



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 GAMPAHA  
FINAL REPORT  
Volume V-3B  
SUPPORTING REPORT



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**ACTION PLAN FOR GAMPAHA**

**FINAL REPORT**

**Volume V-3B**

**SUPPORTING REPORT**

**DECEMBER 2003**



**KOKUSAI KOGYO CO.,LTD.**

## List of Volumes

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V-7B	Action Plan for Nuwara Eliya, Supporting Report

### ***This is Action Plan for Gampaha, 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
DEO	Divisional Environmental Officer
DF/R	Draft Final Report
EIA	Environmental Impact Assessment
F/S	Feasibility Study
GDP	Gross Domestic Product
GMA	Gampaha Municipal Area
GMC	Gampaha Municipal Council
IC/R	Inception Report
IDP	Infectious Disease Prevention
IEE	Initial Environmental Examination
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
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
SPHI	Senior Public Health Inspector
SWM	Solid Waste Management
WTP	Willingness to Pay

# Chapter 1

## Gampaha 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 between July-August 2002, undertaken primarily to quantify the waste stream for the Gampaha Municipal Area (GMA). It complements and provides further information to the waste stream data, assists in understanding the present NMA 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

Provisional 2001 census data gives the total population of GMA as 57,429, comprising an estimated 9,438 people in Gampaha, 12,393 in Bandiyamulla and 35,598 from Yakkala. The 2002 GMA population is estimated to be 57,429, based on a 2.0% annual growth rate.

No official estimates were available of the floating population within GMA. Discussions with the Senior Public Health Inspector (SPHI) suggested that the floating population is in the range of 40,000-80,000, based on GMA having a major railway station, three busy commercial areas, a large number of schools and reputable tuition classes drawing students from other areas, a major hospital, and with the extremely busy, main Kandy-Colombo Rd running through Yakkala and Mirriswatta.

Information on household waste generation and management practices was obtained from a survey of 150 households in seven different areas of GMA covering three high, two middle and two low income areas in both "old" (i.e. former Gampaha Urban Council) and "newly attached" (i.e. new Gampaha Municipal Council (GMC)) areas. 65% of the surveyed households are located in areas where garbage is collected by GMC, while the overall GMA garbage collection service coverage is estimated to be 49% on a population basis. Hence, the survey results were adjusted to reflect this difference in order to estimate the proportions of garbage disposed of by different means for the entire GMA. The corresponding results are summarized below.

A waste generation rate of 0.451kg/cap.d was estimated for GMA, based on JICA survey data for Matale and taking into account GMA having a mixture of Urban Council and Pradeshiya Sabha characteristics.

Table 1-1: Household Waste Management

Waste Management Method	Households in Survey Area (%)	All Households in GMA (adjusted %)	Waste Amount (T/d)
Self-disposal	62.0	67.2	17.8
Discharge for GMC collection	24.9	18.9	4.9
Home composting	2.4	2.6	0.7
Recycling	2.7	3.0	0.8
Illegal dumping	7.9	8.6	2.3
Total	100.0	100.0	26.4

**Notes:**

Detailed calculations are set out in "Gampaha Waste Stream Analysis".

Estimated 2002 population based on a compound growth rate of 2.08% (see "Gampaha Waste Stream Analysis"), giving a 2002 population of 58,577.

Total household waste generation = 58,577 persons x 0.451kg/person.d = 26.4T/d.

Waste amounts disposed of by different means calculated using total waste generation x adjusted percentages in above table, which relate to the entire GMA.

Household waste is expected to be mainly organic, as in Kandy and Matale, but with a higher proportion of garden waste.

## **1.3 Commercial Sector**

### **1.3.1 Commercial Enterprises**

Commercial enterprises covers all commercial operations (e.g. restaurants, bakeries, retail shops, communications centres, banks, hotels, etc.) except for markets and industries, which are classified separately. This includes government or semi-government enterprises that operate commercial oriented businesses and services (e.g. banks, Post Office, Sri Lanka Telecom, etc.)

There are three commercial centres within GMA: Gampaha, Yakkala and Mirriswatta townships. Both Yakkala and Mirriswatta commercial areas are characterized by ribbon development along the main Kandy-Colombo Rd, while Gampaha is more a conventional town.

GMC data gives a total of 1,541 "business activity" trade licences for GMA, while the corresponding number of actual business enterprises is estimated to be 25-50% of this number, with 578 enterprises being adopted (0.375 x 1,541). Excluding 33 industries whose waste is discussed under a separate category<sup>1</sup>, this gives a total of 545 commercial enterprises. These comprise a wide range of businesses, with trade licence data showing 41 bakeries, 57 local hotels, six restaurants, 65 vehicle related businesses (garages, petrol sheds, repairs, cleaning, etc.), 32 mechanical carpentry shops, 26 welding works, 13 printers and 28 hairdressers.

Limited specific investigations were undertaken for commercial enterprises as part of this study, involving interview surveys of 21 small and 11 large commercial enterprises within the Gampaha, Yakkala and Mirriswatta areas, covering seven retail shops, five local hotels/restaurants/reception halls, three supermarkets, three accommodation hotels, three pharmacies, two hairdressers, CWE (wholesale cooperative), eggs/chicken sales, tailoring, communications centre, Sri Lanka Telecom, Agency Post Office, bank, timber depot and ayurvedic medicine sales. Estimated garbage generation and composition, based on the four most common waste types, are tabulated below.

Commercial waste generation is estimated to be 4.5T/d, based on survey data together with discussions with GMC Supervisors, giving a waste generation rate of 8.34kg/enterprise.d.

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<sup>1</sup> Market stalls not excluded as inspection of the trade licence breakdown suggests they are not included in trade licence data.

Waste generation increases approximately 1-3 times on average during festivals and other special occasions (e.g. Sinhala/Tamil new year).

Table 1-2: Commercial Enterprises Waste Generation and Composition

Source	Estimated waste generation (kg/d)	Most common waste types
Small enterprises (21), including two local hotels	0.5 – 10	Pa > F/K > Ca > PI > Ga
Large retail/service (5)	10 - 125	F/K > Ca > Pa > PI > Ga
Restaurants/reception halls (3)	13 – 40	F/K > Ca > Ga > Pa = PI
Hotels (accommodation) (3)	1.5 - 10	F/K > Ga > Pa > GI= PI

**Notes:**

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.

Waste types: Ca = cardboard, F/K = food/kitchen, Ga = garden, Me = metals, Pa = paper, PI = plastics.

Eight commercial enterprises produce very small quantities of hazardous waste, comprising a small quantity of tubelights (2 enterprises), used mosquito coils (1 enterprise), used razor blades (hairdresser), old drugs (pharmacy) and spray/chemical cans (3 enterprises), all of which are disposed with their normal garbage.

For the 21 small enterprises, 19 discharge some (5) or all (14) of their garbage for collection by GMC. Six burn most (4) or some (2) of their garbage on site. Four enterprises also recycle some of their waste: C.S. Food Centre gives 7kg/mth of cardboard to the Cooperative Office, Salon Super Fashion sells 10 bottles/mth to Hope Chemicals and Saneepa Ayurveda Rasayana sells 2kg/mth of broken glass to individual collectors.

Eight of the 11 large commercial enterprises have most (7) or some (1) of their garbage collected by GMC. Four enterprises burn most (1) or some (3) of their garbage on-site. Keels Supermarket direct hauls their garbage to the final disposal site using their own vehicle. Seven enterprises recycle various items, comprising 3,100kg/mth cardboard, 962kg/mth food/kitchen waste for animal feed, 63kg/mth glass bottles and 2kg/mth broken glass. This is the main “disposal” method for two places. No enterprises compost any of their garbage on-site.

Based on this information, it was estimated that 53.7% of commercial waste is collected by GMC, 12.9% is disposed of on-site primarily by burning (e.g. paper waste), 29.2% is recycled and 4.3% directly hauled to landfill.

### 1.3.2 Markets

Gampaha has one public market, comprising fish, vegetable and retail sections, located in the central area of Gampaha. This comprises a total number of 158 active stalls (refer following table).

There is one Pola (weekly fair) held on Sundays in Yakkala. This comprises a total number of 181 active stalls. There is no market or Pola in Mirriswatta, with people in this area utilizing the Balummahara Pola instead, which is located outside GMA.

There is no public slaughterhouse within the GMA. Instead, Gampaha's meat is brought into the city from outside (mainly from Ganemulla and Bollatha for Gampaha and Thihariya for Yakkala).

Table 1-3: Public Market and Pola Details

Market	Number of stalls					SW collection/ disposal
	Meat /fish	Veg/ fruit	Goods	Other	Total	
Public market	26	90	32	10	158	GMC
Sunday Pola	6	150	25	0	181	GMC
Total	32	240	57	10	339	

**Note:** Stall numbers are based on currently functioning market stalls, as determined during JICA field surveys. Stall space is available at some of these markets but is not currently being utilized, including two stalls at the public market and 26 stalls at the Sunday Pola.

An average 730kg/d of market waste is generated by the Gampaha public market, while the Yakkala Pola generates around 1,314kg. Allowing for pola waste only being produced once per week, market waste generation is equivalent to 918kg/d from 184 stalls, or 4.99kg/stall.d.

Market waste generation shows some variations on festival occasions, increasing by 1.5-2.0 times during the Sinhala/Tamil New Year and Christmas.

Additional market information is set out in the following sub-sections.

### 1.3.2.1 Gampaha Public Market

The Gampaha Public market is open six days/week from 7:30am to 7:30pm. It is cleaned twice per day by three market labourers (day shift) and four during the night shift, when the fish market is washed down. A handcart is used for transporting market waste to the transfer station near the GMC office during the daytime and to a stationary trailer parked near the market at night-time. Some recyclable materials are collected by individual collectors on a small scale (estimated to be 10kg/d).

The market has complained to GMC about market waste collection 7-8 times over the last three years. Suggested improvements include improving the market waste discharge system, followed by improved garbage collection frequency and increasing the number of garbage collection labourers and vehicles.



*Gampaha public market*

### 1.3.2.2 Yakkala Pola

The Yakkala Pola operates only on Sundays from 8am to 5pm. It is cleaned on the following Monday and Tuesday by two (sometimes three) GMC labourers, with the market waste being taken to the GMC transfer station, located at the rear of the Pola grounds. According to market authorities, it is collected from here once every two weeks and taken to the GMC final disposal site. Based on this statement and field observations, it is considered that 70% of the Pola waste is burnt at the transfer site, rather than taken to the final disposal site. This is supported by comments made by the Yakkala PHI.

The Pola is not satisfied with GMC's garbage collection service. Suggested improvements are more easily accessible bins, followed by education/awareness raising, improved collection frequency and an improved garbage discharge system.

## 1.4 Institutions

In this category, the focus of our investigations was on hospital waste, primarily due to the hazardous nature of some of the waste (e.g. clinical, waste, sharps, body parts) generated by this sector. Interviews were also conducted with some schools, other educational institutes, government offices and religious places in order to estimate the amount and composition of waste generated by these sectors.

### 1.4.1 General

Interview survey results for institutional waste generation and composition data are set out below.

Table 1-4: Institutional Waste Generation and Composition

Source	Waste generation (kg/d)	Most common waste types
Schools (7)	12 - 520	Pa > PI > Ga > F/K > Ca
Other educational institutes (2)	50 - 105	Ga > F/K > Pa = Te > Ca=Me
Wikkrama Arrachchi Ayurveda Vidyayatanaya	1,356	Ga > F/K > Pa > Ca > Hz
Hospitals (3)	42 - 743	F/K > Pa > PI > Ga > Ca > HH
Religious (1)	45	Ga > F/K > PI > Pa > Ca
Government offices (2)	12 - 50	Ga > F/K > Pa > Ca > Me

**Notes:**

Waste types: Ca = cardboard, F/K = food/kitchen, Ga = garden, HH = hazardous healthcare waste, Hz = hazardous, Me = metal, Pa = paper, PI = plastics, Te = textiles.

The number of institutes shown here in brackets may differ in some cases from the number mentioned in the text below. This is because the above number refers to complete interview surveys that were conducted, while the number in the text may be greater than this due to additional information obtained from GMC conducted to obtain relevant statistical and waste stream data.

Institutional waste generation increases approximately 1-3 times on average, mainly during special functions (e.g. school sports meets, fairs).

Four institutions produce very small quantities of hazardous wastes (batteries, tubelights and spray cans).

### 1.4.2 Schools

Gampaha has a total of 18 schools, including six Type 1AB<sup>2</sup> schools, four Type 1C schools, four Type 2 schools and one Type 3 school<sup>3</sup>. The total estimated number of students and school staff are 26,732 and 1,090 respectively, giving a combined total of 27,822 students and staff. The student population amounts to 47% of the total 2002 GMA population (58,577).

Interview surveys were conducted with seven schools, with additional information being obtained from GMC on the waste disposal practices of one other school. Together, the staff and students at these eight schools comprise 69% of the total school population in GMA.

Five of these schools have all (1) or most (4) of their garbage collected by GMC, while five burn/bury all (1), most (2), or some (2) of their garbage on-site. Four schools recycle 112kg/mth of waste paper/books while two schools compost 105kg/mth of garden waste. Gothami College illegally disposes of some of its waste at an unspecified location. Based on this data, total school waste generation was estimated to be 2.3T/d, equivalent to a waste generation rate of 0.084 kg/(students+staff).d with 49.6% of this waste collected by GMC, 0.2% composted, 49.7% burned/buried on-site, 0.2% recycled and 0.3% illegally dumped.

### 1.4.3 Other Educational Institutes

GMA contains a number of other educational institutes including approximately 14 pre-schools, the Ward International School, eight well known tuition centres (e.g. Samadi Educational Institute, Sorbonne, Montana, Nanik), TEC Sri Lanka, Gampaha Technical College and the Wikkrama Arrachchi Ayurveda Vidyayatanaya (WAAV).

The Technical College, Samadi Educational Institute and WAAV were surveyed as part of this study, with the WAAV results being described separately below.

Most of the Technical College's garbage is collected by GMC, except for some which is burnt on-site and minor recycling of 6.3kg/mth of metals. Samadi Educational Institute burns/buries all its garbage on-site. Waste stream calculations were based on adoption of the school waste generation rate and waste stream breakdown for pre-schools and the Ward International School; using the survey data for the Samadi Educational Institute and assuming other tuition centres self-dispose of 80% of their waste, with the other 20% being collected by GMC; using the survey data for the Technical College with this data

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<sup>2</sup> Type 1AB = Years 1-13 (sometimes 6-13) with A level science/commerce/arts; Type 1C = Years 1-13 (sometimes 6-13) with A level commerce/arts; Type 2 = Years 1-11 (up to O-level only); Type 3 = Years 1-5 (sometimes 9) primary.

<sup>3</sup> No data obtained for three schools.

being combined to obtain an overall waste generation amount of 2.3T/d, equivalent to 0.134kg/(staff+students.d) with 82% of garbage being disposed of on-site and 18% collected by GMC.

#### **1.4.4 Wikkrama Arrachchi Ayurveda Vidyayatanaya (WAAV)**

Wikkrama Arrachchi Ayurveda Vidyayatanaya (WAAV) is an ayurvedic university and hospital located in Yakkala. The university has 155 staff and 275 students. The hospital has 120 beds with a 90% occupancy rate, 300-350 outpatients/d, 60 clinical patients/d and 65 staff, giving a total of 558 patients+staff/d. Together, these combined facilities have 988 staff+students+patients/d.

Combined waste generation from the university and hospital is estimated to be 1.36T/d, which is relatively large, primarily due to high garden waste generation from a large herbal garden situated within WAAV's grounds. Hospital waste is estimated to comprise 14% of total waste generation and is mainly organic, with hazardous healthcare waste being negligible (due to the different nature of ayurvedic medicine compared with conventional medicine). About 1.5mths ago (mid-August 2002), WAAV privatized its waste collection service, following which private contractors collect the combined hospital and university waste, burning it all on-site.

#### **1.4.5 Hospitals**

There are three main conventional hospitals within GMA: Gampaha Base Hospital, Arogya Hospital and the Co-operative Hospital, as well as a number of medical centres/dispensaries. WAAV, an ayurvedic hospital in Yakkala, has been discussed above. The main survey findings for these three hospitals, including hospital statistical data are set out in the following two tables and summarized below.

- The combined hospital facilities in Gampaha are:
  - A total of 570 beds.
  - Average bed occupancy equivalent to 464 beds per day (81%).
  - Average total clinical and outpatients of 1,544 patients per day.
  - Total staff of 709.

Corresponding hospital waste generation is estimated to be 0.86T/d, equivalent to 0.316kg/(staff+patients).d.

- Food/kitchen waste is the most common waste type, followed by paper, plastic, garden, cardboard and healthcare hazardous waste.
- The Base Hospital generates ~710kg/d of normal waste (1/2 trailer load/d) and 33kg/d of healthcare hazardous wastes. Hospital waste is collected by private contractors within the hospital, with normal waste being taken to the waste storage/disposal area, where it is stored in the hospital's own covered trailer<sup>4</sup> for collection by GMC. The hospital indicated it was satisfied with the performance of its private contractors but complained about the irregularity of the GMC collection

service, meaning that it frequently resorts to burning a lot of its normal waste on-site. This was verified by the JICA disposal site survey which found that only two half full loads of hospital waste were brought to the final disposal site over a continuous seven day period (8-14 Aug, 2002). On this basis, it is assumed that 70% of base hospital normal waste is normally disposed of by burning on-site, while only 30% is collected by GMC.

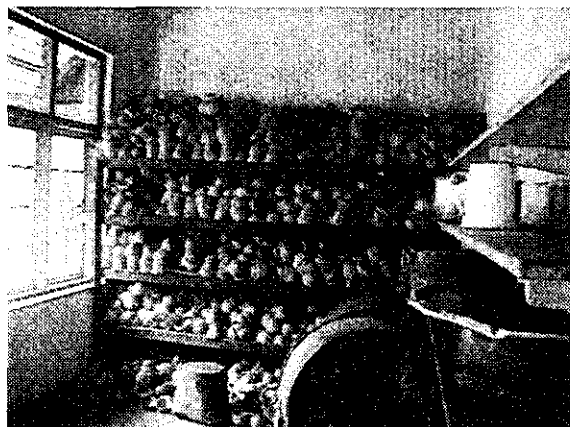
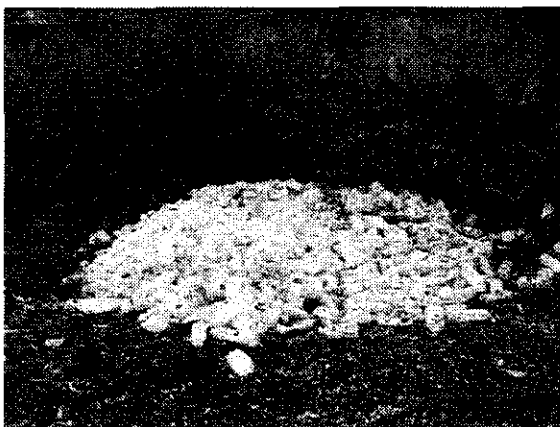
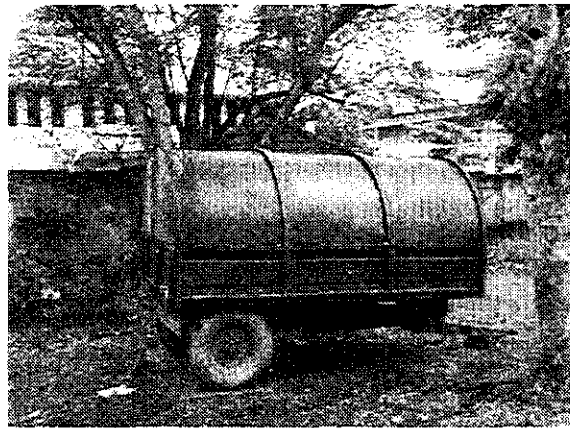
- The Base Hospital disposes of most of its hazardous healthcare waste (HHCW = clinical waste, body parts, sharps, highly infectious wastes) by burning and/or burial on-site, except for post-mortem waste and placentas, which are taken to the cemetery for burial and urine/blood samples which are disposed of to the hospital drainage system/toilets, thus ending up in the hospital's wastewater treatment plant.
- The Base Hospital reuses waste containers. For example:
  - Saline and penicillin bottles are reused (e.g. containers for blood/urine specimen collection).
  - Cardboard boxes are used as sharps storage containers.
- The Base hospital recycles some cardboard, used plastic/glass/metal containers/bottles and coconut shells. Cardboard is given/sold to individual collectors while most other items are auctioned at yearly intervals. The average quantities recycled per month are 200kg of cardboard, 400kg of plastics, 4kg of polythene bags, 675kg of glass, 15kg of metal items and 118kg of coconut shells. Recently, the hospital cleaners have started collecting saline bottles for recycling, with about 6,270 bottles being reused and/or recycled per month.
- Most normal waste is collected by GMC from the other two hospitals, except for small quantities of cardboard and plastic/glass bottles/containers which are given to staff or sold at daily-three monthly intervals: 40 bottles/mth and 50kg/mth of metal items by Arogya Hospital and 3-4kg/mth of cardboard and 10kg/mth of glass by the Co-operative Hospital.
- The Arogya Hospital transports the small quantities of HHCW it produces to a private "local" incinerator in Kochchikade, Negombo for disposal. On the few occasions when body part waste generation is high, they usually transfer this waste to the Base Hospital for disposal. The Co-operative Hospital produces very small quantities of clinical and sharps waste which it burns on site.
- Both the Base and Arogya hospitals are not satisfied with the present waste collection system<sup>5</sup> for a variety of reasons related to the discharge system being poor, the poor quality and irregularity of GMC's cleaning service, problems handling HHCW, etc.
- Only the Arogya Hospital pays garbage collection workers an unofficial collection fee of 1,000Rs/yr.
- Desired SWM improvements ranked in descending order are (numbers shown are weighted average ranks (WAR) for desired improvements):

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<sup>4</sup> Rectangular base with semi-circular top and sliding side doors; Vol = 5.77m<sup>3</sup>.



- Greater recycling/composting of garbage 4.0
- Improved collection frequency 3.0
- Other (give MC facilities, labourers should be more careful) 3.0
- Education to change peoples` bad habits 2.5
- Improved collection and disposal of HHCW 2.0



*Gampaha Base Hospital: Top - on-site disposal; middle = hospital garbage collection trailer; bottom = saline bottles and coconuts being stored separately for recycling.*

<sup>5</sup> The Co-operative Hospital did not respond to this question.

Table 1-5: Hospital General Statistics and Waste Generation

Hospital	Type	No of Beds	Bed occupancy (%)	Out-patients (no/d)	Clinical patients (no/d)	Staff	Waste composition	Normal waste (kg/d)	Clinical waste (kg/mth)	Body parts/placenta (kg/mth)	Sharps (per month)	Highly infectious (/mth)	Other
Base Hospital	Govt	501	79	985	334	595	F/K > PI > Ga > Pa > HH	710	Clin + BP: 314 Plac: 210		480	NA	31
Arogya Hospital	Private	42	100	60	40	54	Pa > F/K > Ca > Me > HH	70	60	Small	Small	Small	Small
Co-operative Hospital	Semi-govt	27	95	80	45	60	F/K > Pa > PI > Ga > HH	40	60	0	0.01	0	Small
Total		570	81	1125	418	709	F/K > Pa > PI > Ga > Ca = HH	820	Clin + BP: 434 Plac: ~210		~480	NA	~31

**Notes:**

Data for hospitals obtained from interviews with relevant staff members of each institute.

Average total number of beds occupied = Sum of (number of beds x bed occupancy rate) for all hospitals = 464.

Waste types: BP = body parts, Ca = cardboard, Clin = clinical waste, F/K = food/kitchen waste, Ga = garden, Gl = glass, HH = healthcare hazardous waste, Me = metal, Pa = paper, Plac = placenta, PI = plastic. NA = no answer.

An accuracy check has only been made on the amount of normal waste, with survey data being amended based on GMC data, as required.

Table 1-6: Hospital Waste Disposal Practices

Hospital	Normal waste	Clinical waste	Body Parts and/or placentas	Sharps	Highly infectious	Other	WWTP	Incinerator	Comments
Base Hospital	~70% of non-recycled waste burnt on-site with remaining 30% collected by GMC. Recycling of cardboard, plastic/glass/metal bottles/containers and coconut shells amounts to 49kg/d.	Burned on site, except for post-mortem remains and placentas which are taken to the cemetery.		Burned on site.	Burned on site except for urine/blood samples which are disposed to drains/toilets (i.e. to WWTP)	No answer	Yes	No	Would like incinerator and financial support to set up colour coded waste discharge system, supply labourers with gloves, etc.
Arogya Hospital	Collected by GMC except for some recycling of plastic bottles and glass.	Incinerated				No answer	No	No	Use incinerator in Kochchikade, Negombo.
Co-operative Hospital	Collected by GMC except for some recycling of cardboard and glass.	Burned on site	Burned on site	Burned on site	Not applicable	No answer	No	No	

- The Base Hospital would also like an incinerator, while it needs financial assistance to implement the colour coded garbage discharge system recommended by the Ministry of Health and to provide hospital labourers with appropriate garbage collection equipment (e.g. gloves). The Arogya hospital transports its hazardous healthcare wastes a relatively long distance for disposal by incineration and would like to have incineration facilities located closer to them.
- The Co-operative hospital is willing to pay 1,200Rs/mth for improved garbage collection services, while the Arogya Hospital interviewee was not able to answer this question directly but indicated that 1,200Rs/mth seemed a reasonable figure. The Base Hospital said that this question should be referred to the Deputy Director of Health Services, Western Province for a response.
- All three hospitals support recycling, with the Base and Arogya hospitals both being very willing to cooperate in separating their waste into different categories for recycling, if requested. However, the Co-operative hospital is not willing at all to co-operate in the source separation of waste.

#### **1.4.6 Government Offices**

There are approximately 25 central and provincial government departments/ministries/authorities with offices in GMA. Together with the Police station, prison and GMC, these offices employ approximately 1,535 workers, while the prison has 50 inmates. Interview surveys were conducted with two of these offices, including GMC, while additional information was obtained from GMC for the Prison and Courts Complex (Magistrate, District and High Courts), meaning six<sup>6</sup> out of a total of 28 government offices within GMA were surveyed.

Three offices have all (2) or most (1) of their garbage collected by GMC, while two burn most (1) or some (1) of their garbage on-site. The Divisional Education Office recycles ~5kg/mth of waste paper. Based on this data, the estimated government office waste generation rate is 0.157kg/worker.d giving a waste generation amount of 0.25T/d, with 70.2% of this waste collected by GMC, 29.7% burned/buried on site and 0.2% recycled.

#### **1.4.7 Religious Places**

The total number of religious places within GMA is approximately 18, comprising five churches, eight buddhist temples and other institutes (e.g. three Pirivena (seminaries)) and approximately two mosques and three hindu temples (kovils). The associated number of religious workers is estimated to be 120. Adopting a religious places waste generation rate of 1.01kg/clergy.d, based on Kandy and Matale data, this gives a total waste generation amount of 0.12T/d. Only one religious institute (Vidyaravinda Pirivena) was surveyed which burns/buries all its waste on-site. Using this survey result, survey data from Kandy and Matale, and taking into account the location of the different institutes and the low GMA

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<sup>6</sup> Courts Complex is listed as three separate offices in the list of government offices obtained from GMC but is discussed as a single office in terms of the waste stream.

garbage collection service coverage, it is assumed that 50% of all religious places garbage is collected by GMC and 50% disposed of on-site.

## 1.5 Industries

According to data supplied by GMC, industrial activity is on a reasonable scale within GMA, particularly in the Yakkala area. 33 enterprises have been classified as industries for the purposes of this study, with these being broken down into a number of sub-categories, as summarized below, which shows the number of industries surveyed and the resulting waste generation and indicative composition results.

Table 1-7: Industry Breakdown, Waste Generation and Composition

Sub-category	No	No surveyed	Waste Generation (kg/d)	Common waste types
Garment factories	6	6	10 - 200	Te > F/K > Ga > Pa > Ca
Desiccated coconut mills	2	2	1,850 - 5,260	Co > F > Pa = Ga
Sawmills	13	5	57 - 1,167	Wc > Sw > Bk
Other	12	6	1.7 - 500	Me > F/K = PI > Ga

**Notes:**

Waste types: Bk = bark, Ca = cardboard, Co = coconuts, F/K = food/kitchen, Ga = garden, Me = metal, Pa = paper, PI = plastics, Sw = sawdust, Te = textiles, Wc = woodchips.

Other = steel goods production (2), scrap metal recycling/steel goods manufacturing (1), plastics recycling/plastics goods manufacturing (1), bag production (1), ayurvedic medicine production (1), coir processing (1), quarries (2), unspecified (3).

Industrial waste production increases approximately 1-2 times mainly as a result of special orders (garment factories) or seasonal factors (coconut mills).

Five industries produce small quantities of hazardous wastes, comprising tubelights (4), batteries (1), paint tins (1), and sulphur (1).

### 1.5.1 Garment Factories

There are six garment factories located within GMA, one in Gampaha, three in Yakkala and two in Kalagedihena. These employ a total of 2,815 workers. All six factories were surveyed as part of this study.

Total garment factory waste generation is estimated to be 545kg/d, equivalent to 0.194kg/worker.d. Four of the six garment factories have most (3) or some (1) of their garbage collected by GMC, while four garment factories burn/bury most (1) or some (3) of their garbage on-site. Five garment factories recycle most (2) or some (3) waste materials, mainly comprising 3,230kg/mth paper/cardboard waste, ~2,240kg/mth food/kitchen waste for animal feed, 300kg/mth metal and 215kg/mth plastics.

Overall, it is estimated that 38% of the garment factories' garbage is collected by GMC, 37% recycled and 25% disposed of on-site.

### 1.5.2 Desiccated Coconut Mills

There are two large desiccated coconut mills located within the Yakkala area of GMA, both of which were surveyed as part of this study. These mills have been included as a separate category due to the large amount of waste produced by them and the distinctly different characteristics of their waste, compared with that from other industries in the area. These two mills employ a total of 230 workers.

Estimated waste generation amounts to 7,110kg/d, equivalent to 30.9kg/worker.d, comprising 360kg/d of normal waste and ~6,750kg/d of coconut associated waste (shells, nuts, etc.).

Bandarawatta Mill disposes of most of its waste on-site, while recycling 300,000-375,000 coconut shells/mth and 27,000kg/mth of "polkurutu" (inner layer of coconut) and illegally disposing its coconut processing wastewater to a nearby stream/river. Bogamuwa Mill recycles most of its waste (300,000 coconut shells/mth taken elsewhere to make charcoal, 1,800kg/mth of polkurutu and 3,000 broken nuts/mth), with residual waste being collected by GMC or disposed illegally to nearby vacant land.

Overall, it is estimated that 39.9% of these mills' waste is recycled, 47.5% disposed of on-site, 10.1% illegally dumped and 2.5% collected by GMC.

### 1.5.3 Sawmills

Interview surveys were conducted with five of the 13 sawmills within GMA to find out about their waste disposal practices and their willingness to co-operate with GMC in giving/selling their sawmill wastes for use in composting as an amendment/bulking agent. The results of these interview surveys are set out in the following table and summarized here:

- These five sawmills employ a total of 30 workers and produce 1.99T/d of sawmill waste, equivalent to 66kg/worker.d, comprising mainly woodchips and sawdust, together with smaller quantities of bark.
- All five sawmills produce significant quantities of wood wastes, comprising around 25.1T/mth of sawdust, 34.4T/mth of woodchips and 0.2T/mth of bark.
- Four sawmills give away all (2) or some (2) of their sawdust, with the remaining sawdust being burnt on-site, while one sawmill burns all its sawdust on-site. Four sawmills give away some (2) or all (2) of their woodchips, while three sell some (2) or all (1) of their woodchips at prices ranging from Rs700-1,200 per tractor load. One sawmill also uses some of its woodchips on-site. Bark is only specified separately by one sawmill and is given away for free.
- All five sawmills were willing to give (4) or sell (1) all of their sawdust to GMC and willing to sell some (4) to all (1) of their woodchips. The one sawmill specifying bark waste separately was willing to give it to GMC.
- Quantities available for free amounted to 24.6T/mth of sawdust and 0.2T/mth of bark. Another 0.75T/mth of sawdust was available for 300Rs. 29.8T/mth of woodchips were available at prices ranging from 700-1,200Rs/kg.

Total sawmill waste generation within GMA was estimated to be 5.2T/d, or 397kg/sawmill, with 84% of it being recycled and 16% disposed of on-site.

#### **1.5.4 Other Industries**

Six out of a total of 12 other industries were surveyed as part of this study. These comprised one steel furniture manufacturer, one scrap metal recycling/steel goods manufacturer, one plastics recycling/plastic goods producer, a bag production factory, ayurvedic medicine manufacturer and coir processing factory. The other six industries not surveyed included one steel goods manufacturer, two quarries and three unspecified industries.

These six industries employ a total of 351 workers. Their total waste generation was estimated to be 703kg/d, equivalent to 2.0kg/worker.d or 117kg/industry.d. Three of these six industries use the GMC collection service for the disposal of some (1) to all (2) of their waste, while three burn most of their garbage on-site. Four industries recycle some waste materials, comprising mainly 2,025kg/mth of cardboard, 1,000kg/mth of coconut fibre, 100-150kg/mth broken glass and 130kg/mth metals.

Overall waste generation from all 12 other industries is estimated to be 1.4T/d, of which 77% is disposed of on-site, 16% recycled and 7% collected by GMC.

Table 1-8: Sawmills Interview Survey Results

Sawmill Name and Location (Respondent)	Waste Quantities (T/month)			Waste disposal	Willing to give/sell to GMC for composting	Comments
	Sawdust	Woodchips	Bark			
Kusum Sawmill, Bandarawatta Gampaha (Mr Pathmasiri, Manager, tel 033-26806)	1.50	2.85	0.24	All sawdust and bark are given away for free while 2.5TL/mth of woodchips are used on-site or given to labourers and 0.5TL/mth is sold at 600Rs.	Willing to give all sawdust/bark for free and to sell 0.5TL/mth woodchips at 600Rs.	Five workers.
Jayasiri Sawmill, Galtotamulla, Yakkala (Ms Srimathee Jayakody, owner's wife, tel 033-23979)	0.75	0.95	Mixed with wood-chips	Sawdust is burnt while woodchips are given away to anyone for free.	Willing to sell all sawdust for 300Rs and 90% of woodchips at a price yet to be decided.	Five workers.
Kumara Sawmill, 4/32, Radawana Rd, Yakkala (Mr S.D.Amarasena, owner, tel 033-24910)	7.50	4.75	Mixed with wood-chips	All sawdust is given away for free, while woodchips are sold at 1,100Rs/TL.	Willing to give all sawdust for free and to sell 4TL/mth of woodchips at 1,100Rs/TL.	6-8 workers. Sawdust can be used to make firewood and for mushroom cultivation.
M.A.C. Sawmill, Kandy Rd, Yakkala, (Mr M.A.C.Munasinghe, owner, tel 033-31655)	11.25	23.75	Mixed with wood-chips	Sawdust is given away for free or burnt while woodchips are either given away for free or sold at 700Rs/TL.	Willing to give all sawdust for free and to sell all woodchips at 700Rs/TL.	6-10 workers.
Ranjanees Sawmill, No 137/1 Kandy Rd, Yakkala (Mr W.Nandasiri, driver, tel 033-20429)	4.13	1.90	Mixed with wood-chips	Sawdust is given away for free or burnt while woodchips are given away to neighbours for free.	Willing to give all sawdust for free and to sell 1TL/mth of woodchips at 800Rs/TL.	Five workers.
Total	25.13	34.40	0.24			

**Notes:** Loads refers to four wheel tractor loads (TL) unless otherwise stated. Loads data was converted to tonnes for tractors based on information supplied by survey respondents, with one load of sawdust being equivalent to 0.75T and one load of woodchips to 0.9-1.0 T.

## 1.6 Other Waste

Other waste accounts for waste collected from public places such as parks, playgrounds, sportsgrounds, roads, drains and canals and from other “informal” sources that are not registered with the relevant authorities and hence not included in official statistics. It may also include some of the waste that is illegally dumped around the city and subsequently collected by GMC.

GMC has no large parks, with the Henarthgoda Botanical Gardens being located just outside GMA limits. There are some sportsgrounds and other public spaces within GMA and a nominal allowance of 0.11T/d (~one handcart load) has been provided for waste generation from these sources, with 50% of this waste being disposed of on-site and 50% collected by GMC.

GMC data gives the total length of roads, drains and canals within GMA cleaned by GMC as 70.5km, 37km and 3km respectively.

*Most road sweeping, drain/canal cleaning and weeding is undertaken by designated sweeper and drain cleaning labourers, with two handcarts collecting normal waste together with road/drain cleanings in the Siri Kurasa/Market sts (Gampaha) and Yakkala town area. Some tractor labourers also undertake road and drain cleaning in the Mirriswatta area. The road sweeping and drain cleaning waste is usually collected by the normal garbage collection vehicle assigned to each zone, although some drain/canal cleanings are simply left at the side of the drain/canal. Information supplied by GMC suggests that the daily road/drain/canal cleaning coverage is relatively low, due to labourer absenteeism problems, resulting in a shortage of road sweepers and drain cleaners, and due to the relatively long length of roads and drains to be cleaned by GMC.*

Road/drain cleaning waste is estimated to be 0.28T/d, assuming 5% of the total road length is cleaned daily and based on typical road sweeping waste generation estimates from other JICA studies, GMA specific conditions and taking into account the average length of roads/drains that can be cleaned by a handcart per day. 50% of road/drain cleanings are assumed to be collected by GMC, with the remaining 50% being disposed of on-site.

## 1.7 Recycling

### 1.7.1 General

Informal reuse and recycling is relatively active in GMA, with there being several shops in the town selling used items and/or recyclables for a wide range of purposes, including used newspapers/exercise books, bottles, containers, tins, shoes, bags, bikes, umbrellas, books, etc. Of these items:

- Waste paper may be used to make paper bags for wrapping purposes (e.g. medicines, food, small goods, etc.).
- Glass and PET bottles may be used as containers for local products (e.g. sauce).



- Empty metal tins may be used to make the metal support that secures broom bristles to the broomstick (ekel broom) or for making toys and other items (e.g buckets).

### 1.7.2 At Source

This section focuses on household recycling at source, as recycling at source from other waste generators has previously been described. Household at source recycling was estimated from the household survey results (150 households), with the relevant results tabulated below. These indicate that 49% of households have recyclables collected from them by individual collectors, 21% take some recyclables to shops for refund/sale, and 3% compost kitchen and garden waste.

Table 1-9: Household Survey Recycling Results Summary

Waste Type	Composting	Individual collects from House	Resident takes to shop
Yes	5	73	32
No	145	77	118
Food/kitchen	5	1	0
Garden/wood	5	0	0
Paper/cardboard	N/a	35	11
Plastic	N/a	1	0
Glass	N/a	64	23
Metal	N/a	8	1

**Note:** The household survey indicated that 122 households are actually visited by individual collectors but only 73 households actually give recyclable materials to these collectors. N/a = not applicable.

The total amount of materials recycled from households at source was estimated using this data together with estimated household waste composition data, 49% average GMA garbage collection service coverage and assuming a 90% recycling rate. This gives a household recycling quantity of 0.78T/d (2.9% of total household waste generation), which is supported by the middleman survey, which found that around 0.72T/d of recyclable materials purchased by them originate directly from households within GMA.

### 1.7.3 During Collection

Both handcart and collection vehicle workers collect recyclable materials in GMA, which they generally sell to middlemen within GMA.

The collection worker survey found that seven out of 30 labourers interviewed are involved in recycling. These seven labourers collect an estimated total of 81kg/mth, or 11.6kg/labourer.mth, comprising mainly bottles (50kg, 76 in number<sup>7</sup>) and various metals (31kg), earning an average of 43-62Rs/mth<sup>8</sup>, as set out in the following table.

During the time and motion study, Yakkala collection workers indicated they collect around 1kg/wk of iron (1.50Rs/kg), 25-50kg of broken glass and bottles (0.75Rs/kg) and 15kg/wk tins (1-1.5Rs/kg), which

<sup>7</sup> Average bottle weight = 0.66kg, obtained by measuring a mixture of 10 arrack and beer bottles, these being the most common bottles recycled.

<sup>8</sup> 43Rs/mth calculated from stated quantities of recycled materials and sales prices, 62Rs/mth = stated survey figure.

they sell weekly to a middleman in Mirriswatta. They stated that four wheel tractor labourers collect more recyclables than them - typically one gunny sack per day.

Using this data, the Yakkala labourers collect 53.5kg/week of recyclable materials, or 76.3kg/labourer.mth (shared between driver and two labourers) with an associated income of 69Rs/labourer.mth. This quantity is much higher than the survey figure while the corresponding income is similar to the stated survey value. This suggests the survey value for the quantity of materials recycled is low. Hence, the Yakkala data is considered more accurate and has been adopted here (refer final column of below table). This gives a total quantity of recyclable materials salvaged by collection workers of 43kg/d, which is still very small.

Table 1-10: Recyclable Materials Recovered by Collection Workers

Item	No of labourers collecting	Quantity (kg/mth)	Price	Estimated Total Quantity (kg/d) (from survey)	Revised Total Quantity (kg/mth)
Bottles	5	50.2	1.5 Rs ea	120	792
Iron	1	15.0	5 Rs/kg	36	237
Metal can	2	15.0	3.3 Rs/kg	36	237
Aluminium	2	1.2	50 Rs/kg	3	19
Total	7	81.4		195	1,284
Average earnings (Rs/lab'r.mth)	62	42.8			69
No of labourers interviewed	30			72	72

Note: GMC labourers + drivers = 72. Estimated total quantity/mth is calculated from survey data x 72 total labourers/30 surveyed labourers. Revised quantity based on survey data x 76.3/11.6.

#### 1.7.4 At Transfer Stations

Waste discharged at the Yakkala transfer station comes directly from handcarts, two wheel tractors or directly from the Pola. Normally, this waste is picked over first by GMC labourers, both during collection and unloading, with most of the discharged waste then being burnt. It is believed there are no other scavengers salvaging recyclables at this location.

According to the SPHI, about four scavengers used to collect recyclable materials from the transfer station near the GMC office, but now there are none, possibly due to a change in unloading and loading procedures.

Hence, overall recycling at GMC transfer stations is assumed to be negligible.

#### 1.7.5 Final Disposal

There are two GMC labourers assigned to the GMC final disposal site. Neither of these are believed to recover recyclable materials from the waste brought for disposal. It is also believed there are no other outsiders collecting recyclable materials from this location, partly due to the remoteness of the disposal site and it being on private land. Hence, recycling at final disposal is considered to be negligible.

## 1.8 Disposal Quantities

Current trips data and disposal quantities for January and July 2002 (GMC data) and the seven day period from Aug 8-14, 2002 (JICA survey) are set out in the following table.

Note that the JICA average density survey result of  $150\text{kg/m}^3$  was considered too low, being much smaller than corresponding waste densities measured in other towns (Chilaw:  $200\text{kg/m}^3$ ; Kandy, Matale, Negombo and Nuwara Eliya:  $260\text{-}390\text{kg/m}^3$ ). This result is believed to be mainly due to drying out of the collected waste between discharge and final disposal, particularly during waste storage and transfer. Hence, the measured extracted density was increased to  $200\text{kg/m}^3$  to represent average conditions (i.e. both wet and dry seasons) and then converted to an in-situ density of  $246\text{kg/m}^3$  (refer supporting report for further details).

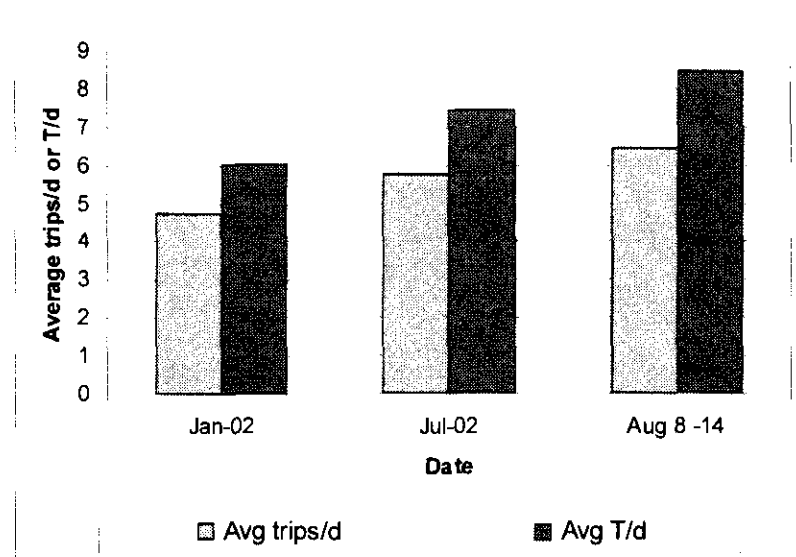


Figure 1-1: Gampaha Disposal Site – Number of Trips and Final Disposal Quantities

Some key points from this data are summarized below:

- The average number of trips was 4.7 in January 2002, 5.7 in July 2002 and 6.4 in August 2002 (JICA survey). The difference between the January and July data may be explained by an additional one load/day of garbage being brought to the GMC disposal site since April 2002 from Yakkala, when GMA was created and the Yakkala area was included within its administrative boundary. The July and August results are similar, with the JICA result being considered more accurate being based on actual disposal site survey data, while the GMC data has been compiled from vehicle running chart records. For these reasons, the August data has been adopted for use in this Study and the following discussion relates to the August data.
- The GMC SPHI estimated the total number of trips to the landfill to be around 8-9, based on six trips from Gampaha, 1-2 from Yakkala and one from Bandiyamulla, which is supported by Zone Supervisor estimates. However, these estimates are about two trips/d higher than the JICA survey data, meaning that GMC are over-estimating the number of trips/day by ~33%.

Table 1-11: GMC SWM Waste Disposal Average Trip and Tonnage Data

Vehicle	Avg Trips/d (range)		Number of Trips – 8-14 Aug, 2002									Avg T/d		Average Tonnage – 8-14 Aug 2002								
	Jan 02	Jul 02	8 Th	9 F	10 Sa	11 Su	12 M	13 Tu	14 W	Tot	Avg	Jan 02	Jul 02	8 Th	9 F	10 Sa	11 Su	12 M	13 Tu	14 W	Tot	Avg
49-8156	1.5 (0-3)	1.5 (0-2)	5	3	0	1	3	3	2	17	2.4	1.9	1.9	6.6	4.4	0.0	0.7	4.4	4.4	2.9	23.5	3.4
49-9561	1.6 (0-3)	1.6 (0-3)	1	1	2	1	1	1	1	8	1.1	2.1	2.1	1.3	1.3	2.6	1.3	1.3	1.3	1.3	10.4	1.5
49-2722	1.6 (0-3)	1.7 (0-3)	2	3	3	0	2	1	3	14	2.0	1.8	1.9	3.0	3.8	3.8	0.0	1.5	0.8	3.0	15.8	2.3
49-9178	N/a	0.7 (0-2)	0	0	0	0	2	2	2	6	0.9	N/a	1.1	0.0	0.0	0.0	0.0	3.1	3.1	3.1	9.3	1.3
25-9190	N/a	0.1 (0-1)	N/a									N/a	0.2	N/a								
Total	4.7 (1-7)	5.7	8	7	5	2	8	7	8	45	6.4	5.8	7.2	10.9	9.5	6.4	2.0	10.3	9.6	10.4	59.1	8.4
Avg/ 4WT	1.6	1.2	2.0	1.8	1.3	0.5	2.0	1.8	2.0	11.3	1.6	1.9	1.5	2.7	2.4	1.6	0.5	2.6	2.4	2.6	14.8	2.1

Note: 4WT = four wheel tractor; 25-9190 only used for four days during July 2002.

- The total number of trips recorded per day varies from two on Sundays to a maximum of eight.
- Individual four wheel tractor trips data for August 8-14 shows:
  - The overall average number of daily trips per tractor is 1.6, with two tractors making only 0.9<sup>9</sup> and 1.1 trips/day, one tractor making 2.0 trips/d and one tractor 2.4 trips/d. Tractors making 2-2.4 trips are those taking at least one fully laden trailer from the GMC transfer station to the landfill site and/or collecting market (overnight stationary trailer) and hospital waste (stationary trailer).
  - One load/day comes from the Yakkala area to the disposal site, except on Sundays, giving an average of 0.86 loads/d from this area.
  - One 50% full load/day is brought from the Gampaha public market to the disposal site.
  - Two 50% full loads were brought to the disposal site from Gampaha Base Hospital during this seven day period.
- The average daily tonnage of waste brought to the disposal site is 8.4T/d (range = 2.0T/d on Sunday to 10.9T/d on Thursday), comprising 0.75T/d from the Gampaha public market, 0.20T/d from Gampaha Base Hospital, 1.19T/d from Yakkala and, by difference, 6.30T/d from the rest of Gampaha/Bandiyamulla.
- GMC converts their estimated number of 4WT trips (average = 8.5 trips/d) to tonnes, based on a conversion factor of 2.5T/load, giving a total estimated tonnage of 21.2T/d. The average conversion factor estimated from JICA survey data is 1.33T/load, which is significantly lower than the GMC factor. GMC's high estimate of the number of trips, together with this high conversion factor mean that their estimate of the amount of waste to disposal is 2.5 times higher than the JICA survey amount. These differences illustrate the importance of establishing a proper trip recording system and using appropriate load to tonnage conversion factors.

## 1.9 Resource Recovery

The GMA recycling/on-site composting system is illustrated below, while recycling quantities have been summarised previously. As there are currently no centralised composting facilities within Gampaha, this section provides a summary of the recycling sector within GMA in relation to home composting, middlemen, NGOs, Super Plastic and Super Steel Industries (recycling factories).

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<sup>9</sup> This tractor was only used on three days over this period, making two trips each day during this time.

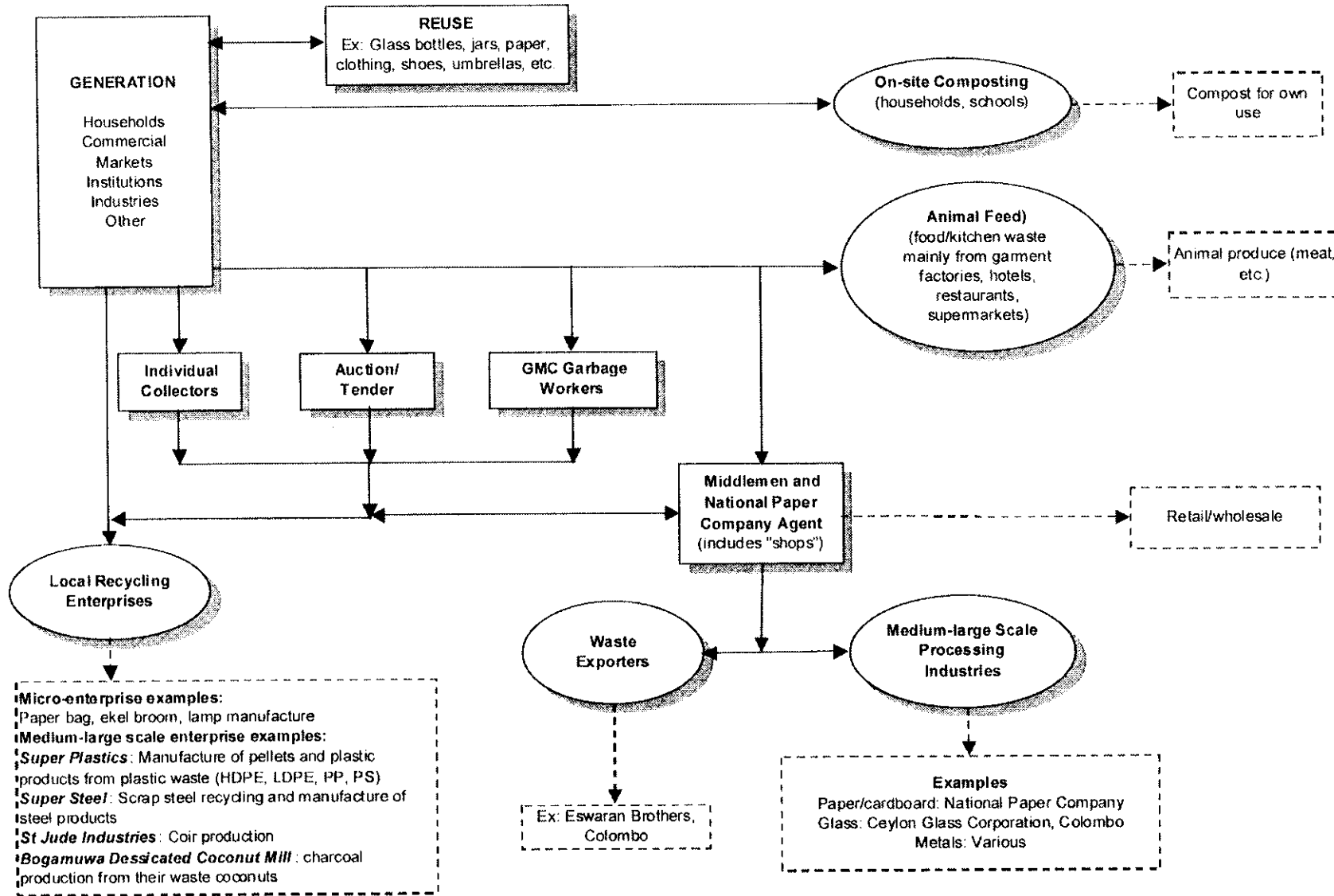
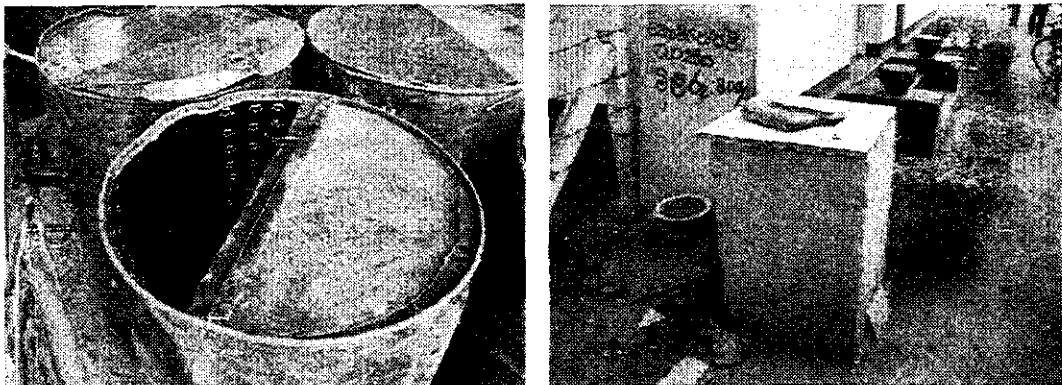


Figure 1-2: GMA Recycling/Composting System

### 1.9.1 Home Composting

Various home composting initiatives have been undertaken within GMA. These include:

- Some compost barrels were distributed in 1999 to residents who requested them by GMC, following the display of a metal compost barrel on the front lawn of the GMC Office.
- Around 120 more barrels were distributed free of charge to residents who requested them in Dec 2001-Jan 2002 by GMC. GMC's Environment Officer and Community Development Officer estimate about 75% of these barrels are still being used. Seven schools were given five compost barrels each around the same time.
- GMC is to distribute another 50 barrels this month to residents on a waiting list.
- Around August 2000, when Yakkala was still administered by the Gampaha Pradeshiya Sabha (PS), a composting awareness programme was undertaken in the Chandanegana area by the PS, after which over 10 households purchased compost barrels at a subsidised price of 400Rs.
- Concrete compost barrels were distributed to Keppitipola MV and Anura MV (Bandiyamulla) and Chandrayothi MV (Yakkala) by the MOH (Bandiyamulla) in June 2002. Anura MV has subsequently returned their compost barrel as it was damaged during delivery.
- GMC is also displaying a concrete rectangular compost bin near its GMC Office, which residents can purchase from them for Rs800.



*Compost Barrels: Left – conventional metal barrel; right – rectangular concrete bin.*

### 1.9.2 Middlemen

Six middlemen operating within GMA were identified and interviewed as part of this study, including an agent of the National Paper Corporation (NPC). One of these middlemen runs four separate recycling shops within GMA, which were treated as one enterprise for the purposes of this study. General information on these businesses is set out below and summarised here.

Table 1-12: Middlemen General Information

Business Name	Address	Years of operation	Total Employees		Recyclables (Rs/mth)	
			Total	FTE	Purchases	Sales
MM1: KG Jothipala	200/1, Aluthgama, Bodeniya, Gampaha	12	3	2.6	2,202,500	2,535,000
MM2: WA Somarathan	220/1, Colombo Rd, Gampaha	3	4	3.1	20,010	24,490
MM3: Mahendran	122, Miriswatta, Gampaha	25	1	1.3	16,020	18,640
MM4: Raja Stores	Colombo Rd, Gampaha	50	4	4.6	539,200	724,295
MM5: National Paper Company Agent	290, Colombo Rd, Gampaha	1	7	4.0	95,875	Not applicable
MM7: Francis, Ananda Stores	21/3, Sangamiththa Rd, Gampaha	20	2	2.1	12,635	19,466
<b>Total</b>			<b>21</b>	<b>17.7</b>	<b>2,886,240</b>	<b>3,321,891</b>

**Notes:**

The number of full-time equivalent (FTE) staff is based on a normal working month in the private sector of 8h/d x 26d/mth = 208h/mth.

Recyclable materials purchases and sales costs were calculated based on the average quantity of each item collected and sold per month and the average purchase and sales prices.

Sales is not relevant for the NPC Agent, as they simply transport the collected paper/cardboard to NPC factories for processing.

MM1 actually operates four separate middlemen operations within GMA, which have been treated as one operation here.

Five middlemen are primarily involved in the collection and selling of recyclable materials, with four having been in business for 10 or more years and one for three years. The NPC agent acts as an NPC collection point for waste paper, which is subsequently transported to NPC's one remaining factory for processing. This agency has been in operation for one year.

At least 21 people (managers/owners, full and part-time workers) are employed by these businesses, representing 17.7 full-time equivalent jobs.

Their estimated monthly expenditure on purchasing recyclable materials is 2.79 million Rs/mth<sup>10</sup>, which shows that the scale of these operations is significant. Corresponding estimated monthly income from the sale of recyclable materials is over 3.32 million Rs/mth, representing a markup of 19%. Respondents were generally reluctant to give total expenditure and income information, with one business not supplying income details, while other data obtained is not considered very reliable, particularly in four cases where stated income and/or expenditure were less than the corresponding recyclable purchases and sales figures. The overall net income quoted by businesses ranged from 5,000-500,000Rs/mth. 5,000Rs/mth is considered a minimum value, for the reasons explained here, while 500,000Rs/mth is approximately 1.5 times larger than the net income suggested by the sales and purchases figures for this middleman.

<sup>10</sup> Excluding NPC Agency waste paper purchase costs (95,875Rs/mth), as there is no corresponding direct income (i.e. the Agency simply transports the waste paper to NPC factories for processing).



Most of the recyclable materials are brought to them by individuals (5), other middlemen (3) or bought by tender (Jothipala). Their demand for all recyclable materials is generally stable, especially for metals. The supply is greater than the demand for plastics/glass and less than the demand for most types of paper and all metals. Polythene is not collected by any of them.

The main sources of most materials is tabulated below and summarised here.

- Households are the main source of plastics, broken glass and glass bottles and significant sources of bags/sacks, paper/cardboard, metals and batteries.
- Hotels<sup>11</sup> are important sources of broken glass and glass bottles.
- Commercial enterprises are the main source of bags/sacks.
- Government offices are the main source of paper/cardboard.
- Industries are the main source of metals and batteries and significant sources of plastics and paper/cardboard.
- According to the survey, no middlemen in Gampaha collect any recyclables from the hospitals within GMA.

Table 1-13: Main Sources of Recyclable Materials

Item	Plastic	Bags/sacks	Paper/cardboard	Broken glass	Glass Bottles	Metals	Batteries	Overall (within GMA)
No collecting these items	2	1	5	4	4	5	5	
No of responses	2	1	5	4	4	5	4	
<b>Main Sources (%)</b>								
Households	80.0	10	9.8	74.2	77.4	14.7	4.1	25.8
Hotels	0.0	0	0.0	16.3	17.6	0.1	0.0	1.0
Commercial enterprises	0.0	90	0.0	8.3	0.6	0.0	0.0	0.3
Govt. offices	0.0	0	56.8	0.8	2.9	2.1	0.0	8.4
Industries	13.3	0	28.4	0.4	1.5	81.7	94.6	61.8
Other	6.7	0	5.0	0.0	0.0	1.4	1.2	2.7
Total	100	100	100	100	100	100	100	100

**Notes:**

Above values are average percentages calculated from the survey data, taking into account the relative quantities of materials purchased by different middlemen.

"Other" is unspecified for plastics; mainly schools, commercial enterprises, markets and by auction for paper/cardboard; workshops for metals and garages for batteries.

The final column estimates the proportion of recyclable materials collected from different sources within GMA only, assuming 65%, 60%, 62%, 40% and 80% of materials from hotels, commercial enterprises, government offices, industries and garages are obtained from inside GMA respectively (based on rough calculations from survey data), with the proportion of materials being obtained from households being calculated by difference so as to get an overall rate of 48% for materials collected within GMA.

Around 48% of these materials are collected from within GMA, 23% within the Gampaha district, 6.5% within the Western Province and 22% from other parts of Sri Lanka<sup>12</sup>.

The total quantities of materials recycled by these middlemen are summarised in the following table, amounting to 5.73T/d, while the table after that provides further details, including purchase and sale

<sup>11</sup> It is assumed hotels includes local hotels (canteens/small restaurants) as there are relatively few hotels offering accommodation in and around GMA.

prices. Adjusting this total to allow for an estimated 48% of these materials being collected from within the GMA gives a recycling amount of 2.77T/d, of which 0.72T/d is estimated to come from households, which is consistent with household survey results.

Table 1-14: Total Quantities of Different Materials Recycled

Materials	Monthly Quantity	Daily Quantity (kg/d)	Comments
Plastics	30 containers and 1,500 bags/sacks = 150kg/mth	4.9	Containers are generally sold for reuse and consequently have not been included in the daily recycling amount. Bags are either sold for reuse or transported to factories for re-processing. Hence, they have been included in the recycling amount ; measured weight of 1 polysack = 0.1kg => 150kg.
Paper/ cardboard	14,285kg/mth	469.6	1,105kg newspaper, 1,680kg exercise books, 3,000kg white paper, 500kg cement bags, 8,000kg cardboard/boxes
Glass	2,400kg broken glass + 4,488kg bottles = 6,888 kg/mth	226.5	Whole bottles are usually beer or arrack bottles; average measured weight = 0.66kg; 6,800 bottles = 4,488 kg.
Metals	145,809kg/mth	4793.7	128,500kg iron, 13,102kg copper/brass, 3,640kg aluminium and 567kg beer cans.
Old battery cases	7,290kg/mth	239.7	Battery cases are drained and then weighed, being recycled primarily for their lead content.
Total	174,422kg/mth	5,734.4	
Total collected within GMA	84,200kg/mth	2,768	Adjusted total to account for 48% of these materials being collected from within GMA.

**Note:** Refer next table for further details. Daily quantities calculated from monthly data by multiplying by 12/365. Monthly data was determined from survey interviews - no independent check was made on the accuracy of these quantities.

Most enterprises act mainly as retail/wholesale outlets, onselling the recycled materials directly from their shops to individuals or commercial enterprises, although Ananda Stores (MM7) transports paper and glass directly to factories, while Jothipala (MM1) and Ananda Stores (MM7) transport metals directly to factories. The NPC Agent also transports paper to NPC factory in Valaichenai.

<sup>12</sup> Percentages are weighted averages, taking into account the relative quantities of materials collected by different middlemen.

Table 1-15: Quantities of Recyclable Materials collected by Middlemen and Corresponding Purchase and Sales Prices

Material	Units	MM 1	MM 2	MM 3	MM 4	MM 5	MM 7	Total			
								Quantity	Purchase price	Sales price	Units
<b>Plastics</b>											
Containers	No/mth		10		20			30	20 - 25	35	Rs ea
Various bags	No/mth				1,500			1,500	3	5.3	Rs ea
<b>Paper</b>											
Old newspaper	Kg/mth		30	25	500	500	50	1,105	2.2 - 13	15 - 20	Rs/kg
Old exercise books	Kg/mth		50		100	1,500	30	1,680	2 - 3	4 - 6	Rs/kg
White paper	Kg/mth					3,000		3,000	19	N/a	Rs/kg
Cement bags	Kg/mth					500		500	4	N/a	Rs/kg
Cardboard	Kg/mth					8,000		8,000	4	N/a	Rs/kg
<b>Bottles</b>											
Broken glass	Kg/mth		100	1,000	1,000		300	2,400	1 - 1.5	1.5 - 3.5	Rs/kg
Arrack, beer other bottles	No/mth		1,000	200	5,000		600	6,800	4 - 5	5 - 8	Rs ea
<b>Metals</b>											
Aluminium	Kg/mth	2,000	40	30	1,500		70	3,640	50 - 70	60 - 80	Rs/kg
Beer cans	Kg/mth	500	10		50		7	567	10 - 25	13 - 40	Rs/kg
Copper/brass	Kg/mth	10,000	50	12	3,000		40	13,102	70 - 120	85 - 130	Rs/kg
Iron	Kg/mth	100,000	1,000	1,500	25,000		1,000	128,500	5 - 8	6 - 10	Rs/kg
Old battery cases	Kg/mth	5,000	200	15	2,000		75	7,290	7 - 10	8 - 12	Rs/kg

The main costs incurred by these businesses in their recycling activities and the associated main problems are summarised in the next two tables respectively.

Table 1-16: Main Costs

Main Costs	Rank				Weighted average
	1	2	3	4	
Buying recyclable materials	6	0	0	0	15.0
Labour	0	2	1	0	5.5
Land/building rental	0	1	1	2	5.5
Storage prior to transportation	0	1	1	0	4.0
Utilities	0	0	2	1	4.0
Transportation	0	1	0	0	2.0

Table 1-17: Main Problems

Main Problems	Rank				Weighted average
	1	2	3	4	
Shortage of Recyclable Materials	3	0	1	0	9.0
Utilities problems	2	0	1	0	6.5
High land/building rental costs	0	1	1	0	3.5
Difficulties in obtaining credit	0	1	0	1	3.0
Loss of market	0	1	0	0	2.0

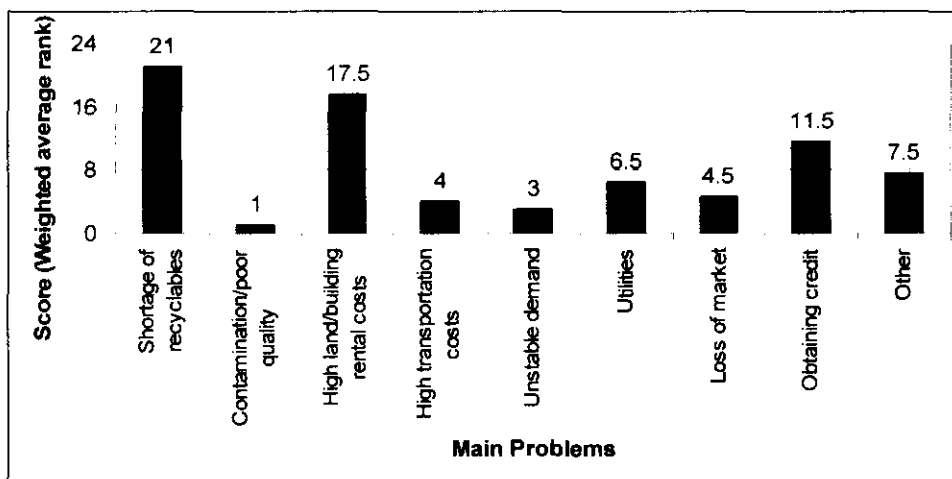


Figure 1-3: Main Problems Faced by Middlemen in Gampaha

### 1.9.3 NGOs

There are no NGOs known to be directly involved in SWM related activities in GMA.

### 1.9.4 Super Plastic Industries

Super Plastic Industries are located at No 1/166 Kandy Rd, Yakkala and has been in operation for five years. Full-time staff include the owner, manager, seven full-time and eight part-time workers, representing 13.4 full-time equivalent staff. They recycle around 20T/mth of plastics/polythene, comprising around 60% mixed, unwashed and 40% clean plastics/polythene, purchasing these materials

at an average price of 22Rs/kg. These plastics comprise low density polyethylene (LDPE), high density polyethylene (HDPE), polypropylene (PP), polystyrene (PS) and some nylon.

These plastics are collected for them by individuals (10%), their own workers from garment factories (5%), local authority garbage collection workers (10%, mainly polythene) and middlemen (75%). The main sources of waste plastics are industries (75% - mainly garment factories; e.g. yarn cones), government institutes (15%; mainly Katunayake airport; e.g. airline cutlery), hospitals (5%; e.g. saline bottles) and commercial enterprises (5%). About 5% of the waste plastics are collected from within GMA, 10% within the Gampaha district, 80% within the Western Province and 5% from other parts of Sri Lanka (Kandy, Kurunegala and Mahawa).

Their recycling factory includes granulating, pelletising, extruding and injection moulding equipment. Incoming plastics are first sorted and washed, as necessary. The plastics are then crushed/melted and extruded into pellets with some of these materials being used to manufacture a range of products via injection moulding (e.g. gully trap covers, broom parts, nose masks, antennae parts, etc.). Imported HIPS (high-impact polystyrene) and pigments are mixed with recycled plastics as appropriate for making different products.

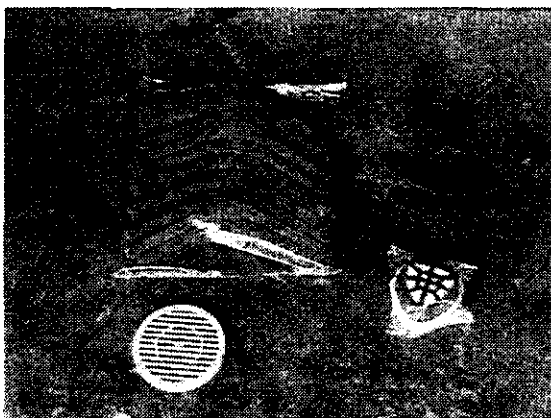
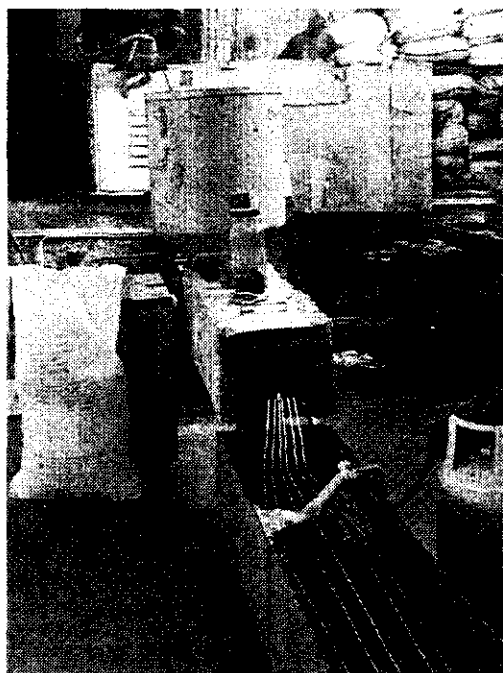
They produce around 10-15T/mth of pellets which they sell at 40-45Rs/kg and ~500kg of other products, sold at various prices ranging from 4Rs for broom parts, 65Rs for gully trap covers, to 2,000-3,000Rs for antennae parts.

Pellets are sold to individuals and small manufacturers for producing various items (e.g. broom parts, buttons), mainly in Pugoda (30km away) and Thihariya (7km away) and also to injection moulding companies in Thihariya, Kandy, Kurunegala, Minuwangoda and Mawanella. Plastic products are sold to Oshaka, Kumarasinghe Radio and other customers, located mainly in Colombo, 30km away.

Their monthly expenditure is estimated to be 773,000Rs/mth, with the main costs being the purchase of recyclable materials (440,000Rs) and other raw materials (HIPS, pigments = 160,000Rs/mth), followed by labour (78,000Rs), electricity/gas (55,000Rs), machinery maintenance (17,500Rs), transport (10,000Rs), land/building rental (10,000Rs) and telephone costs (2,500Rs). They indicated that their net income is about 15% of their monthly expenditure (i.e. 115,950Rs/mth). These figures are roughly consistent with the sales and purchases data provided.

They produce about 500kg/mth of waste materials, which are collected by GMC.

Their main operational problems in order of decreasing severity are difficulties in obtaining credit, followed by utilities problems, high land/building rentals and a shortage of recyclable materials. They also suffer from a shortage of space on-site, resulting in sorting and washing operations being undertaken at another site, about 400m away. In addition, they do not currently have an environmental protection licence for their plastic recycling operations.



*Super Plastics: Top – Waste plastic raw materials: left – mainly soft plastics; right – cotton yarn reels from garment factories; Middle – Soft plastics granulator; Bottom left – Extruder producing a thin ribbon of plastic which is cooled and then cut into pellets; bottom right – some of their plastic products: clockwise from top: TV antennae parts, ekel broom parts, nose mask, gully trap cover.*

### **1.9.5 Super Steel Industries**

Super Steel Industries is located at 125 Kandy Rd, Yakkala and has been in operation for 15 years. It employs one manager/owner and 15 full-time workers, representing 13.1 full-time equivalent staff.

They recycle around 12T/mth of ferrous scrap metal, which they purchase at an average price of 12.2Rs/kg from individuals and middlemen. The ferrous scrap mainly comes from commercial enterprises (95%) and households (5%) located within GMA (40%), Western Province (40%) and other parts of Sri Lanka (20%).

Most of the ferrous scrap is processed into various products on-site, comprising a wide range of vehicle parts (e.g. hubs, vehicle shells, battery covers, handbrakes, etc.) which are sold to commercial enterprises in Homagama, Minuwangoda, Galle and Panchikiwatta. About 1,800kg of leftover scrap is sold for further recycling.

Their stated income and expenditure are 400,000-500,000Rs/mth and 350,000-400,000Rs/mth respectively, giving a net income of 50,000-100,000Rs/mth. Purchases and sales data of 146,400Rs/mth and 802,450Rs/mth suggests the net income could be much higher than this. Their main cost is purchasing of the scrap metal, followed by labour, utilities, land/building rental and transportation.

They produce around 50kg/mth of waste, which is collected by GMC.

Their main problems in order of decreasing severity are difficulties in obtaining credit; followed by utilities problems and excessive transportation costs.

They also stated that a general problem affecting scrap metal recycling in Sri Lanka is increasing exports of copper/brass from the country, which has created a raw material shortage problem for many such small industries.