



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
Ministry of Home Affairs, Provincial Councils and Local Government
Democratic Socialist Republic of Sri Lanka

**THE STUDY
ON IMPROVEMENT
OF SOLID WASTE MANAGEMENT
IN SECONDARY CITIES
IN SRI LANKA**

**ACTION PLAN FOR KANDY
FINAL REPORT
Volume V-4A
MAIN REPORT**

DECEMBER 2003



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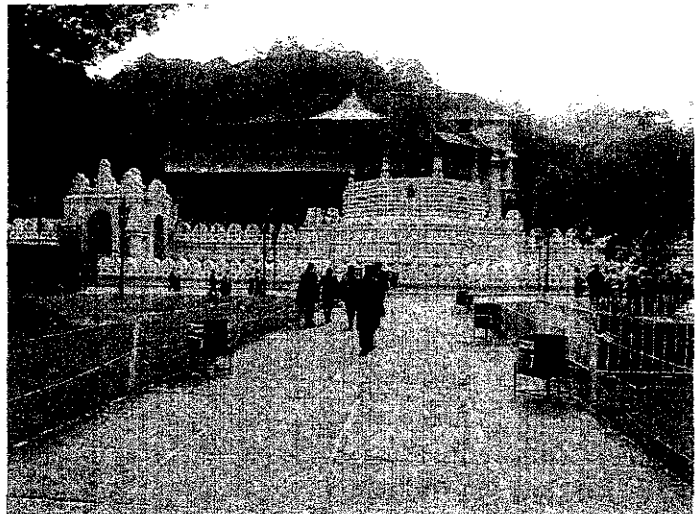
ACTION PLAN FOR KANDY

FINAL REPORT

Volume V-4A

MAIN REPORT

DECEMBER 2003



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List of Volumes

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V-1A	Action Plan for Badulla, Main Report
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V-7A	Action Plan for Nuwara Eliya, Main Report
V-7B	Action Plan for Nuwara Eliya, Supporting Report

***This is Action Plan for Kandy,
which consists of
Main Report (English),
Main Report (Sinhalese),
and References(English).***

In this report, the project cost is estimated using the September 2003 prices and at an exchange rate of 1
US\$ = 117.02 Japanese Yen = 95.28 Rupees



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List of Abbreviations

CDA	Community Development Assistant
CDO	Community Development Officer
CEA	Central Environmental Authority
CMOH	Chief Medical Officer of Health
DEO	Divisional Environmental Officer
DF/R	Draft Final Report
EIA	Environmental Impact Assessment
F/S	Feasibility Study
GDP	Gross Domestic Product
HCW	Healthcare waste
IC/R	Inception Report
IDP	Infectious Disease Prevention
IEE	Initial Environmental Examination
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KMA	Kandy Municipal Area
KMC	Kandy Municipal Council
MOH	Medical Officer of Health
MGTP	Management Plan
M/M	Minutes of Meeting
MOHALG	Ministry of Home Affairs, Provincial Councils and Local Government
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NGO	Non-Governmental Organisation
O&M	Operation and Maintenance
PDM	Project Design Matrix
PHI	Public Health Inspector
POS	Public Opinion Survey
P/R	Progress Report
SCP	Sustainable Cities Programme
SLILG	Sri Lankan Institute of Local Governance
S/W	Scope of Work
SWM	Solid Waste Management
T/d	Tonnes per day
UCDO	Community Development Officer (established under UNICEF)
WTP	Willingness to Pay

Chapter 1 Background Conditions

1.1 Introduction

This plan was prepared by Kandy Municipal Council (KMC) by itself with JICA's technical assistance. Any decisions in the Study were made by KMC.

1.2 Basic Fact Sheet

1.0 General Data

1.1	Province	Central
1.2	District	Kandy
1.3	Local Authority Status	Municipal Council
1.4	Location	Northern part of central highlands, 110km NE of Colombo.
1.5	Topography	Very hilly with man-made lake in town centre; 400-650m in elevation.

1.6 Kandy Municipal Area (KMA) 28.53 km²

1.7 No. of Council members 23

2.0 Socio-economic Data

2.1	Total Population (2001)	110,049 (2002 estimate = 111,116)
2.2	Daily Floating Population	over 100,000
2.3	Average Population Density	38.6 persons per ha (2001)
2.4	Population Growth Rate	0.59 % per year (average 1981-2001 compound growth rate)
2.5	Approximate No of Households	24,303 (2001 census)
2.6	Family Size	4.53 (2001 census)

3.0 Overall KMC Data

3.1	Total Cadre (2002)	Approved: 1,414
3.2	Total Budget Expenditure	269,915,000 (2002)

4.0 Solid Waste Management (SWM)

4.1	Collection Amount (2002)	74.9 T/d; 27,339 tonnes/year
4.2	Budget SWM Expenditure	52,851,300 (2002)
4.3	Cadre for SWM works	Approved: 429 (including 20 drivers), In place: approx. 350 (plus 72 Care Kleen)
4.4	Ratio of SWM to all employees	30.3 % (35.4% with Care Kleen)
4.5	Ratio of SWM to total expenditure	19.6 %
4.6	SWM expenditure per capita	476 Rs/person/year
4.7	SWM expenditure per tonne waste	1,933 Rs/T

1.3 Natural and Social Conditions

Kandy is the cultural and commercial centre of the Central Province. It was the last capital of the Kandyian kingdom and has been declared a World Heritage City, due to the presence of several important religious and historical monuments. These include a holy temple containing a tooth relic of Lord Buddha, which is a famous Buddhist pilgrimage centre. Hence, Kandy is visited by many domestic and foreign tourists, especially during major festivals such as the Esala Perahera, which is held over two weeks in July-August every year.

It's commercial prominence is due to its location, with road networks linking Kandy to the north, south, east and west. Hence, Kandy is always very busy, its daytime population almost doubling due to the large number of people entering the city each day for educational, business and other activities.

Kandy has a relatively pleasant climate, with average rainfall of 1,801mm and humidity of 80%, rainfall being highest during April and October-November (1987-97 data). Land use is tabulated below.

Table 1-1: Land Use in Kandy

Classification	Area	Percentage
Residential	1,159 ha	46.6 %
Commercial	58 ha	2.4 %
Industrial	10 ha	0.4 %
Public facilities	136 ha	6.5 %
Roads	173 ha	7.0 %
Park and play grounds	96 ha	3.9 %
Vacant land	222 ha	9.0 %
Paddy field	67 ha	2.7 %
Forest	364 ha	14.7 %
Waterbodies	174 ha	7.0 %
Total Area	2,853 ha	100 %

1.4 Main Implications for SWM

The main implications of this background information on Kandy for SWM are:

- SWM service provision must be of high quality, due to Kandy being a tourist/cultural centre.
- The waste generation amount, especially for commercial waste, can be relatively high due to Kandy being a commercial and tourist city.
- Garden waste generation can also be very high due to Kandy's climate and the abundant vegetation, plants and trees throughout the city.
- It can be difficult to obtain the cooperation of the large floating population in SWM.
- The steep topography and plentiful rainfall can generate a large amount of soil sediment that enters the city's drains requiring regular removal to avoid blockages.
- It may be very difficult to acquire new land for a landfill site due to the small city area, its urbanized condition, hilly topography and important cultural and historical monuments.

Chapter 2 Current SWM Condition

2.1 SWM Basic Data

2.1.1 Residential Waste Discharge Rates

The results of the waste discharge rate survey conducted in Kandy are tabulated below. They show that high income residents discharge more waste than lower income residents. This is typical, as the waste discharge rate is generally related to the level of material consumption.

Table 2-1: Residential Solid Waste Generation Amount

Residential category	Income range (Rs/month)	Waste discharge rate (g/person/day)
High income	over 6,693	667
Middle income	over 1,358 but less than 6,693	466
Low income	less than 1,358	368
Average		502

2.1.2 Waste Composition Survey

2.1.2.1 Waste Composition Survey Results

The results of the waste composition survey conducted in Kandy are tabulated below.

Table 2-2: Waste Composition and Physical Property Data (% , wet base)

Waste Type	Residential Waste				Market Waste	Collection Vehicle Waste
	High Income	Middle Income	Low Income	Average		
Kitchen	69.28	64.49	77.11	71.11	79.67	58.21
Grass & wood	12.17	14.42	7.81	11.04	14.37	12.31
Paper	7.50	8.18	4.51	6.50	2.62	11.95
Textile	1.03	1.25	1.11	1.12	1.08	1.40
Soft plastic	3.99	5.68	2.76	3.94	0.99	7.28
Hard plastic	1.13	0.88	0.62	0.87	0.05	0.66
Metal	0.96	1.24	0.64	0.91	0.08	0.84
Glass	0.86	1.35	1.07	1.08	0.04	1.13
Leather & rubber	0.19	0.83	0.34	0.41	0.00	0.68
Ceramic & stone	2.76	1.36	3.88	2.84	1.08	5.13
Others	0.10	0.32	0.14	0.18	0.01	0.40
Bulk Density	0.32kg/l	0.32kg/l	0.38kg/l	0.35 kg/l	0.32kg/l	0.30kg/l
Moisture content	59%	60%	66%	-	-	52%

Notes:

1. Market waste samples were taken from the Central and Menikkumbura Markets.
2. Collection vehicle waste samples were taken from collection vehicles at the disposal site.
3. Collection vehicle waste has a lower moisture content than residential wastes. This is attributed to residential waste samples being collected in plastic bags and hence retaining their original moisture content, while the waste carried by collection vehicles is normally discharged at the roadside or in bins and hence has the opportunity to dry out before and during collection.
4. Middle and high income residents discharge more garden waste than lower income residents, due to having larger properties.

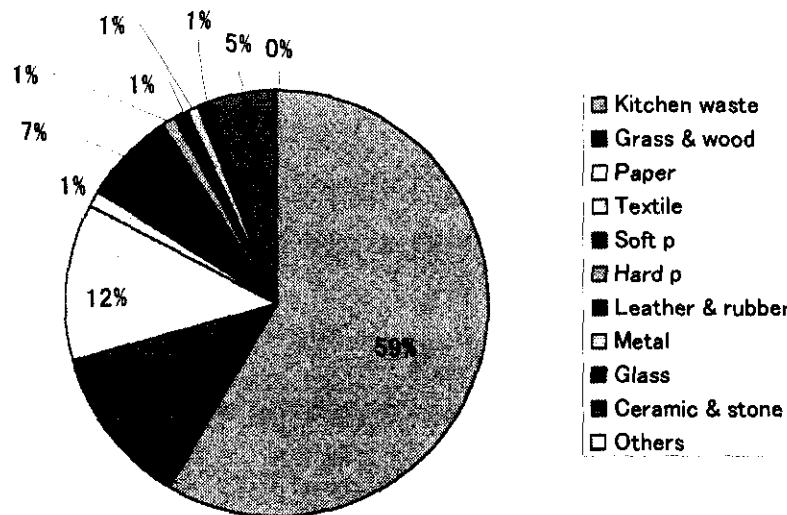


Figure 2-1: Physical Composition of Waste to Disposal (Collection Vehicle Data)

2.1.2.2 Analysis

The above table shows that residential and market waste are very suitable for composting, even without any source separation or pre-sorting, because they are highly organic (food/kitchen and grass/wood waste = 79-94%). Collection vehicle (i.e. mixed) waste has a lower organic content (71%), as it includes commercial waste which contains more inorganic materials, but is still suitable for composting.

It also shows that the percentages of inorganic recyclables (paper, textiles, soft and hard plastic, metal and glass) range from 5-19% in residential/market wastes to 22% in collection vehicle waste, the latter being higher again due to it including commercial waste. These percentages are very low compared with developed countries (typically 40-60%). In particular, the percentages of more profitable recyclable materials (hard plastic, metal, and glass) are very small (0-3%), while the percentages of less profitable materials (paper, soft plastic, textile) are much higher (5-20%). These results indicate that the necessity for introducing a source separation recycling system for residential wastes is currently not high. If KMC wants to introduce such a system, it should target commercial wastes.

2.2 Current Waste Stream

The "waste stream" refers to the "flow" of waste from generation to final disposal. It describes and quantifies the waste generated by different sources within the scope of this Study and quantifies the amounts of waste collected, recycled and disposed of by different means. Determination of the waste stream is one of the most important tasks to be completed in the formulation of a SWM Plan. Waste stream results (mid-2002) are summarised in this section, with additional details being given in the supporting report.

2.2.1 Waste Stream Terminology

The terms used in the waste stream model adopted for the KMA are defined below.

Table 2-3: Waste Stream Terminology

Term	Definition/Explanation
Generation	Production of all waste at source.
On-site disposal	Waste is disposed of by the generator within their property, usually by burial in a pit and/or burning of the waste or sometimes incineration (e.g. hospitals).
On-site composting	Organic waste is composted within the property of the generator itself in order to produce a useful product - compost.
Discharge	Part or all of the waste generated is put out for collection either within the property of the source itself (e.g. hotels, some institutions and industries), outside the property (e.g. in bins or in small piles at the roadside) or at an approved collection point (e.g. concrete bins located around the city).
Direct Haulage	Part or all of the waste generated by different sources is transported directly by them to the official disposal site.
Collection	Waste discharged by a source is collected by Kandy Municipal Council (KMC) or Care Kleen (private contractor) for transportation to the final disposal site.
Disposal	Waste collected by KMC/Care Kleen is discharged at the final disposal site.
Recycling	Part or all of the waste generated is sold or given to an external person/shop/company, etc. for reuse or recycling. In this context, recycling generally refers to the recovery of inorganic and non-compostable waste materials, particularly plastics/polythene, paper ¹ , glass, metals and some textile scraps. Recycling may take place at source, following discharge and collection, and from the final disposal site and illegal dumps.
Composting	Readily biodegradable waste (e.g. food/kitchen, garden, paper wastes) is collected and then decomposed aerobically in a controlled manner at a commercial compost facility run by the local authority, NGO or the private sector. Composting may be carried out in order to reduce the weight, volume, and polluting strength of waste to be subsequently placed in the landfill and/or to produce a marketable product for sale.
Illegal dumping	Part or all of the generated waste is dumped outside the generator's property in an area where such behaviour is prohibited (e.g. open spaces, drains, canals, etc.).

2.2.2 Waste Sources

The main sources of municipal solid waste considered in this Study are households, commercial enterprises, hotels, markets, institutions, industries and "other" (Infectious Disease Prevention (IDP), Botanical Gardens) wastes. Each of these sources is briefly described below.

Table 2-4: Main Waste Generation Sources

Source	Description
Household	Waste generated from domestic activities, including food preparation, cleaning, fuel burning, sweeping, gardening and other miscellaneous household wastes (e.g. old clothing, appliances, etc.).
Commercial	Wastes generated by trade, service, processing and production enterprises, excluding hotels, markets and industries (covered separately).
Hotels	Wastes produced by large hotels within the city.
Markets	Waste from markets selling a high proportion of vegetables, fruit, meat and/or fish (i.e. Central/Menikkumbura markets, Colombo St private market, slaughterhouse).
Institutions	Wastes from schools, Peradeniya University and other education centres, hospitals, KMC, government offices, religious places (Tooth Temple and other), and Forces (police, army, and prison facilities).
Industries	Wastes from Ceylon Tobacco Company (CTC), garment factories (4) and timber industries (7).

¹ Many types of paper may readily be composted, while other types are only slowly biodegradable or not suitable for composting (e.g., glossy magazines).

Source	Description
Other (IDP, Botanical Gardens)	<ul style="list-style-type: none"> IDP: Wastes deriving from mainly from drain cleaning and weeding. Peradeniya Botanical Gardens waste.
Construction and demolition	Wastes originating from construction, rehabilitation and demolition activities, etc. These wastes are not usually handled by KMC but are dealt with by the contractors involved. Typically, they are used as clean fill on other sites or in low-lying areas. Hence, they are not considered further in this Study.
Hazardous (Special)	Hazardous wastes originating from various sources, including household items (e.g. batteries, spray cans, etc.). These are described separately for each category, as appropriate. The management of sharps, clinical wastes, body parts and highly infectious wastes from hospitals is a major concern in Kandy.

2.2.3 Waste Generation

Waste generation rates/amounts (see table below) were measured or estimated from a combination of quantitative and landfill trip data and interview surveys. Key points are summarised here:

- The average household waste generation rate of 0.55kg/cap.d is slightly less than other Sri Lanka data² for municipal councils (0.65 - 0.85kg/cap.d).
- Commercial waste generation is 33T/d (25% of MSW), with the commercial waste generation rate being quite high (10.5kg/enterprise.d). This is considered realistic, being supported by observations of business activities in this area, with the high value being attributed to the relatively high number of restaurants, small hotels³ and bakeries in the city and the very high floating population of over 100,000 people that enter the city each day.
- Market waste generation is significant (12.3T/d, 9.4% of MSW).
- Peradeniya University and the Botanical Gardens have been specified separately as each of these places manages their own wastes. So too has the Temple of the Sacred Tooth Relic (Tooth Temple) as this generates a large amount of waste (450kg/d), with around 20,000 people visiting the temple each day on average.
- Household, commercial and institutional hazardous waste generation is relatively small, comprising typical everyday items (e.g. aerosol cans, toilet cleaners, batteries, fluorescent tubes, razor blades (hairdressers), etc.) which are discharged with normal garbage. CTC produces some asbestos and chemical waste which they dispose of to Gohagoda landfill.
- Significant quantities of healthcare hazardous wastes are produced by both Kandy General and Peradeniya Teaching hospitals, with the other six hospitals within KMA producing smaller amounts of such wastes. Total healthcare hazardous waste generation is estimated to be in excess of 1.5T/mth of clinical wastes, 0.5T/mth of body parts/placentas, 0.7T/mth of sharps and 0.4T/mth of highly infectious wastes.
- Total MSW generation is 131T/d, equivalent to 1.18kg/cap.d. Waste generation by source is shown illustrated below.

² UNEP (2001), State of the Environment Sri Lanka 2001

³ Small hotels = canteens, small eating places, etc.

Table 2-5: Estimated Waste Generation Quantities (mid-2002)

Source	Waste Generation Data			Waste Generation		
	WGR	WGR Unit	No of Units	Amount (T/d)		%
Residential	0.545	Kg/person.d	110,696	60.3	60.3	46.1
Commercial	10.5	Kg/shop.d	3,178	33.3	33.3	25.4
Hotels	0.74	Kg/(guests+staff).d	1,959	1.5	1.5	1.1
Markets	25.9	Kg/stall.d	473	12.3	12.3	9.4
Institutions:						
• Schools	0.033	Kg/(students+staff).d	73,953	2.4		
• Other Educ.	0.081	Kg/(students+staff).d	6,157	0.5		
• Peradeniya Univ.	0.22	Kg/(students+staff).d	13,500	3.0		
• Hospitals	0.39	Kg/(patients+staff).d	12,655	4.9		
• Govt offices	0.25	Kg/worker.d	5,472	1.3		
• Tooth Temple	4.3	Kg/clergy.d	105	0.5		
• Other Religious	2.8	Kg/clergy.d	616	1.7		
• Forces	0.24	Kg/(residents+staff).d	3,905	1.0	15.3	11.7
Industries:						
• CTC	3.0	Kg/worker.d	200	0.6		
• Garment factories	--	Kg/worker.d	ND	0.1		
• Timber	--	Kg/worker.d	ND	1.2	1.9	1.4
Other:						
• IDP				3.5	3.5	2.7
• Botanical Gdns				2.9	2.9	2.2
Total	1.18	Kg/person.d	110,696		131.0	100

Notes:

1. CTC = Ceylon Tobacco Co., ND = no or incomplete data, WGR = waste generation rate.
2. The Commercial WGR was determined from relevant Care Kleen and Gohagoda landfill collection trip records area, together with statistics for the central city area on the number of households, commercial enterprises and institutions.
3. The market WGR is high (26kg/stall.d) but considered realistic, as it is based on actual trips data for the two KMC tractors collecting market waste. This may be due to the actual number of stalls contributing to market waste being considerably higher than 473, as many other traders from the busy commercial area near the Central market are thought to also deposit their garbage in the market's stationary garbage collection trailers.

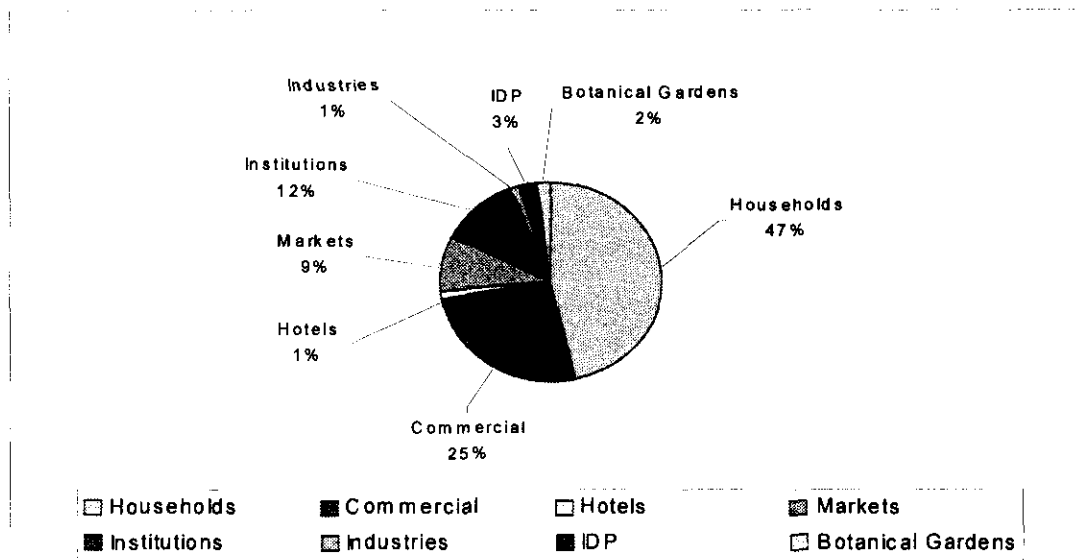


Figure 2-2 : KMA Waste Generation by Source (mid-2002)

The main factors affecting waste generation in Kandy are summarised below:

- Waste generation from commercial enterprises, hotels and markets increases approximately 1-3 times during festivals and on other special occasions, particularly the two week Esala Perahera festival during July-August each year.

- Hotel waste generation increases by 1-3 times during the peak tourist season (Nov/Dec – Apr/May) and for special events (e.g. weddings, parties, conferences).
- Waste generation from religious institutes increases by at least 3-4 times during Poya days and other religious festivals (e.g. Vesak, Poson).
- Police and army waste generation increases approximately five times during the Esala Perahera, when large numbers of additional staff are temporarily deployed in the city.
- Market waste generation also shows some seasonal and weekly variations (e.g. more waste generated during the twice weekly Pola (Tuesdays and Thursdays)).

2.2.4 Waste Stream Breakdown

2.2.4.1 Field Investigation Results

Field investigation results on the proportions of waste being disposed of on-site, discharged for collection, directly hauled to landfill, composted on-site, recycled at source or illegally dumped are tabulated below.

Table 2-6: Waste Stream Field Investigation Results (mid-2002)

Source	Method (%)	Comments
Households	Discharge: 45.4% OSD: 32.5% ID: 11.2% Compost: 6.7% Recycling: 4.2%	Household public opinion survey results, modified to account for an estimated 75% garbage collection service coverage in KMA (by population).
Commercial	Discharge: 94%	Most commercial waste discharged for KMC/Care Kleen collection.
	OSD: 4%	Some commercial places burn a lot of their waste (mainly paper).
	Recycling: 2%	Some recycling – mainly food/kitchen waste to piggeries plus some paper/cardboard, glass and metals.
Markets	Discharge: 99.8%	Almost all market waste is taken to Gohagoda landfill.
	Recycling: 0.2%	Minor recycling, according to data obtained from middlemen shops.
Hotels	Discharge: 48.0%	Discharged for KMC/Care Kleen collection.
	Recycling: 43.7%	Food/kitchen waste is collected from nine out of 16 hotels surveyed by pig farmers, particularly a large piggery near Ukuwela, which also collects inorganic materials for recycling (total recycling = ~645kg/d).
	Compost: 5.2%	Six hotels compost around 1,040kg/d, comprising mainly garden waste, plus some kitchen/paper waste.
	Direct haul: 2.4%	LeKandyan Resorts takes some dry garbage directly to Gohagoda landfill (34 trips over May 01-Apr 02).
	OSD: 0.7%	Le Kandyan Resorts burns/buries some garbage on-site.
Schools	Discharge: 78.3%	Six of nine schools surveyed (40% of total school population) discharge most/all of their garbage for KMC collection.
	OSD: 10.6%	One school burns/buries all its garbage on site.
	Compost: 7.0%	Four schools compost most of their garden waste on-site.
	Recycling: 4.1%	Hillwood College gives their food/kitchen waste to a piggery.
Other Educational	Discharge: 82%	Four of 11 places use the KMC/Care Kleen collection service.
	OSD: 15.8%	Technical College burns/buries the majority of its garbage on-site.
	Compost: 2.3%	Technical College composts some garden waste.
Peradeniya University	OSD: 99.3%	About 3T/d of mixed solid waste disposed to own landfill on-site.
	Compost: 0.7%	About 21kg/d of garden waste.
Hospitals	Discharge: 96.3%	Most normal hospital waste is collected by KMC/Care Kleen, plus some hospitals' hazardous healthcare wastes.
	Recycling: 1.4%	Peradeniya Teaching and Kandy General hospitals each dispose of ~30kg/d of food/kitchen waste to piggeries, recycle most of their used plastic/glass/metal bottles/containers and some cardboard/coconut shells (selling by tender).
	OSD: 1.9%	Two hospitals incinerate their hazardous healthcare waste. Some other hospitals dispose of such wastes by burning/burial on site.

Source	Method (%)	Comments
	ID: 0.4%	Peradeniya hospital burns/open dumps some of its garden waste.
Government offices	Discharge: 82%	Three of five offices surveyed use the KMC/Care Kleen garbage collection service as their only method of garbage disposal.
	OSD: 13%	Two other government offices burn/bury all of their garbage on site, while a third burns/buries some of its garbage on site.
	Recycling: 5%	One office gives its food/kitchen waste to the university piggery.
Tooth Temple	Discharge: 100%	All of the Tooth Temple's waste is collected by Care Kleen.
Other Religious places	Discharge: 77.6%	Three of four places surveyed discharge all of their waste for KMC/Care Kleen collection, while the fourth discharges some of it.
	OSD: 17.0%	Carmel Convent burns/buries some of its garbage on site.
	Compost: 2.7%	Carmel Convent composts its garden waste.
	Recycling: 2.7%	Carmel Convent recycles some of its waste.
Forces	Discharge: 95%	Army camp, two prisons and police use KMC/Care Kleen collection.
	OSD: 5%	Army Training College burns/buries all of its waste on site.
CTC	Direct haul: 100%	Takes own garbage directly to Gohagoda (about 7.4 trips/mth).
Garment factories	Discharge: 78%	Three out of 4 factories surveyed use KMC collection. The fourth burns/buries its garbage on site.
	OSD: 22%	
Sawmills/timber depots	Recycling: 49.9%	One sawmill and five timber depots/carpentry shops/furniture makers dispose of most of their wastes by burning (sawdust) or recycling (sawdust → mushroom growers; woodchips → fuel).
	OSD: 50.1%	
IDP	Discharge: 100%	IDP wastes are collected and taken to Gohagoda by KMC tractors.
Botanical Gardens	Compost: 88.7%	Composts most garden wastes (mainly grass and leaves) on-site.
	OSD: 11.3%	Disposes some normal garbage to an open dump on-site.

Notes: CTC = Ceylon Tobacco Corporation, ID = illegal dumping, OSD = on-site disposal.

2.2.4.2 Recycling at Other Points of the Waste Stream

In addition to recycling at source, recycling also occurs at other points of the waste stream. The quantities of recyclable materials collected at such points were estimated as follows:

- **Following discharge**, individuals (scavengers) may sift through discharged waste prior to collection, recovering items of value to them for reuse/recycling. The amount of recyclables recovered in this manner is assumed to be negligible due to the large number of individual collectors collecting recyclables directly from households (83% of surveyed households) and other places (i.e. at source); the widespread practice of households taking recyclable materials to shops (31% of surveyed households); and very few people observed doing this.
- **During collection**, some KMC and Care Kleen workers salvage bottles, cardboard and metals from the collected waste for sale. An estimated 110kg/d of materials are recovered in this manner, based on survey interviews with 11% of KMC and Care Kleen workers.
- **At the disposal site**, KMC labourers and their families and other people are involved in recycling, collecting an estimated 702kg/d of materials at this point, mainly comprising organic wastes for animal food (nearby piggeries), metal cans/tins and coconut shells.
- **From illegal dumping sites**, it being assumed that a similar proportion of materials is recovered as at the Gohagoda disposal site, amounting to 160 kg/d.

This gives a total quantity of materials recycled at places other than at source of 1,282kg/d = 1.3T/d, equivalent to 1.0% of total waste generation.

Some materials are taken directly to middlemen for recycling by individual collectors and KMC/Care Kleen labourers. Based on interviews with 12 middlemen in the city, the total amount of materials

recovered in this manner from within KMA is estimated to be 1.5T/d. As most of the materials purchased by the middlemen are obtained from households, this amount is assumed to already be included in the household recycling figure of 2.5T/d. The materials recovered from different points of the waste stream are tabulated below.

Table 2-7: Summary of Recycling Data

Material	No of Houses (from survey of 150 households)		Recycling Quantities (kg/d)		
	Giving to individual collectors	Taking to shop	During collection	At disposal site	Collected by middlemen
Organic wastes for animal feed	0	0	0	450	0
Garden/wood	1	1	0	0	0
Coconut shells	0	0	0	56	0
Bone	0	0	0	ND	0
Paper/cardboard	80	21	27	0	471
Plastic	6	2	0	ND	39
Glass	98	41	75 ¹	18 ³	563
Metal	64	5	8 ²	179	402
Textile	23	2	0	0	0
Leather/rubber	0	1	0	0	0
Batteries	0	0	0	0	31
Total			110	702	1506

Notes:

1. 75kg represents ~3,390 bottles/mth (average weight of 1 arrack/beer bottle = 0.66kg (measured).
2. Iron is by far the most common type of metal collected, followed by aluminium, copper and brass.
3. 18kg/d is equivalent to 800 bottles/mth.
4. ND = no data (item is collected but no quantity data was obtained).

2.2.4.3 Collection and Disposal Quantities

Current disposal quantities have been determined from Gohagoda landfill records of the number of vehicle trips to the landfill over the 12 month period: May 2001 to April 2002 inclusive. This data has been converted to tonnes, as shown in the following table, using measured vehicle capacities (m³) for tractor trailers and compactors, filling factors based on observations and the experience of the Landfill Supervisor and appropriate density data.

Table 2-8: KMC and Care Kleen SWM Vehicle Volume and Tonnage Data

Vehicle	Volume (m ³)	Density (kg/m ³)	Fill factor (%)	Tonnage (T)
Handcart	0.42	303	90	0.12
KMC 4WT	6.68	390	85	2.21
Market Tractor	6.68	390	95	2.47
IDP Tractor	2.10	1,000	90	1.89
KMC compactor	3.82	608	100	2.32
Care Kleen tractor	6.68	390	95	2.47
Care Kleen small compactor (227-3146)	3.81	608	100	2.32
Care Kleen large compactor (226-9026)	8.29	501	100	4.16

Notes:

1. Actual vehicle dimensions and vehicle volume/tonnage data for other vehicles (e.g. CTC, Harris pattuwa PS, etc.) are given in the supporting report.
2. IDP waste density assumed from literature data for manure/sludge.
3. Density data, based on WACS survey data for collection vehicles (303kg/m³) and market waste (330kg/m³) and weighbridge data for different collection vehicles measured in Colombo in Jul-Aug 2002 (tractor: 390kg/m³, 4m³ compactor: 608kg/m³, 8m³ compactor: 501kg/m³).

The current collection quantity of 74.9T/d was estimated from the KMA disposal amount (74.8T/d), allowing for the small amount of recycling that occurs during collection, which corresponds to an overall MSW service coverage of 57%⁴.

The difference between the amount of waste discharged for collection and the amount actually collected is 11.2T/d, equivalent to about 4.6 tractor loads/d. This amount is assumed to represent waste that is illegally dumped (in addition to that already counted), waste that is discharged for collection but never collected, or waste that is collected and then disposed of at places other than Gohagoda landfill. It has been added to the illegal dumping amount.

2.2.5 Waste Stream

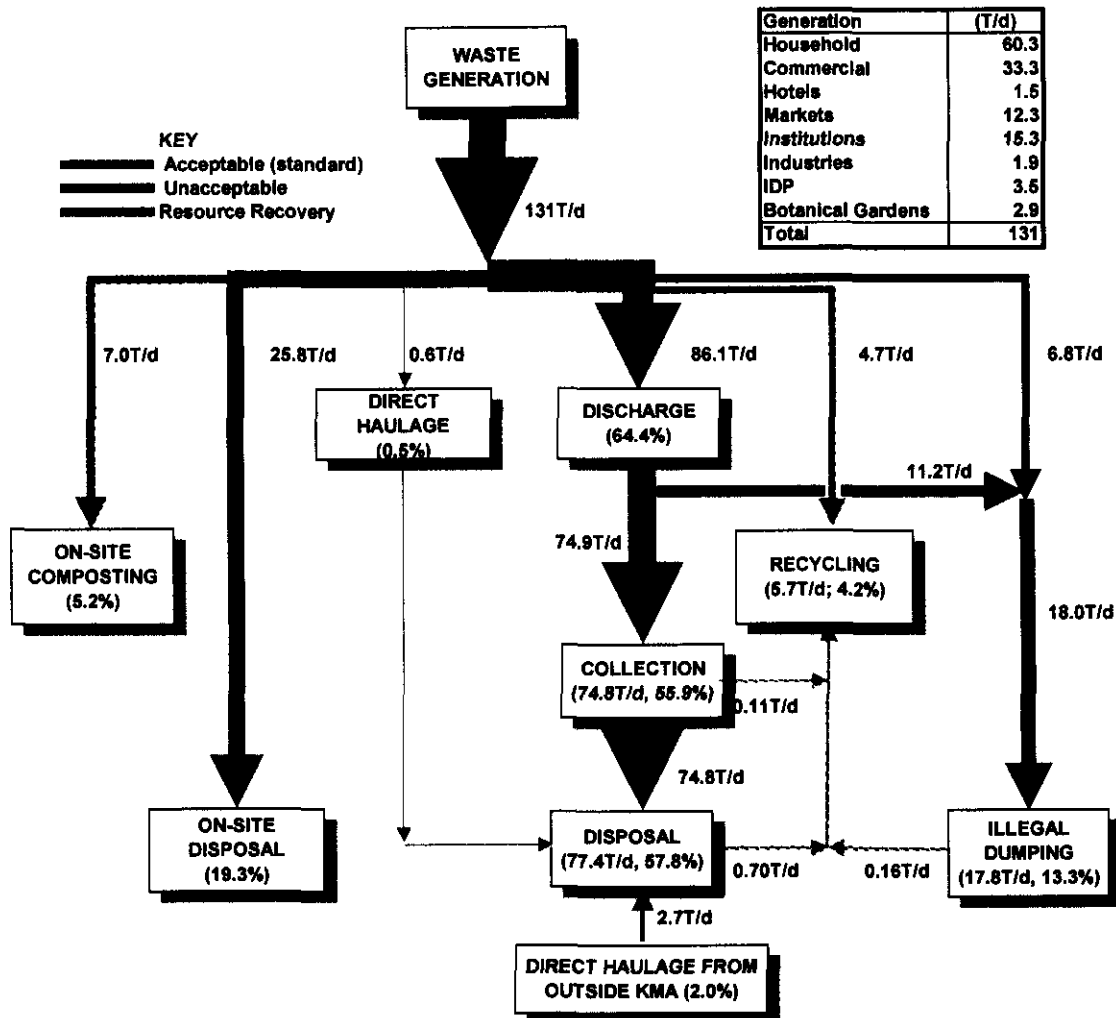
Waste stream data for Kandy is tabulated below.

Table 2-9: Waste Stream Breakdown (mid-2002)

Source	On-site disposal	On-site compost	Dis-charge	Recy-cling	Illegal Dumping	Direct Haul	Gener-ation
Household	19.58	4.02	27.40	2.52	6.78	0.00	60.31
Commercial	1.33	0.00	31.30	0.67	0.00	0.00	33.30
Hotels	0.01	0.08	0.70	0.63	0.00	0.03	1.45
Markets	0.00	0.00	12.25	0.02	0.00	0.00	12.26
Institutions:							
- Schools	0.26	0.17	1.90	0.10	0.00	0.00	2.43
- Other Educational	0.08	0.01	0.41	0.00	0.00	0.00	0.50
- Peradeniya Univ.	3.00	0.02	0.00	0.00	0.00	0.00	3.02
- Hospitals	0.10	0.00	4.73	0.07	0.02	0.00	4.92
- Govt offices	0.17	0.00	1.10	0.07	0.00	0.00	1.34
- Tooth Temple	0.00	0.00	0.45	0.00	0.00	0.00	0.45
- Religious	0.29	0.05	1.34	0.05	0.00	0.00	1.72
- Forces	0.05	0.00	0.90	0.00	0.00	0.00	0.95
Industries:							
- CTC	0.00	0.00	0.00	0.00	0.00	0.60	0.60
- Garment	0.02	0.00	0.09	0.00	0.00	0.00	0.11
- Timber	0.58	0.0	0.00	0.58	0.00	0.00	1.16
Other:							
- IDP	0.00	0.00	3.50	0.00	0.00	0.00	3.50
- Botanical Gdns	0.33	2.60	0.00	0.00	0.00	0.00	2.93
Sub-total	25.80	6.95	86.07	4.70	6.80	0.64	130.95
Collection							
Recycling at discharge			-0.00	+0.00			0.00
Adjustment to account for actual collection			-11.16		+11.16		0.00
Recycling during coll'n			-0.11	+0.11			0.00
Adjusted sub-totals	25.80	6.95	74.80	4.81	17.96	0.64	130.95
Disposal							
DH from outside KMA						2.67	2.67
Recycling at landfill			-0.70	+0.70			0.00
Recycling at ID sites				+0.16	-0.16		0.00
Total	25.80	6.95	74.10	5.67	17.79	3.31	133.63
%	19.3	5.2	55.5	4.2	13.3	2.5	100

Notes: DH = direct haulage; ID = illegal dumping.

⁴ Collected garbage/(generated garbage - direct hauled garbage) within KMA; i.e. 74.9/(131.0-0.6)x100%



Notes:

1. Percentages are relative to total generation within KMA and direct haulage from outside KMA (133.6T/d)

Figure 2-3: KMA – Current Waste Stream (mid-2002)

The waste stream shows:

- Most waste (86T/d, 64%) is currently discharged for collection by KMC or Care Kleen, with 78T/d being disposed of to the Gohagoda landfill.
- On-site disposal is the second most common disposal method (26T/d; 19%). This is appropriate in some parts of Kandy (e.g. houses with large properties, institutions, etc.).
- Illegal dumping is also very common (18T/d; 13%). This should be eliminated in the future.
- Resource recovery, via on-site composting (7.0T/d, 5%) and recycling (5.7T/d, 4%) are both significant. They should be further promoted in the future.

2.2.6 Breakdown of Waste Disposal Amount

The amounts of different wastes being disposed of to landfill are tabulated below. This shows:

- The amount of organic materials that can be composted is about 55T/d, excluding paper.
- Higher value recyclables (glass, hard plastic and metal) amount to only 0.9, 0.5 and 0.6T/d respectively, indicating most of these items are already being recycled.

- Lower value recyclables (paper, textile, soft plastic) are present in much larger quantities (9.3T/d, 1.1T/d and 5.7T/d respectively), indicating less of these items are being recycled. Of these materials, paper has the most (but still limited) potential for increased recycling, particularly if it can be sorted at source and collected separately. Otherwise, once mixed with other garbage, it becomes contaminated and is much more difficult and expensive to recycle. It may also be possible to increase the recycling of soft plastics from the commercial sector.

Table 2-10: Amounts of Waste to Disposal

Waste Type	Waste Physical Composition	Amount to Disposal
Kitchen	58.2%	45.05 T/d
Grass & wood	12.3%	9.52 T/d
Paper	12.0%	9.29 T/d
Textile	1.4%	1.08 T/d
Soft plastic	7.3%	5.65 T/d
Hard plastic	0.7%	0.54 T/d
Metal	0.8%	0.62 T/d
Glass	1.1%	0.85 T/d
Leather & rubber	0.7%	0.54 T/d
Ceramic & stone	5.1%	3.95 T/d
Others	0.4%	0.31 T/d
Total	100.00%	77.40 T/d

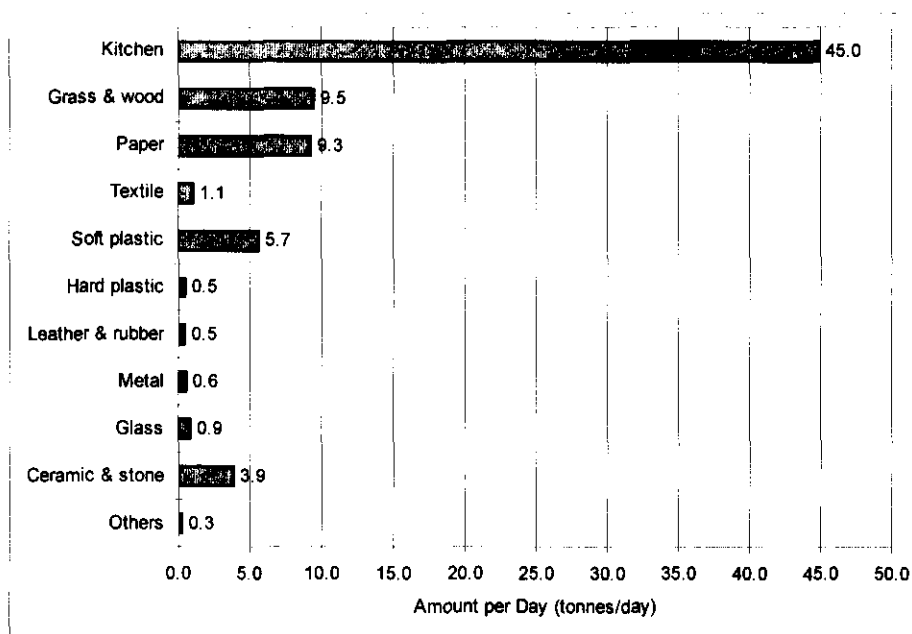


Figure 2-4: Daily Amount to Disposal (mid-2002)

2.3 KMC Waste Management Institutional Setting

The KMC Health Department is currently responsible for SWM⁵ in Kandy. Specific responsibilities include:

⁵ SWM responsibility has changed often in recent years from the Health Department to the Chief Engineer and then Mechanical Engineer on 1 June 2001 and now back to the Health Department since April 2003.

- Collection of MSW within the KMA and transportation to the final disposal site.
- Administration and performance monitoring of Care Kleen (Pvt) Ltd's contract for MSW collection and street sweeping services in the central city area (zone 1A).
- Collection of Central and Menikkumbura Markets garbage (under the Veterinary section).
- Infectious Disease Prevention (IDP) services.
- Septic tank and toilet emptying services.
- Operation and management of the existing final disposal site at Gohagoda.
- Collection of any SWM fees levied for the services provided.
- Enforcement of local ordinances and national laws related to SWM.
- Implementation of policies relating to waste minimization, public education/awareness, etc.

2.3.1 Organisational Structure

The current waste management organizational structure is shown in Figure 2-1 and Table 2-11.

The Chief Medical Officer of Health (CMOH) has overall responsibility for all of KMC's waste management activities, including SWM. At the next organizational level, there are two Public Health Inspectors – Class I (Scavenging Superintendent, SS) and Class II (PHI). The SS is responsible for zones 1, 2 and 3, including performance monitoring of Care Kleen, and also has responsibility for the central market (wholesale area) and Infectious Disease Prevention (IDP) unit. The PHI is responsible for zones 4 and 5, septic tanks/toilets services and the final disposal site. Beneath them, there are 20 supervisors, 20 drivers and 330 labourers, who are assigned to different areas. There are also four administrative staff (Chief Clerk and 3 clerks).

In addition, the KMC Mechanical Engineer is involved in SWM in an advisory role, whilst also being responsible for the maintenance/repair of all SWM vehicles.

The Environment committee serves as an advisory committee to the Council, dealing with environmental issues, including SWM. This comprises about 25 members and is chaired by the Mayor, while the CMOH is the secretary. Other members include KMC Environment Officers and PHIs, Council members and a wide range of community representatives (e.g. Botanical Gardens, Forestry, Police, Irrigation Department, CEB, interested citizens, etc.). It is currently not active, the last meeting having been held in September 2001.

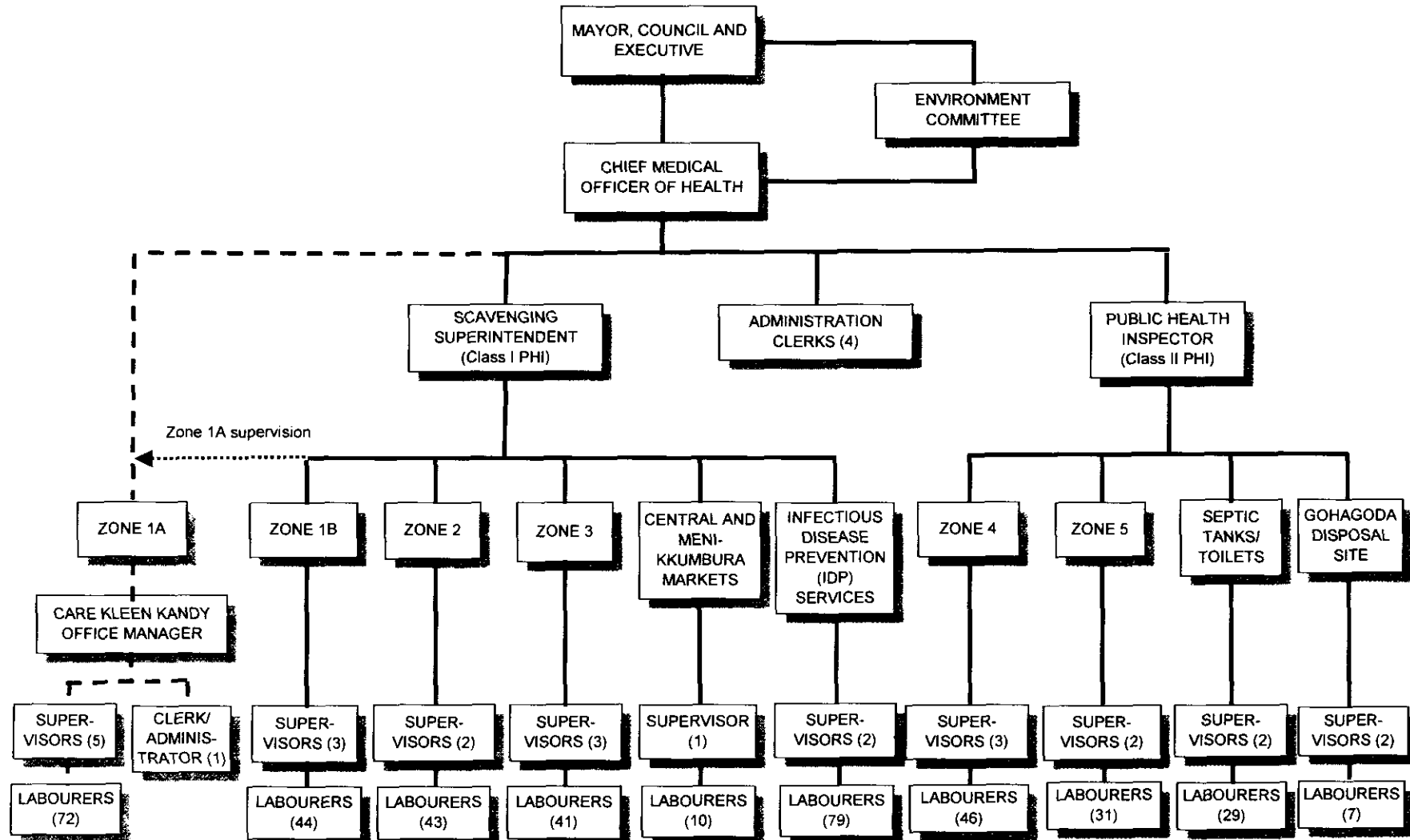


Figure 2-5: KMC SWM Organisational Chart

Table 2-11: SWM – Breakdown of KMC and Care Kleen Staff and Equipment

Area	SS/ PHI	Super- visors	Labourers			Communal Bins		Hand- carts	Vehicles	Toilets	
			Permanen t	Casual	Total	Availabl e	Needing Repair			Public	Bucket
Zone 1B	SS	3	42	2	44	34	4	11	1 4WT, 1 C	0	0
Zone 2	SS	2	42	1	43	25	6	7	1 4WT, 1 C	0	0
Zone 3	SS	3	37	4	41	35	10	12	1 4WT, 1 C	0	0
Zone 4	PHI	3	42	4	46	27	0	19	1 4WT, 1 C	0	0
Zone 5	PHI	2	29	2	31	26	1	21	1 4WT, 1 C	0	0
Central and Menikkumbura Markets	SS	1	8	2	10	0	0	0	2 4WT	0	0
Septic tanks/ Toilets	PHI	2	28	1	29	0	0	0	3 GS 1 4WT	37	2
IDP	SS	2	60 + 17 ⁵	2	79	0	0	0	2 4WT	0	0
Gohagoda Disposal site	PHI	2	7	0	7	0	0	0	1 D4C dozer	0	0
KMC Total		20	312	18	330	147	21	70	10 4WT, 5C, 3GS, 1 D4C dozer	37	2
Zone 1A (Care Kleen)	SS	5	72	0	72	13	Not checked	32	1 4WT, 2 C	0	0
Total (KMC & Care Kleen)		25	384	18	402	160	21	102	15 4WT, 3C, 3GS, 1 D4C dozer	37	2
Allocated cadre		39			389						

Notes:

1. SS = Scavenging Superintendent, PHI = Public Health Inspector, C = compactor, GS = gully sucker, 4WT = four wheel tractor.
2. Drivers come under the Transport section and have not been included in the above table.
3. The SS is provided with a vehicle and driver for work purposes.
4. Care Kleen parks five trailers at various places around the central city area, which serve as "collection points".
5. KMC uses five trailers as collection points (i.e. in the stationary mode): 3 at Central market (near fish market, carpark, pineapple centre), 1 at Menikkumbura market and 1 at Katugastota hospital.
6. IDP labourers have been split into two groups – 60 undertaking IDP works and 17 temporarily assigned for garbage collection in Zone 2.
7. KMC's allocated cadre for supervisors and labourers is 39 and 389 respectively. Hence, KMC are short of about 14 supervisors, allowing for the five supervisors employed by Care Kleen.

2.3.2 Waste Management Equipment

Current waste management vehicle fleet and supporting equipment details are summarized below, together with estimated vehicle lifetimes, based on practical experience of KMC staff.

Table 2-12: Waste Management Vehicle Fleet and Supporting Equipment

Vehicles/ equipment	No	Use (Capacity)	Approx. life (yrs)
Handcarts	70	SWM collection, road and drain cleaning (0.42m ³ , 0.12T)	3-5
Four wheel tractors (4WT)	14	5 – SWM; 2 – markets; 2 – IDP; 1 – conservancy; 4 – spare	15-20
4WT Trailers	16	5 – SWM collection; 4 – markets (3 at Central market; 1 at Menikkumbura market; stationary mode) 1 – Katugastota hospital (stationary mode) 1 – Conservancy (closed type) 2 – drain/street sweepings and tree cuttings (small; under Works) 3 – spare (+ 13 scrap, now used for spare parts/metal but to be sold by tender) (mainly 6.7m ³ ; some 2.1m ³ ; ~1.9-2.5T, depending on contents)	8-10
Compactor	5	SWM collection (~3.7m ³ , 2.3T capacity)	8-10
Pickup	1	Scavenging Superintendent use	8-10
Trailer bowser	1	Clean water conveyance	8-10
Gully suckers	3	Septic tank/public toilets emptying (1 x 3,500 L; 2 x 7,000 L)	8-10
D4C Bulldozer	1	Final disposal site operations (80hp net)	8-10

Garbage collection crew and labourer equipment details are summarised below.

Table 2-13: Vehicle Labourer and Equipment Details

Vehicle	Labourers	Equipment
Handcart	2-3	2-3 ekel brooms, 1 basket, 1 hoe (mamoti)
Tractor	4	Gloves, 1 hoe, 2 shovels, 2 forks
Compactor	4	Gloves, 2 forks, 4 baskets

2.3.3 SWM Costs

KMC's 2002 budget costs, tabulated below, show that 19.6% of KMC's budgeted expenditure was allocated to SWM. This is mainly due to the high number of KMC employees engaged in SWM works (30% of total). These results are comparable with other Councils covered by this study, with SWM expenditure accounting for an average of 22.0% (range = 13-35%) of local authority budgeted expenditure and SWM workers an average of 29% (range = 22-37%) of all Council workers, by cadre.

Table 2-14: KMC Budget SWM Costs and Employees (2002)

Item	SWM	KMC Total	SWM as % of Total
Budget Expenditure (million Rs)	52.9	269.9	19.6
KMC Employees (by cadre)	429	1,414	30.3

Note: Total KMC expenditure excludes water supply services.

2.3.4 Waste Collection/Disposal Fees

KMC, as of June 2002, were charging the following waste collection and disposal fees:

- Only the Citadel Hotel pays KMC for garbage collection services (2,000 Rs/mth + tax).

- KMC charges 350 Rs/tractor load for rubble and garden waste removal from premises within the city limits but very few people use this service, discharging such wastes at garbage collection points or illegally dumping it.
- Private parties (except for Harispattuwa PS) directly hauling their garbage to Gohagoda for disposal are charged 300Rs/load for tractors and 500Rs/load for trucks within KMA, excluding taxes. Corresponding fees for outside KMA are 400 and 600 Rs/load respectively. The main private customers are Ceylon Tobacco Corporation (CTC), LeKandyan Hotel, Ceylon Electricity Board and Bata Shoe Factory.
- Gully sucker charges range from 350Rs/load to over 3,000Rs/load depending on the source (residential, business/government or religious) and location (inside/outside KMA).

Over the 12 month period (May 2001 – April 2002), SWM revenue totalled 71,419 Rs, varying from 1,750 to 21,650 Rs/mth. Gully sucker revenue over the same period was much higher at 1,236,000Rs, ranging from 74,000 – 136,000Rs/mth. More details are given in the supporting report.

It is worth noting that informal payments to cleansing workers are relatively common and include:

- 14% of 150 households surveyed pay an average of 132Rs/yr “small allowance” or 93Rs/yr “reward”.
- 25 of 91 commercial/industrial and institutional places surveyed pay an average of 1,728Rs/yr (range = 10-12,000Rs/yr).

2.3.5 SWM Bylaws

Standard Sri Lankan SWM by-laws are in place. By-law enforcement is poor with many people following illegal practices.

2.3.6 KMC Workshop

The mechanical workshop is responsible for the maintenance and repair of KMC’s vehicle fleet, comprising a total of 52 vehicles, excluding motorcycles. It is managed by the Mechanical Engineer, with the assistance of two Technical Officers. It employs 28 labourers, two clerks and one peon. It has recently been relocated to Katukele.

The spare parts procurement system varies according to the repair cost:

- For repairs up to Rs. 10,000, the Mechanical Engineer can give direct approval.
- For repairs from Rs. 10,000 to 15,000, the Municipal Commissioner can give direct approval, with the spare parts being ordered through the supply accountant, which involves obtaining quotes from a number of suppliers.
- For repairs over Rs. 15,000, these must be approved by the Council and Finance Committee, a process which can take up to two months. However, for very urgent repairs in this category, the

Mechanical Engineer may get prior approval from the Municipal Commissioner and Mayor, enabling him to go ahead and order the necessary spare parts.

The workshop suffers from cramped conditions and a lack of proper equipment and facilities, with most workers being trained on the job, rather than receiving formal training. Many repairs take a long time.

KMC estimate that about 1.33M Rs of the workshop budget is spent on the maintenance of waste management vehicles.

2.4 SWM System Components

2.4.1 Discharge, Collection and Transportation

2.4.1.1 SWM Collection Zones

The city is divided into five zones for SWM purposes, with zonal offices being located within each zone (see Figure 2-6). KMC is responsible for zones 1B – 5 while Care Kleen Pvt Ltd (private contractor) is responsible for zone 1A, the central city area.

Table 2-15: SWM Collection Zones

Zone	Wards	Wards	Responsible Organisation
1A: Central City	17, 18, 19	Kotugodella, Yatinuwara, Wewelpitiya	Care Kleen
1B: Deiyanevela	14, 15, 16	Ampitiya, Malwatta, Deiyanevela	KMC
2: Mahaiyawa	4, 5, 6, 20	Bahirawakanda, Nuwara Dodanwela, Asgiriya, Mahaiyawa	KMC
3: Peradeniya	1, 2, 3, 21, 22, 23	Peradeniya, Mulgampola, Katukele, Suduhumpola, Siyambalapitiya, Bowala	KMC
4: Katugastota	7, 8, 9, 10	Mapanawathura, Katugastota, Mawilmada, Kahalla	KMC
5: Aruppola	11, 12, 13	Watapuluwa, Lewella, Buwelikada	KMC

Field investigations and discussions with SWM staff indicated that the KMC garbage collection service covers 70-80% of KMA on a population basis. An average service coverage of 75% has been adopted for this Study.

2.4.1.2 KMC SWM Discharge System

Most waste generators discharge their mixed garbage by one of the following methods:

- At the roadside for primary collection by handcart followed by transfer to one of 181 x 1m³ reinforced concrete bins (collection points) located around the city or to a collection vehicle.

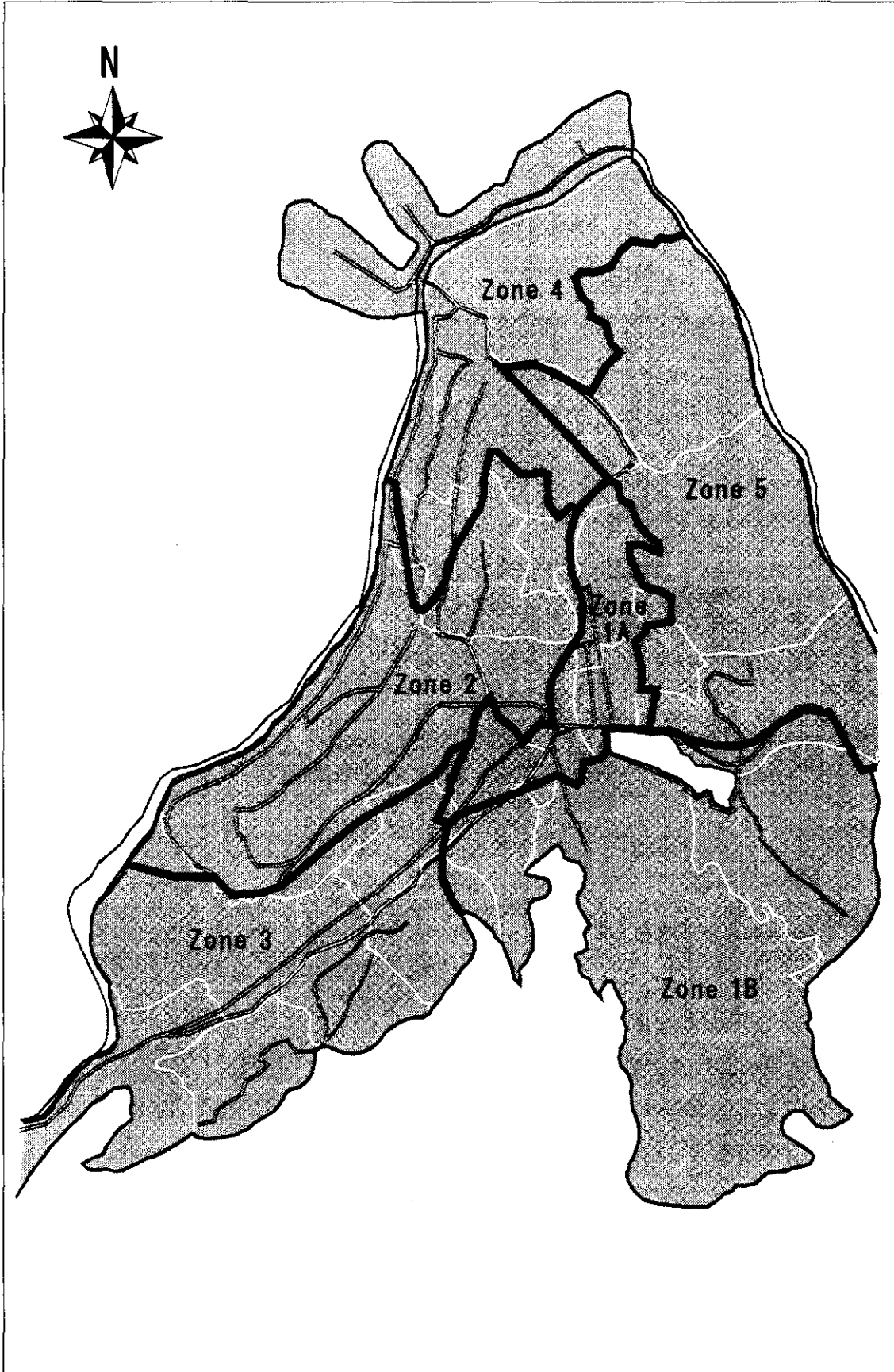


Figure 2-6: KMC SWM Collection Zones

There are also some temporary bins (e.g. half barrels) at various places which serve as collection points.

- Directly to these collection points or collection vehicles.
- At the roadside. An additional 75 locations have been identified where there is no bin, but which are being used by residents for garbage discharge.

Often the garbage is discharged directly onto the ground or into the concrete bin, although some residents do use plastic bags or dustbins. There are also some litter bins located around the town, while some private places have proper garbage storage bins (e.g. tourist hotels, hospitals).

These practices result in lots of scattered garbage and mini-dumps, creating poor sanitary conditions, due to animals - goats, cows, cats and particularly dogs and monkeys - looking amongst the garbage for food.

Large amounts of garden waste are produced in the city, and are typically discharged illegally at collection points for subsequent collection by KMC, or disposed of by open dumping, with many small open dumps being observed along the banks of the Mahaweli Ganga, at roadsides and in gullies. Often, garden waste is burnt at such places, while building waste is also commonly present. Many drains are also full of or blocked with garbage, creating nuisance and health problems.

These observations show that there is an urgent need to improve the current discharge system.

2.4.1.3 KMC SWM Collection System

a. Collection System

Each KMC zone has one compactor and one tractor/trailer assigned to it for garbage collection. Garbage is collected by these vehicles from handcarts and the various collection points described above generally on a daily basis, apart from some low density population areas of the city where garbage is collected every 2-3 days.

Garbage collection is difficult in many of the steeper areas of Kandy, where access is typically by narrow road, footpath and/or steps. In some cases, labourers collect the garbage by basket for transfer to their handcarts, while other areas may not be provided with a garbage collection service (e.g. some parts of Mulgampola and most of Ampitiya). Garbage collection by vehicle is also difficult in many low income and housing scheme areas (e.g. Attupattiya shanty/slum; Deiyannewela, Mahaiyawa and Uplands housing schemes), due to access being via small narrow roads, footpaths and steps, illegal kiosks blocking the roads, etc.

KMC operates a stationary trailer collection system in the Central and Menikkumbura markets and outside the Katugastota hospital.

A number of private parties take responsibility for garbage collection in the immediate area around their premises which lie within KMA, including the Faculty of Dental Sciences and the Ceylon Tobacco Company.

Time and motion studies undertaken by KMC for a tractor and their compactor in August 2001 show that the compactor and tractor took 7.0 and 5.2 hours respectively to complete two collection rounds, while loading made up 49-51% of the total working time for both vehicles.

b. KMC Collection Vehicle Unit Costs

KMC collection vehicle unit costs were calculated for handcarts, tractors and compactors using actual KMC cost data, supplemented by information from other sources where necessary. These costs are illustrated in Figure 2-7 (refer supporting report for additional details).

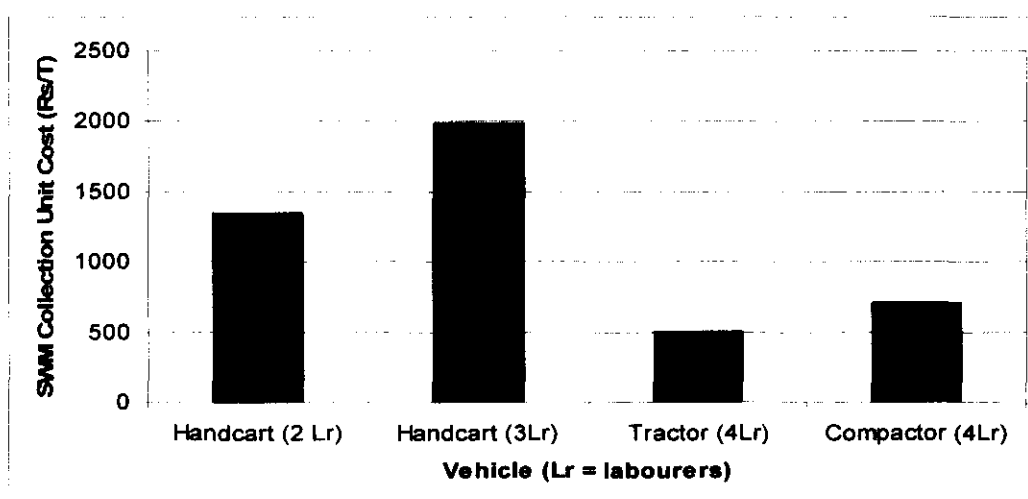


Figure 2-7: KMC Garbage Collection Vehicles – Current Unit Costs

This data shows:

- Handcarts are by far the most expensive means of collecting garbage, with unit costs of 1,340Rs/T with two labourers and 1,980Rs/T with three labourers.
- Tractor unit costs (496Rs/T) are considered slightly high but are lower than compactor costs, indicating that at present, tractor/trailer units are the most economical means of collecting garbage in Kandy.
- Compactor unit costs are considered high at 707Rs/T, despite collecting ~43% more garbage per year than tractors, this primarily being due to compactor diesel consumption and depreciation being 3.6 and 6.3 times greater respectively than corresponding tractor costs.

c. Assessment

The present garbage collection system involves a lot of wasted effort. Many handcarts are used for primary collection, discharging their loads of garbage to many collection points, from where they are loaded into collection vehicles by tractor/compactor labourers. Many collection points are also poorly

designed. This system results in garbage being double handled, loading taking a long time, while both handcarts and collection vehicles often traverse the same routes.

Another major problem is that many of the tractor/trailer units are very old (average tractor age = 13.8yrs; average trailer age = 12.2yrs) and often breakdown. Although the compactors are newer, they were purchased second hand and also require relatively frequent maintenance. Vehicle repairs/maintenance often takes a long time, especially for expensive repairs.

The high unit costs indicate there is considerable potential for reducing handcart, tractor and compactor unit costs by decreasing the number of labourers, increasing the number of daily trips, and improving the collection efficiency. In particular, handcart garbage collection should be restricted to essential places, while compactor unit costs need to be reduced.

Investigations found that both KMC tractor/trailers (6.7m³) and compactors (3.8m³) carry very similar amounts of garbage to landfill (2.2T/d for tractor vs 2.3T/d for compactor). This is due to the different volumes of each vehicle and the high bulk density of Kandy waste (0.3kg/L), meaning that compactors can only achieve small-moderate waste compaction, compared to developed countries where the waste is much "lighter" (e.g. Japan - 0.15kg/L). Compactors have other advantages over tractors, being more manoeuvrable, easier to load, enclosed (resulting in less waste scattering than from open trailers) and faster, reducing travel times during collection and to and from the landfill. However, compactors are more difficult and expensive to maintain. Overall, both tractor/trailers and compactors are considered suitable for Kandy.

2.4.1.4 Care Kleen (Zone 1B) SWM System

Care Kleen undertakes garbage collection, road sweeping, drain cleaning, weeding and decorations/poster removal in the central city (commercial) area under contract to KMC. This contract is for four years covering the period 1 August 1999 until 31 July 2003. Care Kleen's collection area comprises 10.7km of roads, 954 households, 1,560 commercial enterprises and 195 institutions⁶ (Kandy Hospital, many schools and government offices).

One Manager is in charge of Care Kleen's Kandy operations, under whom there are five supervisors and one clerk, four drivers⁷ and 72 labourers. The clerk is responsible for general administration and issuing daily work instructions to the vehicle drivers. Their vehicle fleet comprises 32 handcarts, one four wheel tractor and six trailers and two compactors. Vehicle details are tabulated below.

⁶ Data as per Annexure II of the contract - based on conditions in 1993, which KMC assumed are applicable to the present situation due to the reported stable condition of the town centre.

⁷ There are four drivers although only three vehicles due to the two shift system used by Care Kleen.

Table 2-16: Care Kleen SWM Collection Vehicle Details

Vehicles/ equipment	No	Use	Registration No	Date of Registration
Handcarts	32	SWM collection, road sweeping, drain cleaning, weeding		
Four wheel tractors	1	SWM collection	46-4917	1999
Tractor trailers	6	SWM collection		
Compactors	2	Small (3.8m ³ , 2.3T)	227-3146	1999
		Large (8.3m ³ , 4.2T)	226-9026	1999

Care Kleen have divided the central city area into three areas: A, B and C. Primary collection is by handcart, with labourers discharging the collected garbage into one of 13 concrete bins or one of five stationary trailers located around the central city area.

SWM collection is undertaken in two shifts from 7am – 5pm (45-50 labourers) and from 5pm to 2am (remaining labourers + some daytime labourers doing up to 4 hours overtime). This two shift system is used as the city is very congested during the daytime, making it difficult to clean properly (e.g. parked cars, bus stands, street vendors). A daily report is submitted to KMC summarizing the work done during the previous day and the number of garbage loads collected. KMC's Scavenging Superintendent is responsible for undertaking daily inspections of Zone 1A to monitor Care Kleen's performance.

A comparison of Care Kleen and KMC vehicle performance is set out in Table 2-17 based on collection/disposal records over the 12 month period May 2001-Apr 2002.

Table 2-17: Comparison of Care Kleen and KMC Collection Vehicle Performance

Party	Vehicle	Trips/day	No of vehicles	Trips/ vehicle/d
Care Kleen	Tractor	4.1	1	4.1
	Small compactor	2.2	1	2.2
	Large compactor	2.6	1	2.6
KMC	Tractor	12.5	8.7	1.4
	Peradeniya compactor	2.0	1	2.0
	Central and Menikkumbura markets (Jan-Apr 2002)	4.6	2	2.3

Notes:

1. Since Jan 2002 (opening of Menikkumbura market), 2 tractors have been used to collect market waste.
2. KMC only used eight tractors for collection during July-August and October-November, when an additional hired compactor was used in the Katugastota area. Hence, average number of tractors = $(8 \times 4 \text{mths} + 9 \times 8 \text{mths}) / 12 = 8.7$.
3. Average number of trips per day based on total days rather than working days.

Performance of Care Kleen's small compactor and the KMC compactor is similar while Care Kleen's large compactor is slightly higher, this being due to this compactor working two shifts. Care Kleen's tractor makes an average of 4.1 trips/d to the landfill, this largely being due to the use of a stationary trailer system in the central city area. This performance is much better than KMC's tractors which make an average of 1.4 trips/d (normal collection) and 2.3 trips/d (market stationary trailer collection) to the landfill⁸.

⁸ This may partially be attributed to the time taken to load normal trailers but KMC's time and motion study clearly shows these tractors should be able to undertake at least 2 trips/d. Market collection performance is slightly better, but prior to January 2001, KMC was able to make 3.6 trips/d from the Central market using one tractor. This

KMC and Care Kleen collection costs are compared below.

Table 2-18: Comparison of Care Kleen and KMC Collection Costs

Item	KMC	Care Kleen
Unit collection cost (Rs/T)	1,792	1,076
Cleansing worker wages (Rs/h)	52.4	18.2

Notes:

1. Care Kleen cleansing workers are employed on a daily wage basis (164Rs/day) and paid monthly (i.e. no pension payment).
2. KMC's SWM costs increased by 50% in 2001 due to an increase in public servants' allowances of 2,200Rs/mth.

This comparison shows that Care Kleen collection is considerably cheaper than KMC collection. This is mainly due to the much lower salary paid by Care Kleen to their workers. In addition, Care Kleen labourers are more motivated, as they are more accountable than public sector workers, being subject to stricter supervision and management⁹. They know they may lose their job if they don't work properly. The private sector employment system is also more flexible.

2.4.2 Processing and Treatment

None of the garbage collected by KMC or Care Kleen is currently taken for processing/treatment.

2.4.3 Final Disposal

2.4.3.1 Gohagoda Landfill

KMC's only current landfill is located at Gohagoda, approximately 6km outside the city limits. This site is located on a 13ha block of land that KMC has used since 1932, under a 90 year lease agreement with Harispattuwa Pradeshiya Sabha (PS).

The final disposal site has been operated for much of its lifetime as an open dump, with no environmental protection measures being taken, no daily cover provided, and with leachate being visible seeping from the bottom of the garbage pile. In Jan 2002, a D4C bulldozer began operation at the landfill and has been used for garbage placement and compaction, creation of access roads and the placement of cover soil. This has resulted in a small improvement in landfill operating conditions. However, a shortage of cover soil means that most of the garbage generally remains uncovered. Hence, many birds and animals currently graze on the landfill site.

The main problems associated with this disposal site are:

- The landfill is virtually full.
- Final disposal is largely by open dumping, with soil cover sometimes being applied.
- Leachate is polluting the groundwater and Mahaweli Ganga¹⁰, the longest river in Sri Lanka which runs past the site about 500m downgradient.

suggests that the two tractors being used now are under-utilized and it may be possible to collect garbage from both markets using a single tractor.

⁹ Care Kleen's supervisors are supplied with motorcycles and are required to report to the Manager every two hours.

¹⁰ There will be a very high dilution of leachate entering this river, due to its flow.

- Nearby residents experience odour, pest and fire/smoke problems.
- Lack of consideration for neighbours (e.g. downstream paddy field stopped cultivation, well in temple polluted).
- Vehicles getting stuck during wet weather.

2.4.3.2 Other Disposal Sites

An additional unofficial dumping area, located along Dangolla Rd near the intersection with Sri Amarawansa Rd, is sometimes used by KMC for the disposal of garden waste.

Peradeniya University disposes its solid waste (about 3T/d) onto university land along the banks of the Mahaweli Ganga. Generally, this waste is burnt and then covered with 100mm of soil.

The Botanical Gardens disposes of about 0.33T/d of visitor's garbage by open dumping within its premises along the banks of the Mahaweli Ganga.

2.5 Resource Recovery

Resource recovery is relatively common, with there being a wide range of waste reduction, reuse and recycling initiatives in operation, as summarised below.

Table 2-19: Summary of Resource Recovery Initiatives in Kandy

Item	Comments
Reuse	Many shops and micro-enterprises selling items for re-use (e.g. shoes, bicycles, umbrellas, mobile phones, paper bags, etc.).
Recycling at source	Very common. 83% of households are visited by someone to collect/buy their reusable/recyclable materials, while 31% of households take some reusable/recyclable items to shops for refund/sale.
Recycling by SWM Labourers	<ul style="list-style-type: none"> • 16% of KMC and 38% of CareKleen workers involved. • Collect 110kg/d of glass bottles, cardboard and metal. • Earn "tea money" (141-224 Rs/labourer.mth).
Recycling at landfill	<ul style="list-style-type: none"> • Mainly KMC labourers and their family members. • Collect 702kg/d of organic wastes (for animal feed), cans/tins, coconut shells and bottles.
Middlemen (approximately 20 in total in KMA)	<p>Interview surveys held with 12 middlemen shops found:</p> <ul style="list-style-type: none"> • Established businesses: nine over 15yrs old; 3 new. • Creating jobs: employ at least 33 people. • Recycling wastes: 1.7T/d, 54% from within KMA (0.90T/d). • Generating income: purchases (>389,000Rs/mth) vs sales of >514,000Rs/mth. • Mainly buy high value recyclables: clean paper, glass bottles, sacks and plastic containers for reuse; metals, broken glass and battery cases for recycling. • Main problems: shortage of recyclables > high land/building rental costs > problems obtaining credit.
NGOs	Centre for Development Alternatives started a plastics recycling project in 1998, as part of Clean River Programme (Pavithra Ganga Programme). As of mid-2002, they had stopped collecting plastics, due to a shortage of storage facilities. They would like to resolve this problem and establish a plastics processing facility within Kandy to make higher value pellets
Piggeries	<ul style="list-style-type: none"> • Some piggeries collect food/kitchen waste from at least ten hotels, one restaurant (Devon), school (Hillwood College), religious institute (Good Shepherd Convent) and government office (Agriculture Dept) within Kandy, including the Franciscan Brothers (Ukuwela), seminary (Ampitiya) and Peradeniya University piggeries. • Franciscan Brothers piggery is believed to be largest (250 pigs). It collects food/kitchen waste from 11 hotels/restaurants (415-622kg/d).
Tri-Star Plastic Industries, Handessa	<ul style="list-style-type: none"> • Located at Handessa, about 15km outside of Kandy. • In operation for 10-12yrs. • Process 30-35T/d of plastic wastes into pellets and some products.

Item	Comments
	<ul style="list-style-type: none"> 60-70% of waste plastics from industrial sources, 38-28% from commercial sources and 2% from households. Majority of waste plastics purchased in large quantities by tender from Colombo (60-70%); the remainder come from Kandy and surrounding areas.
Botanical Gardens	Composts about 2.6T/d of garden waste on-site for own use or sale (50Rs per 2kg bag).
Peradeniya University	Composts grass/leaves with cow dung to produce about 2-3m ³ /month of compost.

Refer supporting report for further details.

2.6 Social Aspects

2.6.1 Household Surveys and Interviews

2.6.1.1 Household Public Opinion Survey (POS) Results

A household public opinion survey was conducted in June 2002 within KMA in order to prepare a basic socio-economic profile of Kandy's residents and to gain an appreciation of public attitudes towards the current provision of SWM services, desired improvements to these services, and their willingness to pay for improved services. The survey covered 150 households, comprising fifty households from each of two high income (Weerakoon Garden, Aniwatte), two middle income (Watapuluwa, Ampitiya) and two low income (Mahaiyawa, Suduhumpola) areas.

69% of the surveyed households are Sinhalese, 12% Muslim and 19% Tamil. Data on the average number of people per household and monthly income is set out below.

Table 2-20: General Household Data

Item	Low income	Middle income	High income	Overall
Average number of people per household	5.6	4.5	4.8	5.0
Average monthly household income (Rs/household)	8,300	12,921	25,602	
Average monthly income (Rs/person)	1,477	2,871	5,356	

Key survey results related to SWM are summarized here:

- 99% of surveyed households are provided with a garbage collection service by KMC, of whom 81%¹¹ stated they use this service. Only 16% of surveyed households are very satisfied with present SWM service provision, while 57% are somewhat satisfied. Area-wise data shows less satisfaction in high and low income areas. The overall satisfaction rate is lower than that for most other study towns (refer figure below).

¹¹ Does not quite tally with "main waste discharge" method data, due to some people saying they use the KMC service but then later saying they open dump their waste outside their premises.

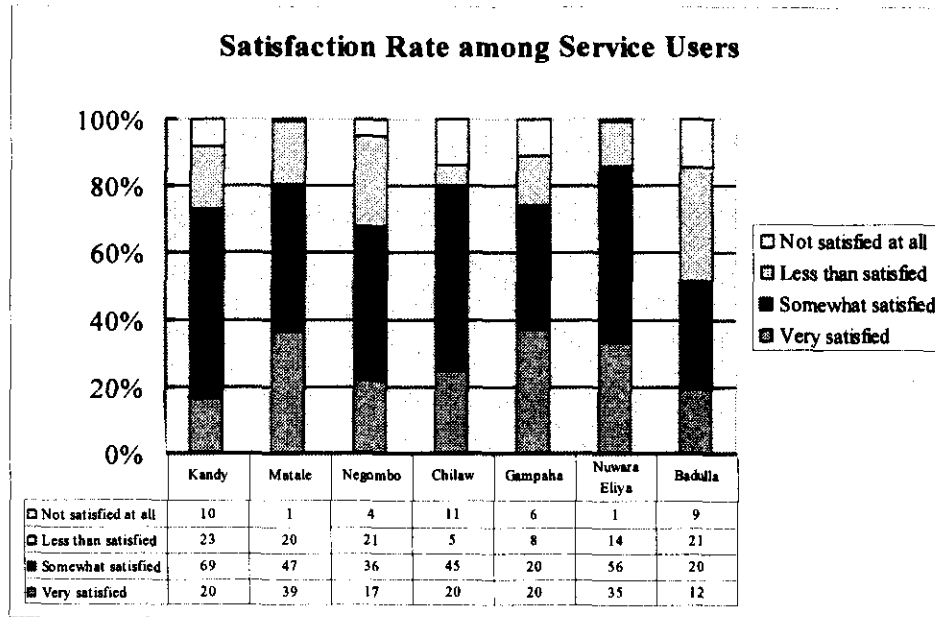


Figure 2-8: Waste Collection Service Users' Satisfaction Rate

- Households' main methods of waste discharge are shown below. The most common methods are carrying garbage to a specified collection point (54%), discharging it outside their premises for house to house collection (19%) and burning/burying waste on-site (17%).

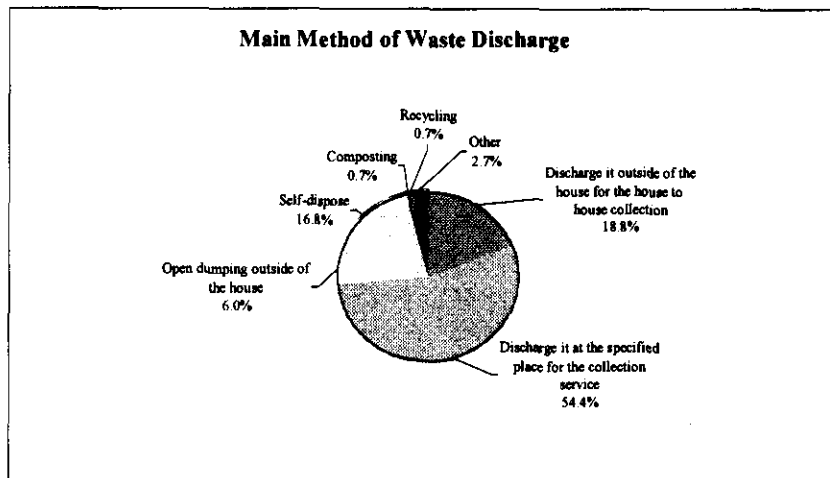


Figure 2-9: Common Waste Discharge Methods

- Although only 31% of surveyed households receive a daily garbage collection service, 53% of households discharge their garbage daily and 12% discharge their garbage as soon as it is generated, the gap between discharge and collection being slightly greater for the high income group. The discrepancy between these figures explains the large amount of discarded garbage present on many streets around Kandy.
- In general, adult females handle waste in about 70% of surveyed households.
- Almost 90% of surveyed households are willing to cooperate with source separation for recycling. However, 83% of surveyed households are called on by someone who comes to collect their