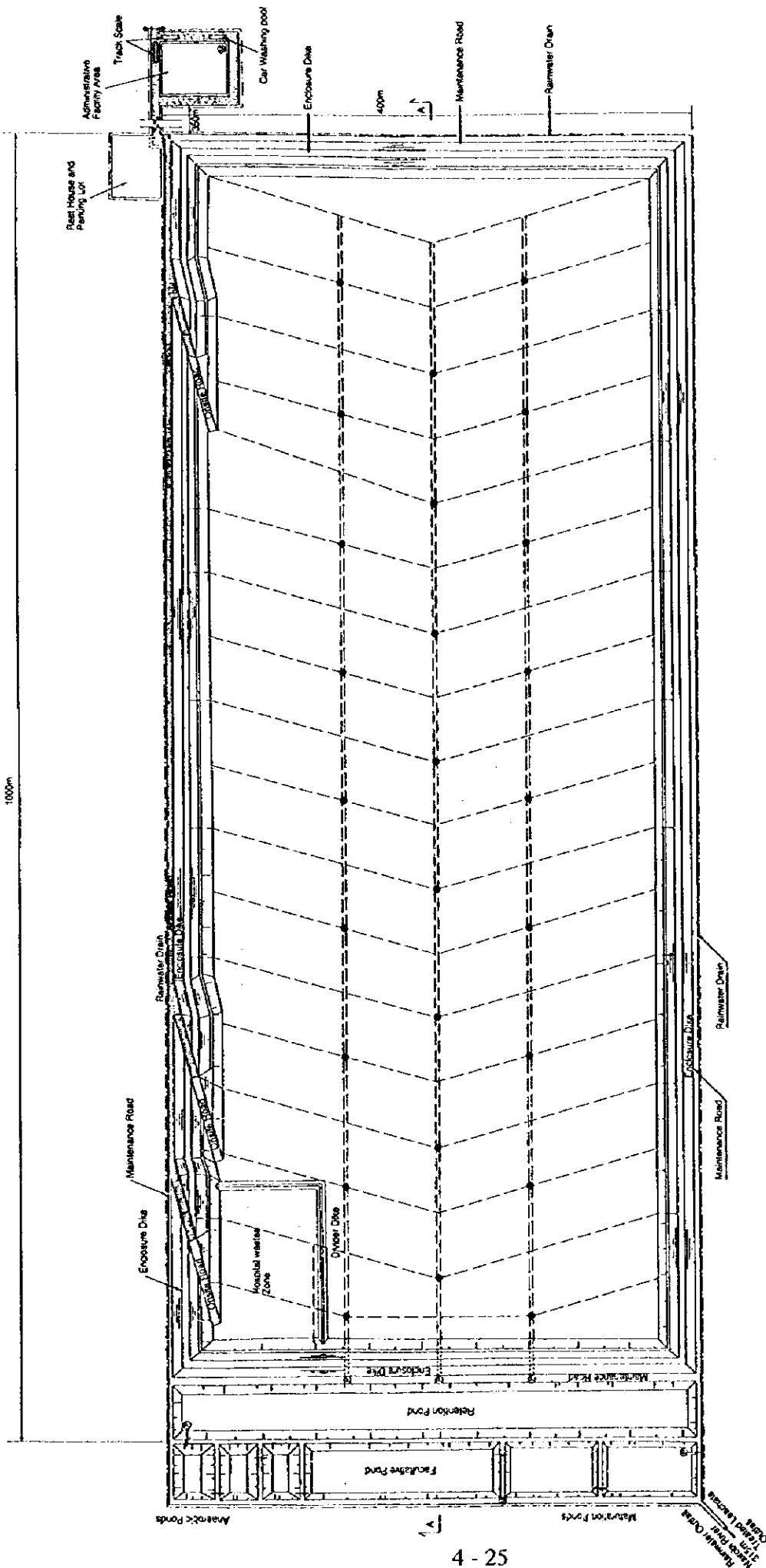
The design plans of the new landfill site(s) are shown in **Figure 4.4-2 to 4.4-4**. These plans are based on **Level 4** and include all components shown in **Table 4.4-9**. The Ruai site has two (2) alternative cases; one has an area of 20 ha and the other has 40 ha. The Ngong Road Forest site is 27 ha. The detail information on the sites are shown in **Volume 7, Drawings**.



LEGEND	
---	Boundary and Net fence
— —	Gate
- - -	Leachate Drain
●	Gas Exhaust Equipment
⊕	Monitoring Well
— —	Ponds Connection Pipe
⊕	Pump

STUDY TITLE: THE STUDY ON SOLID WASTES MANAGEMENT IN NAIROBI CITY IN THE REPUBLIC OF KENYA	
DRAWING TITLE: LAYOUT PLAN OF FACILITY FOR CONSTRUCTION 2nd STAGE OF CASE 1 AND CASE 2 (LAYOUT PLAN OF COMPLETED FACILITY)	
DATE: MAY 1992	SCALE: A4 SHOWN
DWG. NO.	Drawing 4.1.2
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

Figure 4.4-2 Plan of Ruai Landfill Site (20 ha)



STUDY TITLE:			
THE STUDY ON SOLID WASTES MANAGEMENT IN NAIROBI CITY IN THE REPUBLIC OF KENYA			
DRAWING TITLE:			
LAYOUT PLAN OF FACILITY FOR CONSTRUCTION IN STAGE OF CASES AND CASES (LAYOUT PLAN OF COMPLETED FACILITY)			
DATE	MAR. 1983	SCALE	AS SHOWN
DWG. NO.	Dmwp/1.1.3		
JAPAN INTERNATIONAL COOPERATION AGENCY/ICCA			

Figure 4.4-3 Plan of Ruai Landfill Site (40 ha)



LEGEND	
—	Boundary and Net fence
—	Gate
—	Leachate Drain
●	Gas Exhaust Equipment
⊙	Monitoring Well
—	Ponds Connection Pipe
⊕	Pump

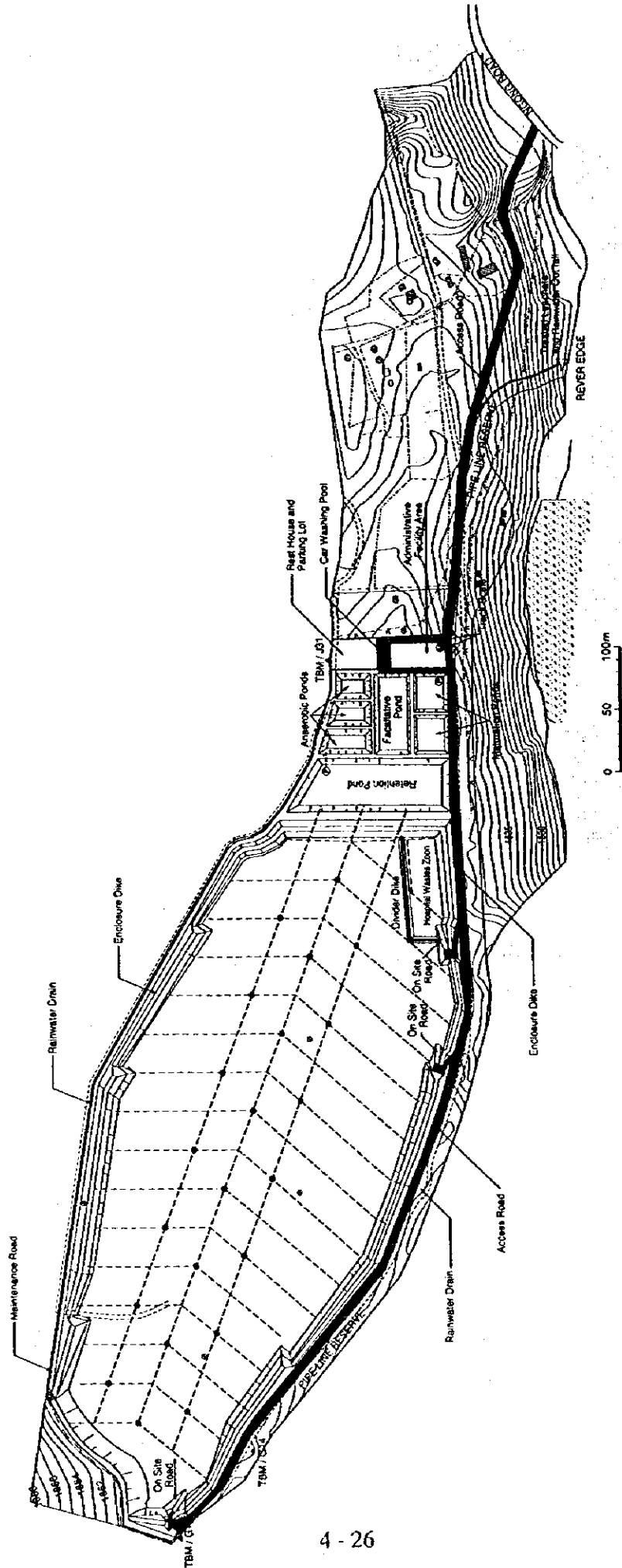


Figure 4.4-4 Plan of Ngong Road Forest Landfill Site

LEGEND	
---	Boundary and Net fence
—	Gate
---	Leachate Drain
●	Gas Exhaust Equipment
⊕	Monitoring Well
---	Ponds Connection Pipe
⊕	Pump

STUDY TITLE	
THE STUDY ON SOLID WASTES MANAGEMENT IN NAIROBI CITY IN THE REPUBLIC OF KENYA	
DRAWING TITLE	
LAYOUT PLAN OF FACILITY FOR CONSTRUCTION 2nd STAGE OF CASES AND CASES (LAYOUT PLAN OF COMPLETED FACILITY)	
DATE	MAR. 1978
SCALE	AS SHOWN
DWG. NO.	Drawing 4.4.2
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

(d) Management of Landfill System

The functions of the landfill system will only be realised if appropriately managed. Therefore, the management of a sanitary landfill system must be thoroughly examined. The detail information on landfill management is described in **Data Book (1), Section 8.5, Operation and Management Manual of Landfill Site**. In principle, the planning must consider the following points:

- (i) Strict adherence to the technical standards set up for maintenance and control of landfill system.
- (ii) Recording and keeping of data on the volume of solid waste dumped, volume of cover material used and the condition of the landfill site in order to correctly control the volume of solid waste dumped into the site and for the planning of efficient operations.
- (iii) The arrangement of proper organisation of the site is a very important point to sustain the sanitary landfill system. The proposed organisation is shown in **Table 4.6-1, Subsection 4.6.4**. The number of operators depends on the transported waste amount.
- (iv) Monitoring of the environment during the land-filling process as well as after completion.
- (v) Inspection and maintenance of each facility in the landfill system should be done periodically and after a heavy downpour or the occurrence of a natural disaster.
- (vi) Rational management taking into account of the prevailing social atmosphere in the region and the actual condition and technical level of the cleansing operators.

(e) Landfill Operation

Details of the landfill operation method mentioned below are shown in **Data Book (1), Section 8.5, Operation and Management Manual of Landfill Site**. In principle, the following items are considered:

- (i) Dumped waste should be covered with soil everyday. Daily application of cover soil is required to reduce smoke and odour, reduce the number of insects and rodents, and accelerate waste decomposition.
- (ii) The cell method is recommended for sanitary landfill in view of the large area of landfill, and uphill method is recommended for bedding and compaction. Daily covering by soil should be done.

(f) Safety and Sanitary Control

A landfill system should be designed to consider safety and sanitary conditions for its workers.

Work at a sanitary landfill system is mainly done outdoors. Workers will be affected by dust, odour and gas emission. In addition, they have some contact with chemicals. Working environment requirements then need to be considered.

(g) Management and Control of Scavengers

The new site(s) will be located in an area which is far from the existing dumping site at Dandora. It may be difficult to accommodate all scavengers from the existing site to the new site(s). On the other hand, the new site(s) will produce new scavengers. They will visit from the slum areas or reside at the new site(s). If NCC will permit their activities at the new site(s), new social problems will arise in area. Therefore, NCC has to prohibit scavenging like in the existing site. The activities of scavengers should be managed and controlled completely by the New Disposal Unit of NCC.

There are two ways to control and manage the scavengers. These are: (1) the licensing of scavengers, and (2) the creation of a cooperative society with the NGOs.

(h) Cost Estimation

(i) Construction Schedule

It is necessary to prepare the new landfill site before the existing landfill site is exhausted. All facilities of the sanitary landfill site in each alternative case will need at least 2 or 3 years to construct, but it is not necessary to construct all the facilities before the beginning of the landfill operation. The construction should be continued even after the commencement of the landfill operation according to the annual landfill amount expected in the successive years. The construction plan of each case is as shown in Figure 4.4-5. It is possible for the landfill operation to begin in the second stage of construction.

Site	Area	Year			
		1st	2nd	3rd	4th
Ruai	20 ha	1 st Stage	2 nd Stage		
			Beginning	Operation	
	40 ha	1 st Stage	2 nd Stage	3 rd Stage	
			Beginning	Operation	
Ngong Road Forest	27 ha	1 st Stage	2 nd Stage		
			Beginning	Operation	

Figure 4.4-5 Phased Construction Plan of Alternative Cases

Work at a sanitary landfill system is mainly done outdoors. Workers will be affected by dust, odour and gas emission. In addition, they have some contact with chemicals. Working environment requirements then need to be considered.

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			Beginning	Operation	
	40 ha	1 st Stage	2 nd Stage	3 rd Stage	
			Beginning	Operation	
Ngong Road Forest	27 ha	1 st Stage	2 nd Stage		
			Beginning	Operation	

Figure 4.4-5 Phased Construction Plan of Alternative Cases

(2) Construction Cost

Construction cost has been estimated for each alternative case and construction phase. The estimated construction cost of each case is as shown in Table 4.4-9. The detail results are shown from Table 8.7-1 to Table 8.7-15 in Data Book (1).

Table 4.4-9 Estimated Construction Cost

Site	Area	Construction Cost			
		1st Year	2nd Year	3rd Year	Total
Ruai	20 ha	519,853	306,744	-	826,597
	40 ha	667,857	338,007	405,100	1,410,964
Ngong	27 ha	412,260	366,964	-	918,174

(in 1000 Kshs)

(3) Selection of Alternative Plan

The Ngong Road Forest Area, one of the candidate sites, was disqualified through the EIA, especially, the social impact assessment. Therefore, in the Master Plan, only the Ruai Area is considered as a final disposal site. The detail reason why the Ngong Road Forest Area was not selected for the final disposal site is explained in Supporting Report Section H.

(4) Annual Disposal Expenditure of Alternative Plan

The annual disposal expenditure of every alternative plan, which consists of design cost, heavy machines purchase cost, construction cost and O/M cost (engineering cost, fuel, electricity, water, spare parts) is shown in the Cost Estimation in Section 8.6 of Data Book (1).

(a) Disposal Site Capacity Requirement

The disposal site capacity requirement is calculated by the waste collection rate. Table 4.4-10 shows the following collection conditions:

Collection Rate: 2000~2003 60%, 2004~2007 80%, 2008~ 100%

Table 4.4-10 Disposal Site Capacity Requirement

Year	(1) Landfill Waste Amount (Ud)	(2) (1)×60% (1)×80% (1)×100%	(2) Landfill Waste Amount (m ³ /d)	(3) Landfill Waste Amount (m ³ /year)	(4) Total Waste Amount (m ³)
			(2) / 1.0*	(3)×365	
1998	1,509	905	905	330,325	330,325
1999	1,587	952	952	347,480	677,805
2000	1,667	1,000	1,000	365,000	1,042,805
2001	1,758	1,055	1,055	385,075	385,075
2002	1,855	1,113	1,113	406,245	791,320
2003	1,959	1,175	1,175	428,875	1,220,195
2004	2,077	1,662	1,662	606,630	1,826,825
2005	2,190	1,752	1,752	639,480	2,466,305
2006	2,316	1,853	1,853	676,345	3,142,650
2007	2,451	1,961	1,961	715,765	3,860,415
2008	2,594	2,594	2,594	946,810	4,807,225
Total	-	-	-	-	5,849,030

* Bulk density of waste at the site is 0.7 to 1.4. Therefore, the bulk density of 1.0 was used for the above calculation as the average density.

(b) Annual Disposal Expenditure

Table 4.4-11 shows the annual disposal expenditure for the new project. The total cost does not include the cost of urgent improvement plan to improve and sustain the condition of the existing Dandora site. The disposal cost is approximately 28 million Kshs/year in 1999 and 2000.

Table 4.4-11 Annual Disposal Expenditures

Year	Waste Amount	Cost (10 ³ Kshs)				Total Cost
		Design*	Construction	Heavy Eqipt.	O/M Cost	
1999		70,548				70,548
2000			667,857	152,300		820,157
2001	385,075		338,007 (227,000)		22,950	360,957 (227,000)
2002	406,245		405,100		24,212	429,312
2003	428,875			78,300	25,561	103,861
2004	606,630				35,306	35,306
2005	639,480				37,218	37,218
2006	676,345				39,363	39,363
2007	715,765			63,200	41,658	104,858
2008	946,810				53,211	53,211
Total	4,805,225	70,548	1,410,964 (227,000)	293,800	279,479	2,054,791 (227,000)

* Design cost is 5% of construction cost.

Figure in parenthesis () is for closure work of Dandora site.

(5) Closure Plan of Dandora Dumpsite

(a) Closure Plan

The existing Dandora dumping site should be closed when a new site(s) is constructed. There is a plan that the area will be developed by a private company as a residential area. However, any portion which will not be used for any another purpose is to be left as it is.

The site will remain with many environmental problems in the future. Therefore, NCC has to consider the closure plan as well the post-closure land-use plan.

The existing site is an uncontrolled dumping site and it is very difficult to restore it quickly to its original ground condition. The following closure work will be done and it will need more than ten years to stabilise the ground condition.

- (i) Scattered wastes have to be gathered together to the northern part of the site. The work will reduce the waste distributed area, and the cleaned-up land along the public road can be used immediately for any land-use.
- (ii) The waste distributed area should be covered completely by soil material. The thickness of cover soil should be 50 cm, at least.
- (iii) Gas outlet equipment and leachate collection pipes should be installed in the waste distributed area to promote the stabilisation of the waste layer.
- (iv) Rainwater drainage ditch should be constructed around the site area.
- (v) Periodical monitoring is required to check the progress of stabilisation.
- (vi) The waste distributed area has to use the open space area, i.e., football ground or park until the waste layer has stabilised completely.

(b) Cost Estimation for the Closure of Dandora Dumpsite

The main closure work consists of land reclamation and soil cover work. The closure work is shown in Figure 4.4-6. The quantity of complete closure works and cost estimation is described in Table H.4-2, Supporting Report Section H. The table shows that the work requires approximately 302 million Kshs and a one year construction period. Even if NCC will not be able to assure enough budget for complete closure work, NCC has to carry out the minimum closure work shown in Table H.4-1 of Supporting Report Section H. The particular work requires approximately 227 million Kshs and a half year construction period.

(c) Post-Closure Land-Use Plan

The landfill process will finally result in the formation of a useful land area. Therefore, it is desirable that the completed filled-up area should be utilised as early as possible and, in the meantime, should be easily manageable. The post-closure land-use plan aims at reclaiming a piece of land with added value.

On the other hand, the following points should be considered before starting the post-closure land-use plan:

- (i) Rate of subsidence;
- (ii) Leachate quality;
- (iii) Quality and quantity of gaseous products; and
- (iv) Internal temperature of landfill.

The existing Dandora Dumpsite will need more than ten years to stabilise before it is available for use as a construction area for residential houses and buildings. Therefore, the area in the main time should be used for open space and NCC should continue periodical monitoring of the site.

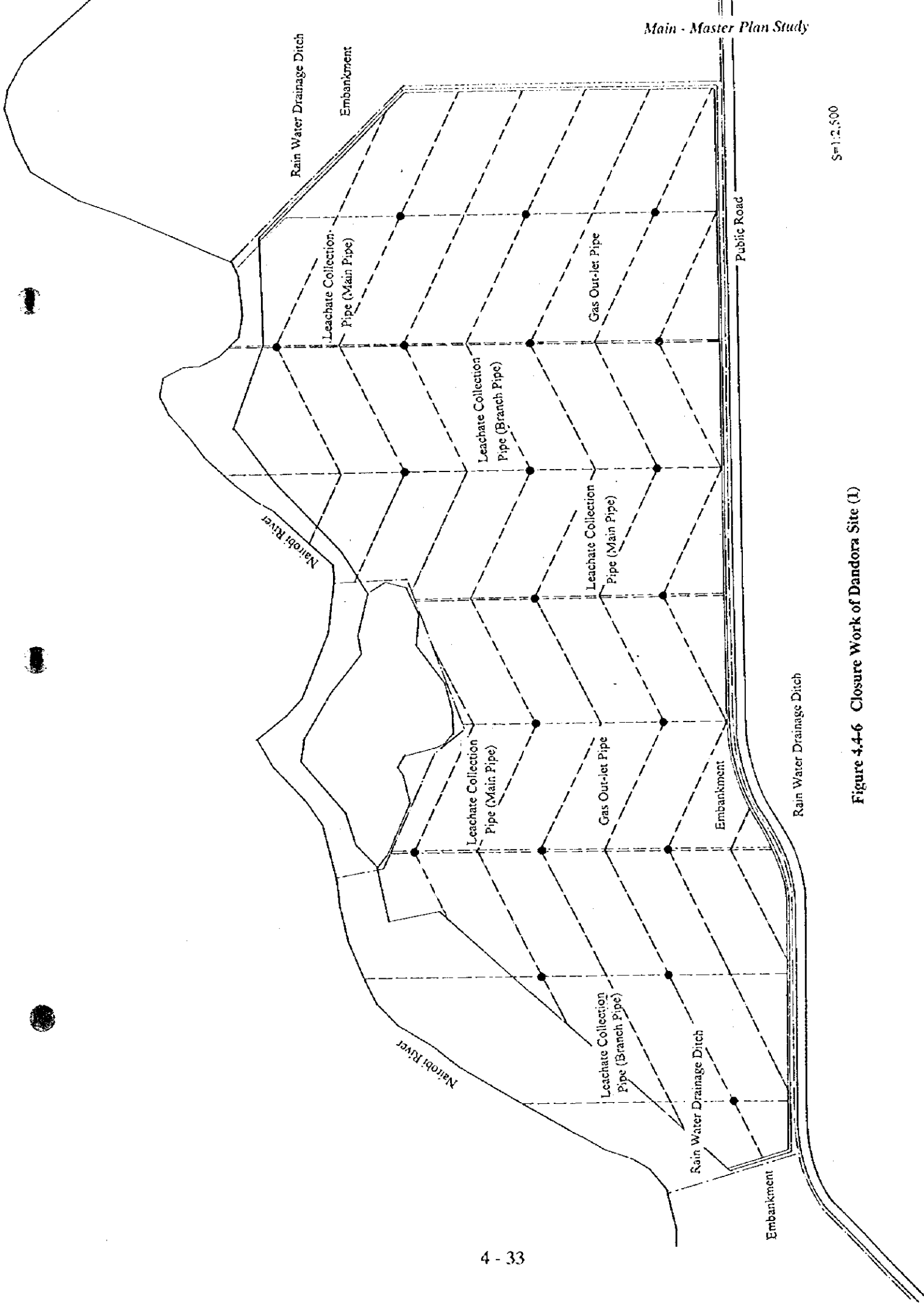


Figure 4.4-6 Closure Work of Dandora Site (1)

4.5 Technical Evaluation of Alternative Plans

Technical options in each sector plan have been developed and evaluated previously in Section 4.4, and several compatible technical options in each sector have been selected. Alternative plans will be structured in a combination of technical options of each sector plan so as to evaluate compatible plans for selection of the most preferable alternative plan.

4.5.1 Identification of Alternative Plans

(1) Fundamental Conditions for the Construction of Alternative Plans

The combination of technical options developed in each sector plan was considered for the construction of alternative plans. Since the Waste Reduction and Recycling have no options and the Intermediate Treatment Plan will not be implemented before the planning target year 2008 due to financial constraints, the Waste Reduction, Recycling and Intermediate Treatment Plan was excluded from the formulation of alternative plans. In the alternative plans, the technical options of the Collection and Transportation Plan and the Final Disposal Plan are combined to comprise the integrated solid waste management plan for Nairobi.

(2) Alternative Plans

The following is an outline of the technical options of each sector to compose the alternative plans.

(a) Technical Options of Collection

- A-1 : Container system with side loaders, dump trucks and wheel loaders
- A-2 : Dump truck (tipper) system with wheel loaders
- A-3 : Dump truck (tipper) system with manual loading
- A-4 : Compactor system with side loaders, dump trucks and wheel loaders

(b) Technical Options of Transportation

- B-1 : Two final disposal sites (Ruai and Ngong Road Forest) with a transfer station
- B-2 : One final disposal site (Ruai) with a transfer station
- B-3 : One final disposal site (Ruai) without a transfer station

(c) Technical Options of Final Disposal

- C-1 : Two final disposal sites (Ruai and Ngong Road Forest)
- C-2 : One final disposal site (Ruai)

4.5.2 Evaluation of Alternative Plans

(1) Assumptions

Conditions and assumptions including unit costs are basically the same as those mentioned in Section 4.14, Evaluation of the Master Plan. The following are additional assumptions made.

- (a) Costs are estimated from 1999 to 2008 with 100% solid waste collection.
- (b) Number of personnel are estimated in a way that is most effective to the system.

(2) Economic and Financial Evaluation

Examined here is the financial appropriateness of the alternative plans. Each alternative plan is evaluated from the viewpoint of cost effectiveness or collecting/disposing cost per ton. Collection and disposal options are examined independently since they do not affect each other.

(a) Results of Cost Calculation for Collection System Options

Based on the preceding quantities and assumptions, the costs of the options were estimated, as shown in Table 4.5-1.

Table 4.5-1 Cost of Collection System Options

System Option	Unit Cost w/ capital (US\$/ton)	Unit Cost w/o capital (US\$/ton)	Cost Index*	Ranking
Option A-1	46.50	38.96	100.0	1
Option A-2	46.87	40.46	100.8	3
Option A-3	46.63	42.31	100.2	2
Option A-4	47.88	43.03	103.0	4

* Cost index is calculated for the unit costs with capital.

The appropriateness of options was examined from the financial point of view. Option A-1 was evaluated as the most appropriate for the collection system, as described in the Collection and Transportation Plan, not only from the financial but also the environmental and social viewpoints.

(b) Results of Cost Calculation for Transportation System Options

Based on the preceding quantities and assumptions, the unit cost of the options employing Option A-1 were estimated, as shown in Table 4.5-2.

Table 4.5-2 Cost of Transportation System Options

System Option	Unit Cost w/ capital (US\$/ton)	Unit Cost w/o capital (US\$/ton)	Cost Index*	Ranking
Option B-1	32.78	26.26	100.0	1
Option B-2	46.12	36.28	140.7	2
Option B-3	46.25	38.96	141.1	3

* Cost index is calculated for the unit costs with capital.

(c) Results of Cost Calculation for Final Disposal System Options

Based on the preceding quantities and assumptions, the unit cost of the options were estimated, as shown in Table 4.5-3.

Table 4.5-3 Cost of Final Disposal System Options

System Option	Unit Cost w/ capital (US\$/ton)	Unit Cost w/o capital (US\$/ton)	Cost Index*	Ranking
Option C-1	8.67	1.97	100.0	2
Option C-2	7.17	1.75	82.7	1

* Cost index is calculated for the unit costs with capital.

(d) Results of Cost Calculation for Combined System Options

The cost of each transportation option combined with final disposal options was estimated, as shown in Table 4.5-4. All options employ Option A-1 for the collection system.

The combined system options are as follows:

- D-1** : Two final disposal sites (Ruai and Ngong Road Forest) with a transfer station
- D-2** : One final disposal site (Ruai) with a transfer station
- D-3** : One final disposal site (Ruai) without a transfer station

Table 4.5-4 Cost of Combined System Options

System Option	Unit Cost w/ capital (US\$/ton)	Unit Cost w/o capital (US\$/ton)	Cost Index*	Ranking
Option D-1	41.44	28.24	100.0	1
Option D-2	53.29	38.03	128.6	2
Option D-3	53.42	40.71	128.9	3

* Cost index is calculated for the unit costs with capital.

The above tables show that Option B-1 has the lowest unit cost for the transportation system and Option C-1 for the final disposal plan. As for the combined system options, Option D-1 has the lowest unit cost but it is not selected due to environmental and other considerations as mentioned in

Item (4) below. This brings the selection to **Option D-2**, the second best option, because of its lower operation and maintenance cost which will result in a lesser financial burden for NCC.

(3) **Technical Evaluation**

From the technical viewpoint, there is no difference between the option with two final disposal sites (**Option D-1**) and the options with only one final disposal site (**Options D-2 and D-3**). As far as **Option D-2** is concerned, no special expertise and management skills are required for the operation and maintenance of its transfer station because the mechanical system is not complicated, although a transfer station has never been used in Kenya so far.

(4) **Environmental Evaluation**

As a result of the Environmental Impact Assessment (EIA), the construction and operation of a final disposal site at the Ngong Road Forest Area (**Option D-1**) have the possibility of causing many negative impacts to the surrounding environment. In addition, a final disposal site at the area will bring in scavengers and may result in the deterioration of the environment as well as deforestation, because they may reside inside the forest and cut trees for fuel. Therefore, **Option D-1** is not environmentally appropriate.

In **Options D-2 and D-3**, on the other hand, the final disposal site is planned to be in a suburban area, i.e., Ruai, which is not densely populated and located just next to a sewerage treatment plant. These options are therefore not considered to significantly affect the environment.

(5) **Social Evaluation**

The activities of scavengers in the final disposal site may be inevitable and will create new social tensions in the area. If the final disposal site is constructed near the city centre or the residential area like in the case of Ngong Road Forest Area (**Option D-1**), the relocated scavengers will reduce the efficiency of site operations and raise security problems not only for plant personnel and equipment but also for the residents and their properties.

On the other hand, the construction and operation of a final disposal site in **Options D-2 and D-3** will not bring the same social problems as **Option D-1** because of the location of the site. Therefore, **Options D-2 and D-3** are preferable to **Option D-1** from the social viewpoint.

(6) **Selection of Appropriate Option**

The above evaluation points to **Option D-2** (one final disposal site at Ruai with a transfer station) as the most appropriate option. The implementation cost and schedule of this option are presented in **Section 4.13**, and further analysis, especially, financial affordability is examined in **Section 4.14**.