



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 SCHOOLS
IN SRI LANKA**

**ACTION PLAN FOR KANDY
FINAL REPORT
Volume V-4B
SUPPORTING REPORT**



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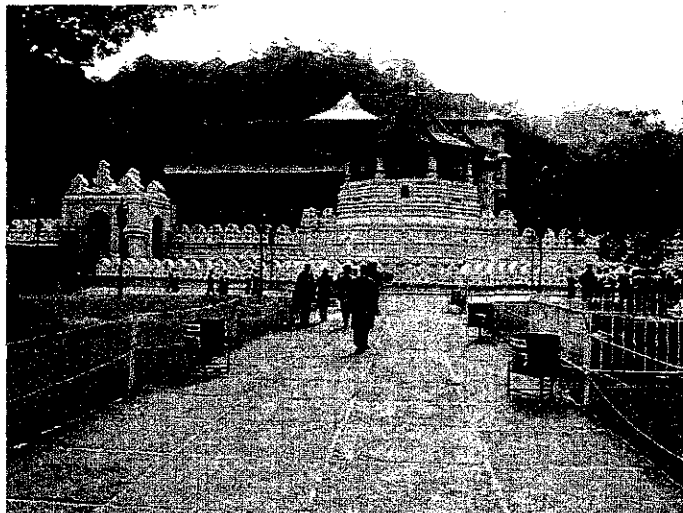
ACTION PLAN FOR KANDY

FINAL REPORT

Volume V-4B

SUPPORTING REPORT

DECEMBER 2003



KOKUSAI KOGYO CO.,LTD.

List of Volumes

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***This is Action Plan for Kandy,
Supporting Report.***



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
DEA	Divisional Environmental Officer
DF/R	Draft Final Report
EIA	Environmental Impact Assessment
F/S	Feasibility Study
GDP	Gross Domestic Product
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
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
S/W	Scope of Work
SWM	Solid Waste Management
WTP	Willingness to Pay

Chapter 1

Kandy Waste Stream Data

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Chapter 1 Waste Stream Data

1.1 Introduction

This appendix summarises information collected from field investigations carried out from May-July 2002, undertaken primarily to quantify the waste stream for the Kandy Municipal Area (KMA). It complements and provides further information concerning the waste stream data, assists in understanding the present KMA solid waste management (SWM) system and identifies some issues that do or may need to be addressed at some stage in the future.

1.2 Households

Household statistics were obtained from the provisional results of the July 2001 Census (total KMA population of 110,049 people in 24,303 households; equivalent to 4.53 people per household) and average population compound growth rate of 0.97% over 1981-2001, giving a 2002 population of 111,116. There is an additional estimated 100,000-125,000 "floating" population, representing people who come into the city to undertake their daily activities, but then return at night to their homes outside the city limits.

Information on household waste generation and management practices was obtained from a survey of 150 households in six different areas of the city, covering two high, two middle and two low income areas and a Waste Amount and Composition survey (WACS) of 90 households in the same six areas. 148 (99%) of the surveyed households were located in areas where garbage is collected by KMC, while the overall KMA collection service coverage is ~75%. Hence, these survey results were adjusted to account for other parts of the city not provided with a garbage collection service in order to estimate the proportions of garbage disposed of by different means for the entire KMA. The corresponding results are tabulated below and give a household waste generation rate of 0.55kg/person.d; which equates to 60.5T/d.

Table 1-1 : Household Waste Management

Waste Management Method	% of Households in Survey Area	Adjusted % of Households in KMA	Waste Amount (T/d)
Self-disposal	23.4	32.5	19.7
Discharge for KMC collection	60.6	45.4	27.5
Home composting	4.8	6.7	4.0
Recycling	3.0	4.2	2.5
Illegal dumping	8.1	11.2	6.8
Total	100.0	100.0	60.5

Notes:

1. Average household waste discharge rate = 0.502kg/person.d, representing garbage that is normally discharged for collection, illegally dumped or disposed of on-site (WACS survey).
2. Average household waste generation rate = $0.502 / ((0.234 + 0.606 + 0.081)) = 0.545 \text{ kg/person.d}$.
3. Estimated 2002 population = $110,049 \times 1.0097 = 111,116$.
4. Total household waste generation = $111,116 \times 0.545 \text{ kg/person.d} = 60.5 \text{ T/d}$.
5. Waste amounts disposed of by different means calculated using total waste generation x adjusted percentages in above table, which relate to the entire KMA.

Household waste is mainly organic, comprising 79-85 wt% organic waste (food/kitchen and garden/wood), 5-8 wt% paper and 10-13 wt% inorganic materials.

1.3 Commercial Sector

1.3.1 Commercial Enterprises

Commercial enterprises covers all commercial operations (e.g. trade, service, processing and production), except for hotels, markets and industries, which are classified as separate categories. This includes government or semi-government enterprises that operate commercial oriented businesses and services (e.g. banks, Post Office, Water Board, etc.). The total number of such commercial enterprises within the KMA is estimated to be 3,178, based on KMC trade licence data and JICA field investigations¹. This includes at least 80 restaurants, local hotels² and bakeries. Limited field investigations were undertaken for a range of commercial enterprises as part of this study, involving interview surveys of 34 commercial enterprises, covering 29 small and 5 large waste generators^{3,4}, including six restaurants/local hotels, situated almost entirely within the central city area. Estimated garbage generation and composition, based on the four most common waste types, are tabulated below.

Table 1-2 : Commercial Enterprises Waste Generation and Composition

Source	Estimated Waste generation (kg/d)	Most common waste types
Small enterprises (29)	0.25 – 20	Pa > F/K > In > PI
Large retail/wholesale (2)	35 – 100	Pa > F/K > PI > In
Large Restaurants (3)	145 – 245	F/K > Pa > PI > In

Notes:

1. Waste generation amounts were estimated by the survey respondents. Such estimates are generally not very accurate, but give an indication of the amount of waste generated.
2. Waste types: F/K = food/kitchen, Pa = paper/cardboard, PI = plastics, In = inerts.

Commercial waste generation is estimated⁵ to be 33.3T/d, equivalent to 10.5kg/enterprise.d. Waste generation increases approximately 1-3 times on average during festivals and other special occasions (e.g. Esala Perahera).

A few enterprises produce small amounts of hazardous wastes, mainly comprising aerosol cans, batteries, fluorescent tubes and razor blades (hairdressers) which they dispose of with their normal garbage.

¹ KMC Budget 2002 = 3,675 trade licences – (469 market stalls + 16 hotels + 12 industries) = 3,178.

² Local hotels refers to small canteens/eating places with no accommodation.

³ The large waste generators survey focused on hotels within the commercial sector which are discussed separately. This is why very few other enterprises were surveyed in this category.

⁴ One small waste generator (restaurant) was reclassified as a large waste generator on the basis of its stated waste generation.

⁵ Estimates of commercial waste generation were made based on Gohagoda landfill trip records for Care Kleen (central city area, Zone 1A) and associated statistical data (Care Kleen contract: 945 households and 1,755 commercial enterprises/institutions in this area).

All of these enterprises indicated they use the KMC or Care Kleen garbage collection services. Only one restaurant was involved in recycling, with its kitchen waste being collected by a piggery at Ukuwela. It is expected that some commercial enterprises burn some or all of their waste, particularly paper, as was found in Matale. Based on this information, 94% of waste is assumed to be collected for disposal, 4% disposed of on-site and 2% recycled (e.g. paper/cardboard, glass, metals, food/kitchen waste to piggeries, etc.).

1.3.2 Markets and Slaughterhouse

Kandy has two main public meat/fish, fruit and vegetable markets, the Central Market, located in the city centre, and the new retail/wholesale Menikkumbura Market at Katugastota which opened in January 2002. There is also a public slaughterhouse and a small private market (Colombo St). These places have been classified as “markets”, as they mainly produce organic waste. They comprise a total number of 469 active stalls (refer table below).

There are five other smaller public “markets” within the city, together with many small scattered public and private market stalls around the city, which mainly contain small retail shops. These markets have been classified as commercial enterprises, due to their nature. These markets contain a total of 555 active stalls (refer table above).

Table 1-3 : Public and Private Markets Details

Market	Number of stalls						SWM Collection
	Meat/ fish	Vege/ fruit	Goods	Small hotels	Others	Total	
Mainly meat/fish, fruit and vegetables							
Central market:							
Official	52	113	104	8	0	277	KMC
Unofficial	5	42	2	0	2	51	
Menikkumbura							
Wholesale	0	65	2	3	1	71	KMC
Retail	8	30	2	0	0	40	
Colombo St (private)	0	28	0	2	0	30	Care Kleen
Total	65	278	110	13	3	469	
Mainly retail							
Railway Station Rd	0	10	39	12	58	119	Care Kleen
George E de Silva Park	0	0	115	1	22	138	Care Kleen
Goodshed Stalls	0	21	19	27	44	111	Care Kleen
Torrington Lane	0	0	35	6	68	109	Care Kleen
Keppitipola	Unknown (currently closed)					0	Unknown
Other public	Unknown					50	KMC or
Other private	Unknown					28	Care Kleen
Total	0	31	208	46	192	555	

Notes:

1. Stall numbers are based on currently functioning market stalls, as determined during JICA field surveys. More stall space is available at many of these markets but is not currently being utilized, including Menikkumbura retail (41 stalls currently closed); Torrington Lane (75 stalls currently closed); Keppitipola (35 out of 54 stalls are currently rented but this entire market is closed due to a legal dispute) and other markets (6 stalls closed).
2. A small number of pavement traders are included under “others”.

A “Pola” (temporary market) is held twice weekly on Tuesday and Thursday near Bogambara Prison from early morning to around 1pm. This typically comprises around 75-100 stalls.

An average of 4.6 tractor loads of market waste⁶ are collected from the Central and Menikkumbura markets per day by KMC tractor, equivalent to 11.4T/d. During the festival season, market waste generation may increase by 50-100%.

Total market waste generation, including the Colombo St private market and slaughterhouse, is estimated to be 12.3T/d (25.9kg/stall.d), with a nominal amount being recycled (0.02T/d) based on the middlemen survey, while the rest is collected by KMC/Care Kleen. In addition, fish/meat waste is supposed to be stored in closed containers at each market and taken to the landfill by the KMC Conservancy tractor. This system appears to be working at the Menikkumbura market but not at the Central market.

Market waste is highly organic, with Central market waste comprising 91 wt% food/kitchen/garden and 4 wt% paper waste, while Menikkumbura market waste comprises 71 wt% food/kitchen/garden and 12 wt% paper waste.

The slaughterhouse kills around 20-25 cows and 15-25 goats per day, peak kill rates during festivals rising to around 80-100 cows and 60-80 goats. Animal dung, blood and faecal matter from the slaughterhouse are generally discharged via a concrete channel to the Meda Ela (small stream), while most of the solid wastes (bone, skull, hooves, etc.) are collected by the KMC Conservancy tractor and transported to the Gohagoda disposal site. Here, they are placed in a separate pit for subsequent sale of the bones for fertilizer following decay.

Additional information on the Central and Menikkumbura markets and the slaughterhouse is set out in the following sub-sections.

1.3.2.1 Central Market

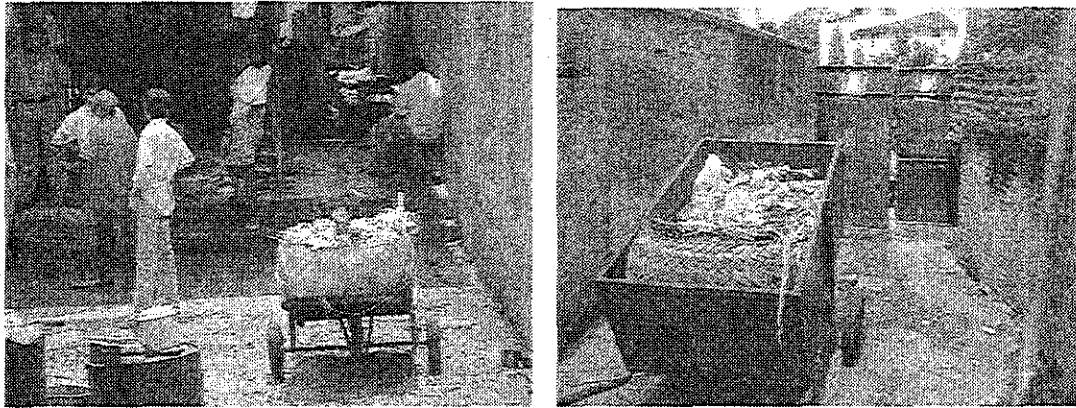
The Central market is open seven days per week from 6:30am-8:30pm. It is now primarily a retail market, comprising 277 stalls, following the relocation of its wholesale section to the Menikkumbura market around January 2002. However, about 51 unofficial traders are now operating in the area previously occupied by the wholesale section⁷.

The Veterinary section is responsible for waste collection and cleaning within the official market. They employ one Market Inspector and 22 labourers, working in two shifts (6am – 2pm – 12 labourers; 2-9pm – 10 labourers), for this purpose. Regular meetings are held with market traders around every 3-4 months to discuss any issues of concern. Market by-laws require every trader to have a “plastic garbage bucket” in front of their stalls. However, very few traders do this, as they know their waste will be collected anyway.

⁶ Gohagoda landfill records, Jan-Apr 2002

⁷ KMC may construct a 3-4 storey building in this area in the future and would like to remove these traders. However, as of July 2002, this was not possible as the traders had taken out a court case against KMC, which meant an injunction was in place preventing their removal.

KMC Veterinary labourers collect market waste, including fish and meat waste, using handcarts and discharge it to a stationary trailer "collection point" parked near the fish section of the market. It is collected from here by KMC tractor and taken to Gohagoda landfill around 1-2 times/d. The collection point is only wide enough to accommodate one trailer and hence it is left empty until the trailer returns from the landfill, around 60-90min later, thus disrupting market labourers' garbage collection work.



Central Market: Left – KMC labourer at work; Right – Market garbage collection point, showing handcart waiting for the market trailer to be returned from emptying.

KMC SWM labourers have responsibility for transporting the official market waste to Gohagoda landfill and for cleaning, waste collection and transportation from the area outside the market. Another two trailers are parked outside the market, in the carpark and near the pineapple area, for this purpose. One supervisor and 10 labourers work in this area (8am-5pm).

Market garbage collection problems include:

- Complete reliance on a single KMC tractor for their garbage collection. If the driver is absent or late, this can cause market waste to stockpile, including some highly putrescible meat and fish waste. Irregular garbage collection has been a major problem in the past, with market management complaining to the KMC SWM authorities on numerous occasions over the last three years, when the tractor has failed to turn up. However, this situation seems to have improved recently.
- Labourer management problems: market labourers are KMC employees and are often absent or do not carry out their duties properly.
- The market waste management system needs improving. In particular, the collection point should be redesigned, while market traders should also provide garbage bins for their stalls.

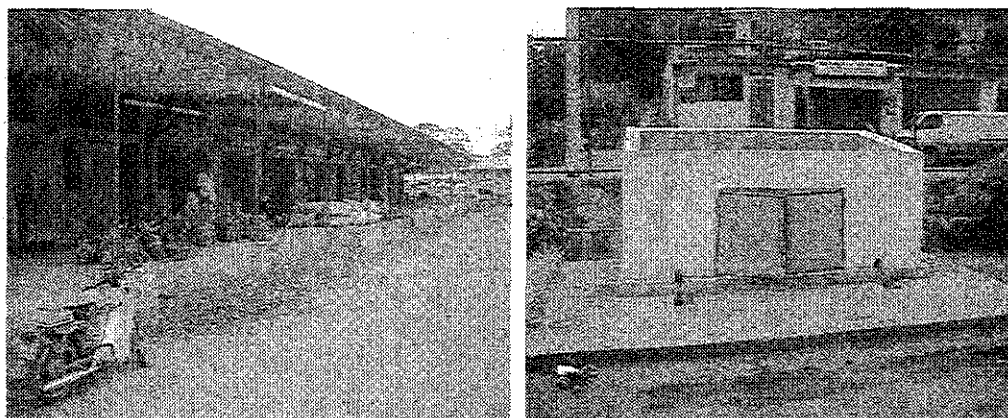
1.3.2.2 Menikkumbura Market

This wholesale/retail market was opened in January 2002 and has been operating for around six months now. Initial resistance by wholesale traders to being relocated seems to have dispersed now and the market contains around 71 wholesale and 40 retail stalls. Another 41 retail stalls are currently closed, this partly being due to their poor design.

The KMC Veterinary section is responsible for waste management within the market. They employ one Market Supervisor (acting) and 11 labourers for this purpose. The wholesale section is open from seven days/wk from 2-10pm except on Poya and some festival days (open from 4-10pm) while it is closed during Vesak, Poson and New Year (2days). On average, around 150 trucks/d (maximum = 300-350) bring fresh produce to the wholesale market each day. Some of the fresh produce is packaged in vegetable matter (e.g. banana leaves), with the packaging adding to the market waste generated.

The retail section is open from 8:30am – 8pm. There is a concrete collection bin located in the retail section, but this is essentially disused due to poor trader cooperation.

Market cleaning is done from 6am – 2pm. Garbage is collected from both sections of the market by one of five handcarts and taken to a central collection point. Another concrete bin is located here, but this is virtually unused as it is badly designed, with garbage removal being extremely difficult. Instead, a stationary trailer is parked near this point for labourers to discharge their waste into.



Menikkumbura market: Left – wholesale section; Right - poorly designed central collection point.

The market also has its own wastewater treatment plant (WWTP) for treatment of vegetable/fish/meat washwater and toilet wastes from the market's eight toilets. This is a Puritas Activated Sludge Plant, comprising two 35,000L tanks, following which the effluent may be directed either to an upflow clarifier and chlorination chamber or to sand beds.

Only one of the two 35,000 tanks is currently being used, due to the low flow of wastewater from the market. Gully sucker waste has been brought here from time to time to make use of this surplus capacity but this practice has been discontinued as the plant does not include a screen and plastics in the gully sucker waste were blocking the WWTP's pumps. In addition, traders didn't like gully sucker waste being discharged within the market. A possible solution to these issues could be to install a small receiving station, including a screen, outside the market for the receipt of gully sucker waste, and to pump it from here to the WWTP.

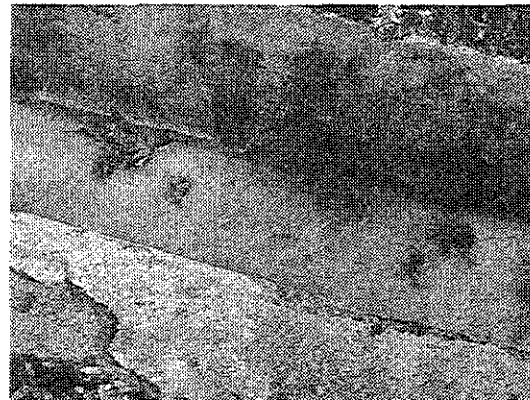
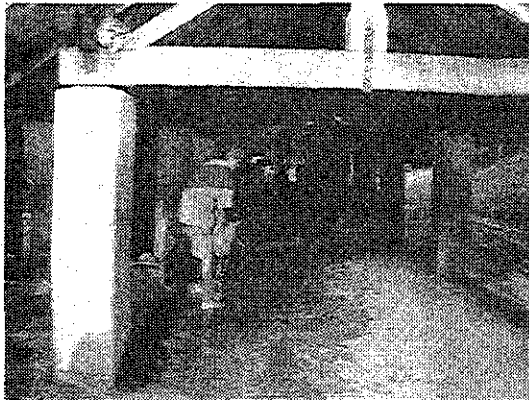
The main SWM problems at this market are poor trader cooperation, poorly designed garbage collection points, resulting in these points not being used and inefficient waste transfer to the stationary trailer, and under-utilisation of the WWTP.

1.3.3 Slaughterhouse

There is only one slaughterhouse within the city, occupying about 0.4ha of land at Suduhumpola, just off the Peradeniya Rd and next to the Meda Ela. The slaughterhouse is very old, being constructed during the british era (pre-1948). It is open six days per week and closed on Sundays and Poya days. KMC employs one Supervisor (supervision, issuing of receipts, record keeping), three labourers (cleaning, sweeping, etc.) and two drivers (mutton/beef transport) at the slaughterhouse. In addition, there are up to 20-25 slaughtermen, employed by their respective butchers, working on-site. Killing takes place early in the morning, with the meat being inspected and certified as fit for human consumption by the KMC Veterinary Surgeon. Condemned meat and organs are buried on site in a pit.

A new slaughterhouse has been constructed at Gohagoda close to the landfill. However, attempts to relocate to this site have failed due to strong protests from nearby residents, particularly Buddhist monks living in the area. This new facility is unlikely to ever be used.

The slaughterhouse urgently needs an improved SWM and liquid waste management system, particularly to avert the direct discharge of liquid and/or solid wastes to the Meda Ela.



1.3.4 Hotels

There are 16 major hotels located within the KMA, which were all interviewed as part of this study. Around 1,140 staff are employed on average by 14 of these hotels⁸. Guest numbers increase from an average of 500 guests/d to a peak of 1,360 guests/d, the peak season generally running from Nov/Dec to Apr-May. Total guests and staff are estimated to be 1,959/day.

Hotel waste generation is estimated to range from 15-280kg/d, giving a total waste generation of 1.45T/d (16 hotels), equivalent to 0.74kg/(guests+staff).d. Waste generation increases by 1-3 times during the peak season and on special occasions (e.g. weddings, parties, conferences).

Food/kitchen waste is by far the most common waste type, followed by paper, plastics and garden waste. The hotels produce relatively small quantities of hazardous wastes, comprising toilet cleaners, aerosol cans, batteries and fluorescent tubes, although one hotel stated they produce around 100 fluorescent bulbs/month and another hotel around 60 aerosol cans/month.

Nine hotels have their food/kitchen waste collected from their premises by a number of pig farmers, particularly one large piggery near Ukuwela which collects food/kitchen waste from seven hotels, together with paper/plastics/glass and metals for recycling (~370kg/d). The total amount of waste materials recycled in this manner is estimated to be 635kg/d.

Six hotels compost around 820kg/mth of their garden waste on-site, with one of these also composting around 200kg/month of food/kitchen waste and 20kg/mth of paper waste.

Three hotels (Hill Top, King's Park, Devon) stated they recycle and/or compost all their wastes, this mainly being possible due to the service provided to them by the Ukuwela piggery.

Le Kandyan Resorts takes some "dry waste" directly to Gohagoda landfill using its own tractor (34 trips over the last 12 months (35kg/d)) and also burns/buries some of its garbage on site.

All other waste is collected by KMC or Care Kleen and taken to Gohagoda landfill for disposal.

Based on this data, it is estimated that 48% of hotel waste is collected by KMC/Care Kleen, 44% is recycled (mainly food/kitchen waste for pig food), while 5.2% is composted, 2.4% is taken directly to Gohagoda and 0.7% is disposed of by burning/burial on site.

1.4 Institutions

Investigations focused on hospital waste in this category, primarily due to the hazardous nature of some hospital waste (e.g. clinical, waste, sharps, body parts). Interviews were also conducted with some schools, other educational institutes, religious institutions, government offices and the Forces (Army, Prison and Police) in order to estimate the amount and composition of waste generated by these sectors.

1.4.1 General

Estimated institutional waste generation and composition data is tabulated below.

Table 1-4 : Institutional Waste Generation and Composition

Source	Waste generation (kg/d)	Most common waste types
Schools (9) and other educational institutes (3)	24 – 260	Pa > F/K > Ga > PI > In
Hospitals (8)	50 – 2,700	F/K > Pa > Ga > HH
Religious institutes/temples (6)	30 – 250	F/K > Ga > Pa > In > Ca
Security Forces (5)	50 – 390	F/K > Ga > GI/In > Pa/Ca
Government offices (5)	10 – 630	Pa > F/K > Ga > PI > Ca

Notes: Waste types – F/K = food/kitchen, Pa = paper, Ca = cardboard, Ga = garden, PI = plastics, In = inerts, Te = textiles, HH = hazardous healthcare waste

Institutional waste generation increases approximately 1-3 times on average during festival times and other special occasions. Eleven institutions produce small quantities of hazardous wastes (e.g. batteries, bulbs and aerosol cans). One school also produces very small quantities of waste laboratory chemicals.

⁸ Data not obtained for two hotels

1.4.2 Schools

Kandy has around 48 schools, with a total estimated number of 70,378 students and 3,575 school staff. The student population amounts to 64% of the total population of the KMA (110,049), this being attributed to a large number of students commuting daily to schools within Kandy from outside the city, possibly as high as 75% for some schools⁹. Interview surveys were conducted with nine of the largest schools, whose staff and students comprise 40% of the total school population within Kandy.

Garbage management methods practised by different schools vary, ranging from:

- Six of these schools discharge most, if not all, of their garbage for collection by KMC/Care Kleen.
- Hillwood College gives its food/kitchen waste to a piggery.
- Four schools compost some of their garden waste on site, with all composting operations being on a small scale (e.g. 10-50kg/mth).
- One school burns and/or buries all its garbage on site.

Based on this data, total school waste generation is estimated to be 2.4T/d, equivalent to 0.033kg/(students+staff).d, with 78% of school waste collected by KMC/Care Kleen, 4.1% recycled (mainly food/kitchen waste for pig food), 7.0% composted and 11% burned/buried on site.

1.4.3 Other Educational Institutes

There are around 12 other major educational institutes within the Kandy Municipal area, including Peradeniya University, Kandy Technical College, Nurses Training School, and several large international schools. Excluding Peradeniya University (discussed separately below), these institutes are estimated to comprise a total of 6,157 staff and students. Interview surveys were conducted with three of these institutes, this information being supplemented by additional data from KMC for two other institutes, representing 57% of the total other educational institute population (excluding Peradeniya University).

Four of these utilize the KMC/Care Kleen garbage collection service, while the Technical College indicated it burns/buries all of its garbage on site by burning/burial, apart from composting some garden waste. The Deaf and Blind School also burns some of its waste on site.

Other educational institutes waste generation was estimated to be 0.50T/d, equivalent to 0.081kg/(staff+students).d, with 82% being collected by KMC/Care Kleen, 16% being burned/buried on site and 2% composted.

1.4.4 Peradeniya University

Peradeniya University is Sri Lanka's first university, established in 1942. It has 9,500 undergraduate and 1,500 postgraduate students and 3,500 staff and associated people, including around 1,000 other residents (lecturers and their families) living in 480 houses on campus. There are 16 student hostels,

including nine major ones, with around 60% of students living on campus. The total campus area is around 715ha.

The University collects and disposes of its own garbage, with their Health Department being responsible for all solid waste, excluding garden waste. The Health Department has one four wheel tractor and trailer (~5m³ capacity¹⁰) and one covered truck (~5m³ capacity) for refuse collection. SWM staff comprise one PHI, two drivers, seven collection labourers and three disposal site labourers¹¹.

Several years ago, separate refuse collection bins were introduced at the university on a trial basis. However, this initiative failed and all solid wastes are now collected together, except for garden wastes.

Each vehicle collects around 1 load per day, giving an estimated total waste generation amount of 3T/d. Paper is the most common waste material, followed by kitchen/food waste and then polythene wastes. The collected waste is disposed of by controlled tipping onto university land next to the Mahaweli River. Generally, the disposal site labourers burn recently deposited waste to control flies and then cover it manually with ~100mm of soil/construction debris sourced from within the university grounds. They estimated that the filling area used over the last year was around 15m x 7m and 4m deep (total volume = 420m³). The University PHI believes this area has been used for waste disposal since the university opened, the total filled area being estimated to be around 300-400m long by 30m wide with the filling depth varying from 4-10m.

Garden waste is handled by the University's Landscape Division. Some grass is taken to the university farm for use as animal feed. Other grasses and leaves are mixed with cow dung and composted. About 2-3m³/mth of compost¹² is produced, which is mixed with urea and used as a fertilizer.

Total waste generation is estimated to be 3.02T/d (0.224kg/(staff+students).d).



⁹ Informal communication, Mr Ekanayake, Deputy Director, Administration, District Education Office, Kandy

¹⁰ 10 x 6 x 3 ft trailer

¹¹ The university employs a total of 60 labourers and 3 supervisors for various tasks. SWM is not allocated a separate supervisor.

¹² Estimated garden waste composted = 625kg/mth (21kg/d), assuming a garden waste density of 100kg/m³ and allowing for a 60% volume reduction during composting.

1.4.5 Hospitals

There are eight hospitals within the KMC area, as well as a number of medical centres/dispensaries. A new private hospital (Aloka hospital) is currently in the early stages of construction along William Gopallawa Rd, although KMC is contesting whether this development should go ahead. The Abeysekara Maternity Hospital has closed and now functions as an international school. The main survey findings, including hospital statistical data are summarized in the following two tables and below:

(a) The combined hospital facilities in Kandy are extremely large representing:

- A total of 3,108 beds.
- Average bed occupancy equivalent to 2,783 beds per day.
- Average total clinical and outpatients of 5,082 patients per day.
- Total staff of 4,790.

Corresponding hospital waste generation is estimated to be 4.9T/d, equivalent to 0.388 kg/(staff+patients).d.

(b) Hospital waste is highly organic with food/kitchen waste being the most common waste type, followed by paper, garden waste and healthcare hazardous waste.

(c) Most normal waste is collected by KMC or Careklean (Kandy General hospital only), although Peradeniya Teaching hospital and Kandy General hospital each dispose of around 30kg/d of their kitchen waste to the Peradeniya University and Ampitiya seminary piggeries respectively.

(d) Only two hospitals have an incinerator, which are used for the disposal of their healthcare hazardous waste.

- The Dental hospital incinerator is a two chamber (0.84m³ total volume) incinerator. It is 3.5 years old and maintained by Peradeniya University. Its capacity is estimated to be at least 15-30kg per 6 hours, based on stated ash generation of around 6kg per two days by hospital waste management staff¹³. It has a 7.6m high chimney, which is significantly shorter than the intended design height due to the presence of an overhead electricity cable during construction which has now been relocated underground. This means it can not be operated when teaching classes are being held in the third floor lecture room due to the resulting nuisance to students.
- The Suwasevana incinerator has a capacity of 2kg/h, chimney of 3.7m height and normally operates for around 2h/d. It is relatively old.

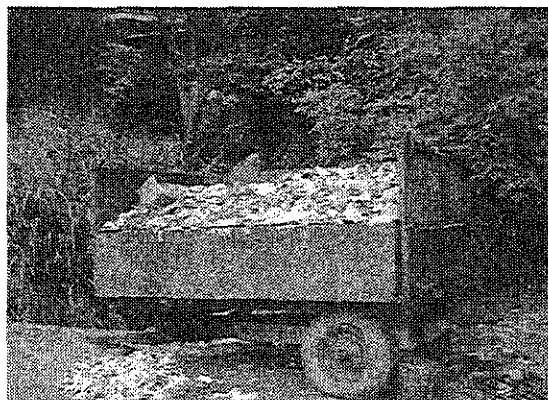
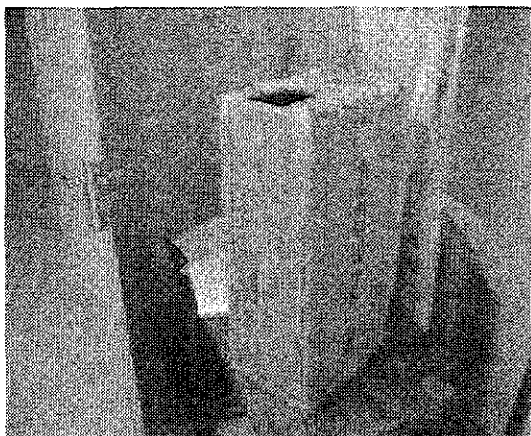
(e) Inadequate collection and disposal of healthcare hazardous waste is a serious problem, with significant quantities of healthcare hazardous waste being produced by both Kandy General and Peradeniya Teaching hospitals. Currently, these wastes are normally disposed of by burning and/or burial, except for the two hospitals having incinerators. Two hospitals also use autoclaves for the treatment of specimens and cultures prior to disposal.

¹³ Assuming ash = 10-20% of input waste.

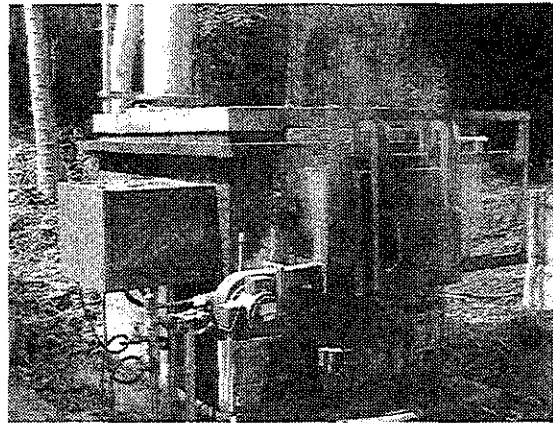
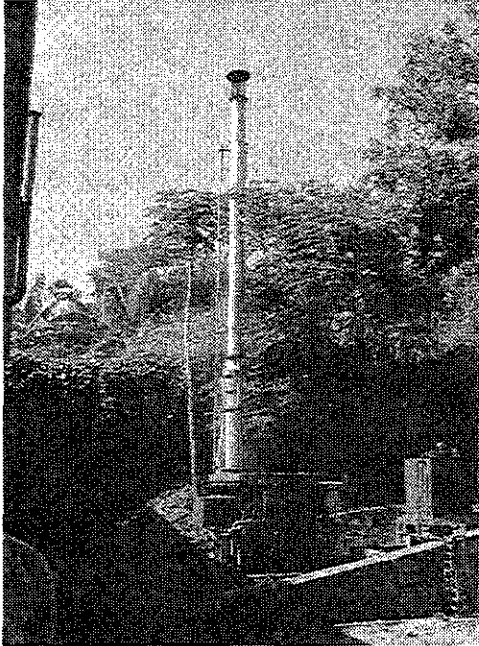
- (f) Many hospitals reuse waste containers. For example:
- Saline bottles are reused, by cutting off the top and using as a container for collecting sputum samples.
 - Penicillin bottles are re-used for blood and urine specimen collection.
 - Cardboard boxes are used as sharps storage containers.
 - Plaster of paris tins are used as carbon dioxide jars.
- (g) Both Kandy General and Peradeniya hospitals recycle most of their used plastic, glass and metal bottles/containers while Kandy General hospital also recycles newspaper and Peradeniya hospital coconut shells. These items are stored and then advertised for sale by tender at intervals ranging from three months to five years. Patients records and x-rays are kept for five years and then also sold by tender. Indicative data on the quantities of materials sold by tender was obtained from Peradeniya Hospital. Over 7 months, they sold 67,750 containers (plastic, glass and metal containers of various sizes), 605 kg of tins and 91 kg of cardboard. Kandy General hospital is likely to sell larger quantities of recyclable materials. However, no data could be obtained to verify this, other than them selling 200-300kg/mth of newspaper. Sale prices range from:
- Small plastic containers: 0.25-0.70 Rs ea.
 - Large plastic containers: 15-20 Rs ea.
 - Small glass bottles: 0.20-0.60 Rs ea.
 - Small tins: 0.10-0.30 Rs ea.
 - Large metal cans/tins: 5-20 Rs ea.
 - Cardboard: 0.75 Rs/kg
 - Coconut shells: 0.30 Rs ea.
- Total average recycling quantities are estimated to be 67kg/d.
- (h) Three hospitals (Lakeside, Kandy Private and Suwasevana) all pay garbage collection workers an unofficial collection fee ranging from 75-500Rs/yr.
- (i) Three out of eight hospitals are dissatisfied with the existing garbage collection service, the main reasons being:
- Poor discharge system (3).
 - Collection time is too early or too late (2).
 - Problems of handling healthcare hazardous waste (1).
 - Garbage collection point is too far away (1).
 - Garbage collection/sweeping is not properly done (1).
 - Garbage collection/sweeping frequency is too low (1).
 - Lack of recycling (1).
- (j) Desired SWM improvements ranked in descending order are: WAR¹⁴

¹⁴ WAR = weighted average rank

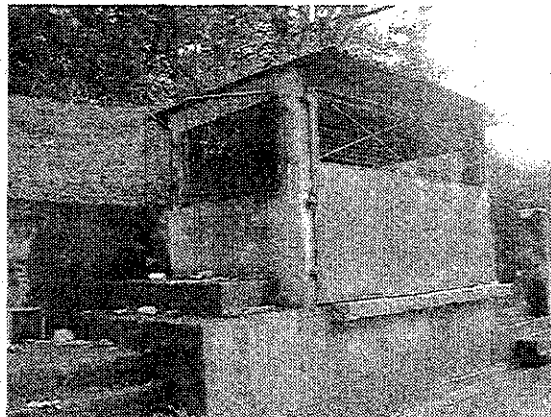
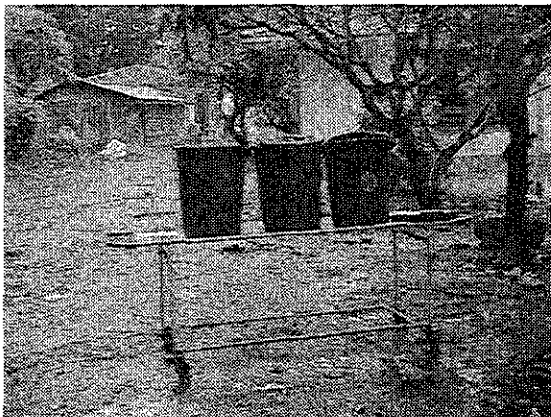
- Improved collection and disposal of hospital hazardous waste 7.5
 - More reliable garbage collection service 5.0
 - Improved garbage discharge system 4.5
 - Greater recycling/composting of garbage 4.5
 - Education to change peoples' bad habits 3.5
- (k) Three hospitals (Peradeniya, Katugastota, Kandy General) specifically requested the provision of an incinerator, while the Dental hospital incinerator's chimney requires extension. The capacity of the two existing incinerators in the city is likely to be too small for any sharing arrangement between hospitals to be feasible.
- (l) Only two hospitals were willing to pay for improved SWM services: Lakeside Adventist Hospital (>2000 Rs/mth) and Suwasevana Hospital 251-500 Rs/mth).
- (m) All hospitals except Lakeside Adventist Hospital are very willing to cooperate in separating their waste into different categories, with one hospital (Peradeniya teaching hospital) partially doing this already.



Kandy General Hospital: Top left – improved cardboard box “sharps bin”; top right – on-site open burning of sharps; bottom left – plastic containers stored for auction; bottom right – stationary trailer garbage collection point



Dental Hospital Incinerator



Peradeniya Hospital: Top left – hospital normal garbage bins; top right – hospital garbage bin; bottom left – open burning of cardboard boxes, saline bottles and sharps; bottom right – some needles and syringes present on the ground near the burning pit.