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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
Ministry of Home Affairs, Parliamentary 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 BADULLA
FINAL REPORT
Volume V-1B
SUPPORTING REPORT

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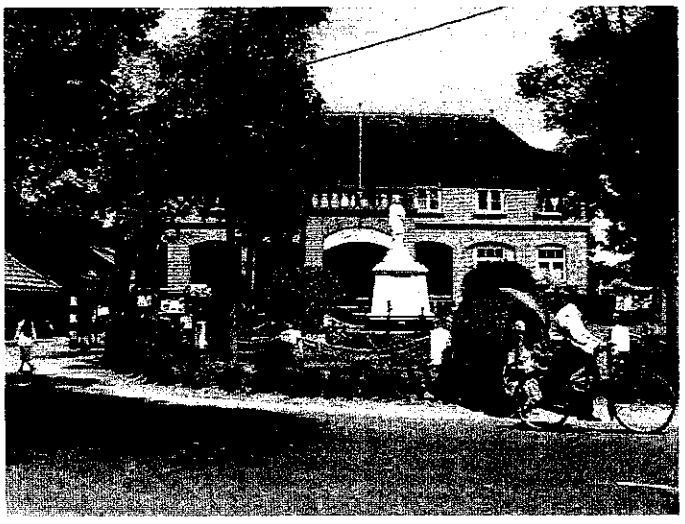

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This is Action Plan for Badulla,

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

Contents

List of Abbreviations

BMA	Badulla Municipal Area
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
MCB	Badulla 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

Badulla 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 September-October 2002, undertaken primarily to quantify the waste stream for the Badulla Municipal Area (BMA). It complements and provides further information to the waste stream data, assists in understanding the present BMA 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 results of the July 2001 Census give the total population of the Badulla Municipal Area (BMA) as 40,920. The 2002 population is estimated to be 41,358, based on a population growth rate of 1.07%, this being the 1981-2001 average annual compound population growth rate derived from census data.

BMC estimate the floating population in Badulla to be 10,000, this being influenced by the city being both the Badulla district and Uva province capitals and the main administrative, educational, financial and trading centre at both district and provincial levels, as well as having a major hospital.

Information on household waste generation and management practices was obtained from a survey of 120 households in six different areas of Badulla covering two high, two middle and two low income areas. 81% of the surveyed households are located in areas where garbage is collected by BMC, but only 52% stated they actually use this service. From discussions with BMC SWM staff, it is estimated that the overall BMC garbage collection service coverage is 75-85% on a population basis, as there are some other areas of BMC that were not surveyed that do not receive a garbage collection service at all.

Hence, these survey results were adjusted slightly to account for the other parts of BMC not provided with a garbage collection service in order to estimate the proportions of garbage disposed of by different means for the entire BMA. The corresponding results are summarized below.

The waste generation rate for Badulla was estimated to be 0.477kg/cap.d, this being 6% higher than the value measured for Matale, as both municipalities have similar population and characteristics, while the collection vehicle waste composition is also very similar in both places, except for Badulla having a higher proportion of food/kitchen waste which should make Badulla's waste slightly heavier than that of Matale on a per capita basis.

Table 1-1: Household Waste Management

Waste Management Method	Households in Survey Area (%)	All Households in BMA (adjusted %)	Waste Amount (T/d)
Service coverage (%)	81	80	
Self-disposal	32.8	33.1	6.53
Discharge for BMC collection	43.8	43.4	8.56
Home composting	6.9	7.0	1.38
Recycling	2.2	2.3	0.45
Illegal dumping	14.2	14.3	2.82
Total	100.0	100.0	19.73

Notes:
Detailed calculations are set out in "Matale Waste Stream Analysis".
Estimated 2002 population based on a compound growth rate of 1.07%, giving a 2002 population of 41,358.
Total household waste generation = 41,358 persons x 0.477kg/person.d = 19.73T/d.
Waste amounts disposed of by different means calculated using total waste generation x adjusted percentages in above table, which relate to the entire BMC.

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

1.3 Commercial Sector

1.3.1 Commercial Enterprises

Badulla functions as the district and provincial centre for the distribution of food, fertilizer and fuel as well as being the major financial centre and housing a significant number of private sector wholesale establishments. According to UDA data[1], 14.2ha (1.4%) of BMC is used for commercial activities, 98% of which is concentrated in the town centre in three blocks.

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 as separate categories. This includes government or semi-government enterprises that operate commercially oriented businesses and services (e.g. banks, Post Office, Sri Lanka Telecom, etc.).

BMC data gives a total of 1,235 business enterprises[2] within BMA, of which approximately 7.5% are large waste generators (e.g. restaurants, guesthouses, bakeries) and the remaining 92.5% small waste generators.

Limited specific investigations were undertaken for commercial enterprises as part of this study, involving interview surveys of 15 small and 18 large commercial enterprises, covering nine retail shops, two banks, one supermarket, one repair shop, one communications centre, one pharmacy, one printers, one government bus company, two garage/vehicle repairs, 10 hotels and four restaurants/local hotels. Estimated garbage generation and composition, based on the four most common waste types, are summarized below.

[1] Draft Development Plan for Badulla MC Area (January 1994), prepared by the Badulla Municipal Council with technical assistance of UDA.
[2] 1,461 enterprises (= trade licences) less 28 industries, 17 educational institutes, two private hospitals and 179 market stalls at the Central and Welekade markets.

Table 1-2: Commercial Enterprises Waste Generation and Composition

Source	Estimated waste generation (kg/d)	Most common waste types
Small enterprises (15	0.25 – 15	Pa > F/K > Ca > Pl > In
Large enterprises, including one bus company and two garages/vehicle repairs (4)	20 – 60	Me > Pa > F/K > Ca > Pl
Hotels (10)	2 – 125	F/K > Ga > Pa > Pl > Ca
Local hotels/restaurants (4)	10 – 175	F/K > Pa > Pl > Ca > Me

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, In = inerts, Me = metals, Pa = paper, Pl = plastics.

Commercial waste generation is estimated to be 7.22T/d, based on survey data together with discussions with BMC Supervisors, giving a waste generation rate of 5.84kg/enterprise.d. Waste generation increases approximately 2-3 times on average during festivals and other special occasions (e.g. weddings and school holidays for hotels).

Eight commercial enterprises (bank, pharmacy, Ceylon Transport Board (CTB), five hotels) produce some hazardous waste, comprising small quantities of tubelights (4 enterprises), batteries (2), spraycans (4), all of which are disposed of with their normal garbage.

For the 15 small enterprises, all are covered by the BMC garbage collection service and all use this service for some (4) to all (11) of their garbage, either placing their garbage outside for collection (8), directly carrying it to a collection vehicle (5) or taking it to a waste collection point (3) (one multiple answer). Five small enterprises recycle some of their garbage amounting to a total of 17kg/mth paper, 30kg/mth cardboard, 80 polysacks/mth and an unspecified quantity of dust from a jewelry shop.

For the 18 large enterprises, 16 are covered by the BMC garbage collection service and all 16 use this service for the disposal of most (10) to all (6) of their garbage. Two enterprises burn all (Badulla Tourist Inn) or most (New Rajan Printers) of their garbage on-site, while another five places use this as a secondary disposal method. CTB directly hauls most of its garbage to the BMC disposal site. 11 enterprises recycle some of their waste, comprising a total of 131kg paper, 615 bottles, around 150 plastic containers and 25-30 bags, 450kg metals and 50kg food/kitchen waste for animal feed monthly, while CTB also recycles around 150 tyres/mth[3].

Based on this information, it is estimated that 78.9% of commercial waste is collected by BMC, 10.2% is disposed of on-site primarily by burning (e.g. paper waste), 5.8% is recycled and 5.1% directly hauled to the disposal site.

1.3.2 Markets

Badulla has three main public markets (Central (two markets) and Welekade markets) and a large Pola held on Wednesdays and Sundays. Market and pola details are given below.

[3] Omitted from waste stream calculations as this is considered a special case, which would distort the waste stream percentages if included.

Table 1-3: Public Markets Details

Market	Number of stalls		SW collection/ disposal
	Description	Total	
Central	Central New Shopping Complex: 13 meat/fish/chicken; 7 vegetable/fruit; 3 retail; 28 other New Shopping Complex: 5 vegetable/fruit; 12 retail; 69 other	137	Collection and disposal by BMC
Welekade	4 meat/fish; 15 vegetables/fruit; 10 retail; 13 other	42	
Wednesday Pola	Mainly fruit/vegetable	75	
Sunday Pola	Mainly fruit/vegetable	600	
Total		854	
Total (equivalent number of daily stalls)		**295**	

Note: Stall numbers are based on currently functioning market stalls, as determined during JICA field surveys. Another six stalls at the Welekade market and seven at the Central market are closed.

BMC also runs a public slaughterhouse within BMA, which is estimated to be equivalent in size to 20 market stalls.

Overall market and slaughterhouse waste generation is estimated to be 4.0T/d (13.7kg/stall.d), from an equivalent number of 295 daily stalls. 94.7% of this waste is collected by BMC, 3.5% is recycled, 0.2% is composted and 1.5% illegally dumped. Further market, pola and slaughterhouse details are given in the following sub-sections.

1.3.2.1 Central Market

The Central market comprises two separate markets – the Central New Shopping Complex and the New Shopping complex. The latter is more a retail market than meat/fish/fruit/vegetable market but discharges its waste to the same place as the Central New Shopping Complex. Hence, both markets are considered together. These markets produce about 1.0 tractor loads of waste per day (2.09T/d), with waste generation increasing by up to six times during the Sinhala/Tamil New Year. Meat/fish and fruit/vegetable waste are the most common waste types.

Garbage is discharged in front of traders' stalls and collected from there by three MC labourers, who take it to one of two BMC collection points. Some other commercial traders from surrounding areas are also understood to discharge their garbage at these collection points. Market waste should be collected from these points twice daily, but is often collected less frequently due to vehicle shortages/breakdowns. About 40kg/mth of paper/cardboard is sold to individual collectors by market traders.

The market supervisor supports promoting recycling but believes separate collection bins and more vehicles would be needed if a source separation market collection system was to be introduced.

1.3.2.2 Welekade Market

The Welekade market is currently housed in a temporary location in Clinic Rd, while a new Welekade market complex is being constructed in the central city area, with funding from the Urban Development and Low Income Housing Project (UDLIHP). The new market is due to be completed in September 2003 at a cost of 49M Rs.

The Welekade market produces somewhere between 0.33-1.0 tractor loads of waste per day, with the lower estimate being used here (0.69T/d), as it is considered more realistic. Waste generation increases by 2-3 times during the Sinhala/Tamil New Year.

Market waste is discharged in front of traders' stalls and collected from there by one MC labourer[4], using a handcart. It is subsequently unloaded at a community collection point in the commercial area from where it is collected by tractor/compactor approximately once or twice daily. The market committee treasurer complained that MC labourers don't clean the market properly.

1.3.2.3 Pola

Both the Sunday and Wednesday Pola are held at the same place. The Sunday Pola is by far the largest of the two Pola, comprising about 600 stalls and generating around three tractor loads of waste (6.3T). Trading is understood to begin on Saturday afternoon. The Wednesday Pola is much smaller, comprising around 75 stalls and generating around 0.5 tractor loads per day of garbage (1.05T).

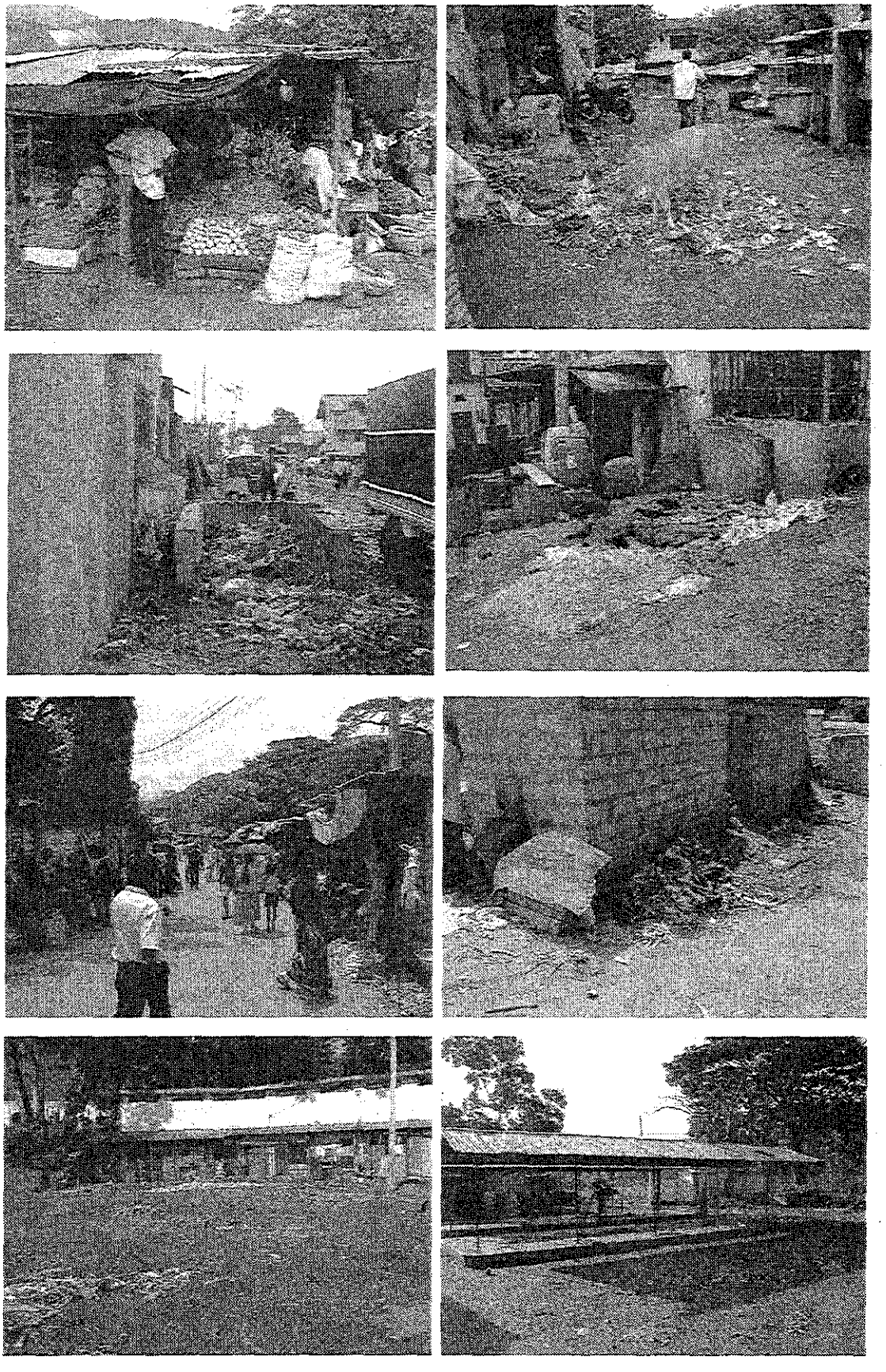
The Pola premises are cleaned by two-five BMC labourers on Monday and Thursday using baskets and brooms but no handcarts, making the cleaning process long and tedious. All pola waste is collected by BMC.

1.3.2.4 Slaughterhouse

BMC operates a public slaughterhouse immediately behind the general cemetery next to the Badulla Oya. Mutton and beef stalls are tendered to private butchers by BMC. The slaughterhouse is open six days per week with two MC labourers employed for cleaning of the slaughterhouse and surrounds (e.g. grass cutting).

It produces about 70kg of cow/goat dung, 55kg animal skins, 65kg animal bones/hooves, 20kg/d of animal fat and 1kg of garden waste per day. About 10kg of animal dung are used as garden manure while the skins, bones/hooves and animal fat are sold to Colombo and the garden waste burnt. The remaining 60kg/d of animal dung is disposed directly to the Badulla Oya, together with some animal blood.

[4] Understood to be one of the Central market labourers.



Top and upper middle - Central Market, the upper middle photos showing two of the market collection points; Lower middle – Welekade temporary market – stalls (left) and garbage collection point (right); Bottom – Pola on Monday morning.

1.3.2.5 Other

According to BMC, there is another area of about 100 stalls near the Post Office, selling mainly fruit/vegetables and some retail items. These produce around two tractor loads of waste per day, which is collected by BMC. As this area was not investigated, it is assumed to be covered under commercial waste. However, if BMC is to consider composting market waste in the future, this area should be investigated further to determine the amount of organic waste generated by it.

1.4 Institutions

In this category, investigations focused on hospital waste, 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, government offices (including police and prison) and religious places in order to estimate the amount and composition of waste generated by these sectors.

1.4.1 General

According to UDA data, 43.4ha (4.3%) of BMC is used by public and semi-public institutions, while an additional 9.6ha (0.90%) is designated for religious activities. Interview survey results for institutional waste generation and composition data are set out below.

Table 1-4: Institutional Waste Generation and Composition

Source	Waste gen (kg/d)	Most common waste types
Schools (5)	3 – 40	F/K > Ga > Pa > Ca=Pl
Other educational institutes (4)	10 – 120	F/K > Ga > Pa > In
Hospitals (3)	13 – 1,422	Pa > F/K > Pl > Ga = Gl
Government offices (6)	5 – 150	F/K > Ga > Pa > Ca > Gl
Religious (1)	220	Ga > In > F/K > Pa > Ca

Note: Waste types: Ca = cardboard, F/K = food/kitchen, Ga = garden, Gl = glass, In = inerts, Pa = paper, Pl = plastics.

Institutional waste generation increases approximately two times on average during festival times and other special occasions.

Four schools, three other educational institutes and four government offices produce small quantities of hazardous wastes (batteries, tubelights, spray cans) which they dispose with their normal garbage. The Muthiyangana Raja Maha Viharaya produces more significant but still small quantities of hazardous wastes comprising 30 tubelights, six batteries, 25 blades and 300 mosquito mats per month.

1.4.2 Schools

Badulla has a total of 15 schools, including four Type 1AB[5] schools, seven Type 1C schools, two Type 2 schools and one primary school (details not specified for one school). The total estimated number of students and school staff are 15,302 and 821 respectively, giving a combined total of 16,123 students

[5] 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.

and staff. These schools serve a larger catchment area than Badulla itself, with the student and teacher population amounting to 39% of the total 2002 BMC population (41,358).

Interview surveys were conducted with five schools, making up 64% of the total BMC schools' staff and student population. All five schools discharge most (3) to all (2) of their garbage for collection by BMC, while another three burn/bury some of their garbage on-site. None of the surveyed schools currently recycle or compost any of their waste.

Based on this data, total school waste generation is estimated to be 0.20T/d (0.013kg/(students+staff).d), with 78.5% of this waste collected by BMC and 21.5% burned/buried on-site.

1.4.3 Other Educational Institutes

Badulla has a number of other educational institutes, comprising the Nurses Training School, Technical College, London Technical College, an International school and four major tuition centres, as well as around 22 MC and 15 private pre-schools. Together, these institutes are estimated to comprise 6,919 students and staff.

Four of these institutes (Nurses Training School, Technical College, Sri Siddartha and Vidyothansa tuition centres) were surveyed. Four of these burn/bury all (2) or some (2) of their garbage on-site, while one discharges most of their garbage for collection by BMC, and one (Sri Siddaratha) illegally dumps some of its garbage on the banks of a stream/river. The Nurses Training School recycles about 3kg/mth of paper.

Total other educational institutes waste generation was estimated to be 0.45T/d, equivalent to 0.065kg/(staff+students).d, with 47.5% of this waste being disposed of on-site, 49.4% collected by BMC, 0.1% recycled and 3.1% illegally dumped.

1.4.4 Hospitals

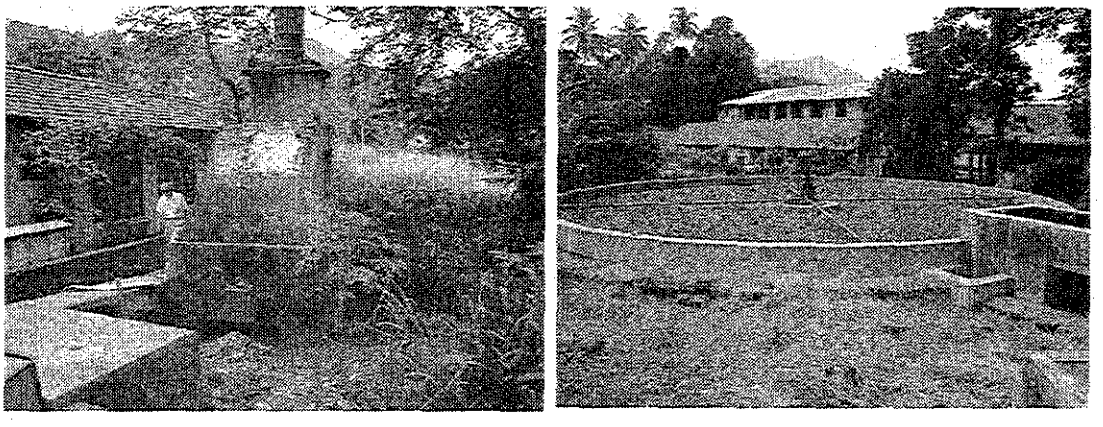
There are three main hospitals within BMA – Badulla General Hospital, Central Hospital and the Lanka Nursing Home, as well as a number of medical centres/dispensaries. The main survey findings for these three hospitals only, including hospital statistical data are set out in the following two tables and summarized below:

- The combined hospital facilities in Badulla are :
  - A total of 1,053 beds.
  - Average bed occupancy equivalent to 1,186 beds per day (113%).
  - Average total clinical and outpatients of 1,733 patients per day.
  - Total staff of 1,135.

  Corresponding hospital waste generation is estimated to be 1.47T/d, equivalent to 0.363kg/(staff+patients).d.

- Paper is the most common waste type, followed by food/kitchen, plastic, garden/glass waste. Healthcare hazardous waste is produced by all three hospitals.
- The General hospital uses a two colour polythene bag system for the discharge and storage of hospital waste – black for normal garbage and yellow for hazardous waste.
- All normal hospital waste is collected by BMC, except for small quantities of cardboard, plastic/glass bottles/containers and coconuts recycled by the General and Central hospitals as described further below.
- Currently, the General Hospital disposes of its clinical waste on-site, while sharps and highly infectious wastes are burnt on-site in its own incinerator. Body parts and placentas are taken directly to the cemetery every 10 days. Some highly infectious liquid wastes (e.g. laboratory wastes) are disinfected and then discharged to the hospital drainage system which conveys them to the hospital wastewater treatment plant.
- The incinerator is about four years old and was constructed with funding from the Provincial Council. It is a basic incinerator, comprising one chamber, fueled by firewood/coconuts and with a 7.6m chimney. It is in relatively poor condition, given its age. Ash from the incinerator is placed in a pit on-site.
- The Central Hospital discharges very small quantities of clinical wastes for collection by BMC, while some body parts are sent to Colombo for experiments; others are discharged to the drainage system and others are burnt on-site, together with placenta and sharps waste.
- The Lanka Nursing Home disposes of small quantities of clinical, placenta and sharps waste by on-site burning/burial.
- The General Hospital reuses waste containers. For example, saline and penicillin bottles are reused as containers for blood and urine specimen collection, while the hospital has recently started to stockpile surplus saline bottles and is planning to send these to Colombo for recycling. It also uses cardboard boxes as sharps storage containers.
- The General hospital recycled around 5,630 plastic items, 1,500 glass bottles and 230 metal items in its most recent auction, which are held at approximately six month intervals. It also uses coconut shells as fuel for its incinerator. The Central hospital recycles around 5kg/mth of cardboard and 15kg/mth of plastics.
- Overall, it is estimated that 95.5% of hospital waste is collected by BMC, 1.7% disposed of on-site, 0.7% recycled and 2.0% directly hauled to the cemetery.
- The Central Hospital pays garbage collection workers an unofficial collection fee of 500Rs/yr.
- Both the General hospital and Lanka Nursing Home are not satisfied with the present waste collection system, the main reasons being garbage collection/sweeping is not properly done (2), is irregular (2) and of too low a frequency (2). The Lanka Nursing Home also identified problems with handling hospital hazardous waste.

- Desired SWM improvements ranked in descending order are (numbers shown are weighted average ranks (WAR) for desired improvements):
  - Education to change peoples' habits 4.5
  - Greater recycling/composting of garbage 3.0
  - More reliable garbage collection service 2.5
  - Fine system for irresponsible behaviour 2.5
- The General Hospital would also like a covered trailer to reduce waste scattering during transportation of hospital waste to the BMC disposal site; financial and technical assistance to start a composting project at the hospital[6], and a better incinerator. The Lanka Nursing Home would also like a proper healthcare hazardous waste disposal system.
- The General Hospital and Lanka Nursing Home are willing to pay 1,200Rs/mth and 200Rs/mth for improved garbage collection services.
- All hospitals are very willing (2) or somewhat willing (1) to cooperate in separating their waste into different categories for recycling.



Badulla General Hospital: left – hospital incinerator; right – hospital wastewater treatment plant.

[6] They also have an interest in a biogas project, but think a composting project may be more feasible.

Table 1-5: Hospital General Statistics and Waste Generation

Hospital	Type	No of Beds	Bed occup-ancy (%)	Out-patients (no/d)	Clinical patients (no/d)	Staff	Common Waste Types	Normal waste (kg/d)	Clinical waste (kg/ mth)	Body parts (kg/ mth)	Sharps (kg/ mth)	Highly infect-ious	Other
General Hospital	Govt	1,004	115	916	757	1,061	F/K>Pa> Pl>Ga	1,365	675	BP: 5 Plac: 900	62	Small	Small
Central Hospital	Private	29	40	5	25	34	Gl>Pa>Pl >Ga	12.7	1.5	BP: small Plac: 6	0.25	0	Small
Lanka Nursing Home	Private	20	100	20	10	40	F/K>Pa> Ca>M	30	Small	BP: 0 Plac: 9	2	0	Small
Total		1,053	113	941	792	1,135		1,407	~226.5	~45	~64	Small	Small

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 = 1,186.

Waste types: BP = body parts, Ca = cardboard, Clin = clinical waste, F/K = food/kitchen waste, Ga = garden, Gl = glass, M = metal, Pa = paper, Plac = placenta, Pl = plastic.

Quantity of normal waste specified above excludes recyclables.

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

Table 1-6: Hospital Waste Disposal Practices

Hospital	Normal waste	Clinical waste	Body Parts and/or placentas	Sharps	Highly infectious	Other	WW-TP	Incin-erator	Comments
General Hospital	Collected by BMC except for some recycling of plastic/ glass containers/bottles and coconut shells.	Disposed of on-site.	Taken to cemetery every 10 days.	Incinerated on-site	Incinerated on-site	Not stated	Yes (see note)	Yes (see note)	Would like covered trailer, technical/financial assistance for composting; better incinerator
Central Hospital	Collected by BMC, except for some recycling of paper and plastics.	Collected by BMC (small)	Some body parts sent to Colombo for experiments; some discharged to drainage system; others + placentas disposed of on-site	Burned/ buried on-site	Not applicable	Not stated	No	No	
Lanka Nursing Home	Collected by BMC.	On-site disposal	BP: Not applicable Plac: on-site disposal	On-site disposal	Not applicable	Not stated	No	No	Would like proper healthcare hazardous waste system

Note: The Base Hospital's incinerator is about four years old but is in relatively poor condition for its age. The hospital's wastewater treatment plant (WWTP) is quite old (>50yrs?) and is under capacity according to hospital staff. However, a brief inspection of the WWTP showed that most of the system capacity is being bypassed due to poor operational procedures.

1.4.5 Government Offices

Badulla has a large number of provincial government ministries and departments and most of the district offices of the Central government, being both the district and provincial capital.

There are approximately 40[7] central and provincial government departments/ministries/authorities with offices in BMC. These offices, together with BMC, the police and prison employ approximately 2,717 workers, while the prison houses around 350 inmates. Interview surveys were conducted with six of these offices, including BMC, Provincial Council Complex, the police and prison.

Three of the four government offices surveyed discharge most (2) to all (1) of their garbage for collection by BMC, while one burns all of its waste on-site and two use this as a secondary disposal method. Together, these four places produce 0.21T/d of garbage from 1,186 workers, equivalent to 0.173kg/worker.d.

The police and prison produce much more waste per worker, with all the police and some of the prison waste being collected by BMC. The remaining prison waste is burnt on-site, apart from recycling of about 1,200kg/mth coconut waste.

The calculated government waste generation rate and corresponding waste stream percentages were applied to other government offices to estimate total waste generation and waste stream breakdown from these offices and then combined with the prison and police data to obtain total government office waste generation of 0.64T/d (0.236kg/worker.d), with 73.7% of this waste collected by BMC, 20.1% burned/buried on-site and 6.2% recycled.

1.4.6 Religious Places

The total number of religious places within BMC is approximately 27, comprising 13 Buddhist temples, three hindu kovils, seven mosques and four churches. The associated number of religious workers is estimated to be 90.

Only the Muthiyangana Raja Maha Viharaya temple was surveyed as part of this study, this being the most significant religious place within Badulla. This produces around 220kg/d of garbage, discharging most of it for collection by BMC, while burning some waste on-site, recycling about 30kg/mth paper and composting 1,500kg/mth of flowers (temple offerings) for their own and neighbours' use.

Waste generation from the temple is relatively high (11kg/clergy.d) compared with the average rate of 1.01kg/clergy.d measured in Kandy and Matale, this primarily being due to the many visitors frequenting the temple each day. Hence, this lower average waste generation rate was applied to other religious places together with corresponding waste stream breakdown percentages of 80% for on-site disposal and 20% for BMC collection and then combined with the temple survey data to obtain total

estimated religious places waste generation of 0.29T/d, equivalent to 3.23kg/clergy.d. 39.8% of religious places waste is estimated to be disposed of on-site, while 42.7% is discharged for BMC collection, 17.2% is composted and 0.3% recycled.

1.5 Industries

According to UDA data, industrial land use constitutes 4.7ha (0.5%) of total land use within BMC.

A total of 28 enterprises were classified as industries for the purposes of this study, comprising one sawmill, six timber depots, 16 rice/grinding mills, one garment factory, distillery, Colombo Commercial Engineering Co and two lathe workshops.

11 of these industries were surveyed, including three timber depots, two grinding mills and all of the other industries listed above.

Interview survey results for industry waste generation and composition data are set out in Table 7.

Table 1-7: Institutional Waste Generation and Composition

Source	Waste generation (kg/d)	Most common waste types
Sawmills and timber depots (4)	25 - 833	Sawdust and woodchips
Rice/grinding mills (2)	150 - 291	Paddy husks and rice bran
Other industries (5)	2.5 - 132	Ga > Me > Te > Pl > F/K

Note: Waste types: F/K = food/kitchen, Ga = garden, Me = metal, Pl = plastics, Te = textiles.

Industry waste generation increases approximately two times during the harvest season for the grinding mills.

The Colombo Commercial Engineering Co. produces small quantities of tubelights per month, while the garment factory produces more significant quantities of hazardous wastes, including around 625 waste needles per month.

1.5.1 Sawmills and Timber Depots

Interview surveys were conducted with the one sawmill and three of the six timber depots within BMA to find out about their waste disposal practices and their willingness to co-operate with BMC in giving/selling their timber wastes for use in composting as an amendment/bulking agent. The results of these interview surveys are set out below and summarized here:

These four places employ a total of 21 workers and produce 1.59T/d of wood wastes, equivalent to 79kg/worker.d, comprising mainly sawdust and woodchips together with smaller quantities of bark.

All five enterprises produce significant quantities of wood wastes, comprising around 26.3T/mth of sawdust, 5.7T/mth of woodchips, 14.3T/mth of combined sawdust/woodchips and 1.5T/mth of bark.

[7] Counting the Provincial Council Complex as a single office, which is in fact made up of at least 14 separate offices.

All sawdust and woodchips are recycled, either being given away for free (sawdust) or sold (woodchips), except for 8.3T/mth of sawdust and woodchips which are open dumped along the banks of a stream/river by Central Timber Stores.

Three enterprises (one no response) are willing to give all of their sawdust to BMC for free, with one stipulating that BMC must pay any associated labourer loading charges. No enterprises were willing to give/sell their woodchips (one "not willing" and two no responses).

Quantities available for free amounted to 7.6T/mth of sawdust and an additional 18.8T/mth if BMC pays any associated loading charges.

Total sawmill/timber depot waste generation within BMA is estimated to be 2.5T/d, or 417kg/sawmill, with 79% of it being recycled and 21% illegally dumped.

1.5.2 Rice/Grinding Mills

Two of the 16 rice/grinding mills within BMA were surveyed. These produce 150-291kg/d of waste, comprising mainly paddy husks and rice bran, equivalent to 49.0kg/worker.d. One mill recycles all of its waste, while the other recycles about 20%, directly hauling the rest of its waste to the BMC disposal site. These practices are considered representative of all mills within Badulla, as BMC stated that at least three mills directly haul their waste to the disposal site. Hence, total mill waste generation was estimated to be 3.5T/d, with 72.9% of this being recycled and 27.1% directly hauled to the final disposal site.

1.5.3 Other Industries

Other industries surveyed comprise the Colombo Commercial Engineering Co, who manufacture and repair machinery for the tea industry, the Asia Great Unicorn garment factory, distillery and two lathe workshops.

The two lathe workshops produce very small quantities of waste (2.5-3kg/d), which are largely recycled (80kg/mth of metals) although one workshop does burn some waste on-site.

Table 1-8: Sawmill and Timber Depot Survey Results

Sawmill/Timber Depot Name and Location (Respondent)	Waste Quantities (T/mth)			Waste disposal	Willing to give/sell to BMC for composting	Comments
	Sawdust	Woodchips	Bark			
Tata Timber Depot, Passara Rd, Badulla	0.75	0	0	Sawdust is given away for free.	Willing to give for free	3 workers
Kandy Timber Dealers, 33 Station Rd, Badulla	6.8	0.95	Mixed with woodchips	Sawdust is given away for free; woodchips are sold at Rs250-300/yard.	Willing to give sawdust for free; woodchips not indicated.	2 workers
Central Timber Stores, 38 Bank Rd, Badulla	14.3		Not specified	6T/mth of sawdust are recycled; remaining waste is open dumped along the banks of a stream/river	Not stated	13 workers
Managalasiri Mills, 20 Bank Rd, Badulla	18.75	4.75	1.5	Sawdust is given away for free; woodchips are sold at Rs50/50kg.	Willing to give sawdust provided BMC covers labour loading charges; not willing to give/sell woodchips.	3 workers
Total	26.3 (+ 14.3 mixed sawdust/woodchips)	5.7	1.5			21 workers

Notes:

Loads refers to four wheel tractor loads (TL) unless otherwise stated below. 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.

Sawdust was specified in terms of ELF lorry loads for Kandy Timber Dealers. This was converted to tonnes based on 0.68T/load, calculated on a pro rata basis, assuming lorry volume = 1.98m^3 (Matale data), while tractor volume = 2.2m^3 for a sawdust tonnage of 0.75T/tractor load.

Central Timber Stores produces both sawdust and woodchips, with only the combined daily quantity of sawdust/woodchips being specified by them (550kg/d), which was converted to a monthly figure based on 26 working days month.

The other enterprises produce 45-132kg/d of waste. Only the distillery discharges most of their waste for collection by BMC with residual waste materials being recycled – 17kg paper/cardboard, 667 bottles and 10 polysacks per month. The garment factory and engineering company burn most of their waste on-site with all other waste being recycled - 3kg/mth of cardboard, 3kg/mth of metals and 350kg/mth of textiles by the garment factory and 12kg/mth paper and 200kg/mth of metals by the engineering company.

Overall waste generation from these five industries is 0.24T/d, equivalent to 0.922kg/worker.d, of which 66.4% is disposed of on-site, 15.5% collected by BMC and 18.2% recycled.

1.6 Other Waste

Other waste accounts for waste collected from public places such as green spaces (parks, etc.) streets, 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 BMC.

1.6.1 Green Spaces (Parks, etc.)

According to UDA (2000) data, parks/playgrounds make up 13.1ha (1.2%) of BMA, while cemeteries comprise another 6.4ha (0.60%).

The Children's Park (0.6ha) is cleaned by eight BMC labourers (six from Works, two from Health) using a wheelbarrow. Around 4-5 polysacks of waste are collected daily, comprising mainly garden waste and some inorganic materials (e.g. lunch packet waste). Waste generation may double from April-June during the "leaf falling" season. The collected waste is placed at community collection points from where it is collected by BMC. There is little space within the park for on-site composting.

The Botanical Gardens (1.42ha) is cleaned by 11 BMC labourers (eight from Works, three from Health) using a handcart and wheelbarrow. Normally, around 8-10 handcarts of waste are collected per day, increasing to 12 handcarts per day during April-June. This is almost entirely garden waste and is made into piles on-site, sprayed with urea and left to compost. Very small quantities of inorganic materials are separated out and burnt.

Dewala Park (30 perches) is cleaned by one MC labourer, who collects around 1-2 polysacks/day of mainly garden waste which is composted in a pit on-site.

Similarly, around one handcart per day of waste is collected from Vincent Dias playground, which is believed to be composted.

The cemetery is swept and weeded by seven BMC labourers (two from Works, five from Health). The amount of waste produced from these works is negligible.

Around two handcarts per day of waste are estimated to be produced from the Racecourse, of which 80% is assumed to be composted and 20% collected by BMC.

For other parks/green spaces, a nominal waste generation figure of one handcart/day has been adopted, of which 50% is assumed to be composted and 50% collected by BMC.

Overall, parks and green spaces waste generation is estimated to be 0.59T/d, of which 78.5% is composted and 21.5% collected by BMC.

1.6.2 Road/Drain Cleaning

BMC data gives the total length of roads and drains within BMA that are cleaned and maintained by BMC as 55.2km and 5.8km respectively. Assuming 5% of these roads/drains are cleaned daily and using road sweeping waste generation estimates from other JICA studies, road/drain cleaning waste was estimated to be 0.27T/d. This equates to each of the five handcarts used by BMC cleaning an average of 490m of road per day and 51m of drains. Furthermore, it was assumed that 50% of road/drain cleanings are simply deposited at the side of the road/drains, while the remaining 50% is collected by BMC and taken for disposal, the latter being equivalent to about 1.2 handcart loads/d.

1.7 Recycling

1.7.1 General

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

- 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).
- Textile scraps may be used to make cushions, pillows, etc.

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 (120 households), with the relevant results summarised below. These indicate that 46% of households have recyclables collected from them by individual collectors, 28% take some recyclables to shops for refund/sale, while 13 surveyed households compost kitchen and/or garden waste.

Table 1-9: Household Survey Recycling Results Summary

Waste Type	Composting	Individual collects from House	Resident takes to shop
Yes	13	55	33
No	107	65	87
Food/kitchen	11	0	0
Garden/wood	13	0	0
Paper/cardboard	0	18	2
Plastic	N/a	1	0
Glass	N/a	48	31
Metal	N/a	6	0
Textile	N/a	10	0
Tyres	N/a	1	0

Notes:

The household survey indicated that 101 households are visited by individual collectors but only 55 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, 80% average BMC garbage collection service coverage and assuming a 90% recycling rate. This gives a household recycling quantity of 0.45T/d (2.3% of total household waste generation).

The middleman survey indicated around 0.57T/d of recyclable materials purchased by them originate directly from households within BMA. This agrees reasonably well with the household survey estimate, with the latter figure being adopted for the waste stream, this being a conservative approach.

1.7.3 During Collection

BMC garbage collection workers collect recyclable materials in Badulla, which they generally sell to middlemen within the town.

The collection worker survey found that nine out of 30 labourers interviewed are involved in recycling. These nine labourers collect an estimated total of 151kg/mth, comprising mainly bottles (82kg, 124 in number[8]), cardboard (20kg), metal cans (30kg) and smaller quantities of aluminium (15kg) and iron (4kg), equivalent to 38kg/labourer.mth and earning an average of 99Rs/labourer.mth, as set out below.

A disposal site survey of tractor collection crews found all crews are active in recycling, collecting around 81kg/labourer.mth of bottles, cardboard and metals, which is over two times higher than the collection worker survey amount. Vehicle labourers are expected to collect more recyclables than other MC collection workers. However, the difference between the two survey results is quite large. Hence, an average value of 59kg/labourer.mth has been adopted, giving an estimated total quantity of recyclables recovered by all SWM labourers during collection of 1,195kg/mth.

Table 1-10: Recyclable Materials Recovered by Collection Workers

Item	Collection Worker Survey			Disposal site survey (8 labourers + 3 drivers)	Estimated Total Quantity (kg/mth)
	No of labourers collecting	Quantity (kg/mth)	Price		
Bottles	8	82	0.5-1.5Rs ea	149	423
Cardboard	2	20	2.0-2.5Rs/kg	338	304
Iron	2	4	2.5-6.0 Rs/kg	411	468
Metal can	4	30	1.5-4.0 Rs/kg		
Aluminium	2	15.4	40-60 Rs/kg		
Total	9	151.2		898	1,195
Average earnings (Rs/labourer/mth)	99			240	170

Notes:

No of labourers interviewed = 30, while total BMC SWM labourers + drivers = 67, excluding septic tank/toilet, cemetery, disposal site, ayurvedic centre and slaughterhouse labourers.

Total quantity calculated from collection worker survey = 9/30 x 67 x 59kg/labourer.mth = 1,195kg/mth.

Final Disposal

There is one BMC labourer assigned to the BMC disposal site, who is not involved in recycling.

Some scavengers do collect recyclable materials from the disposal site, recovering approximately twice the amount of recyclables collected by the BMC collection vehicle workers (JICA disposal site survey), giving a total recycling figure of 81kg/d.

1.8 Disposal Quantities

Current trips data and disposal quantities over the seven day period from Sep 24-30, 2002 (JICA survey data) are summarized below.

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

Vehicle	Registration	Date & Day								
		24 Tu	25 W	26 Th	27 F	28 Sa	29 Su	30 M	Tot	Avg
		Number of Trips								
BMC 2WT	74-1732	2	2	2	0	2	0	2	10	1.43
BMC 4WT	37-6053	4	4	3	3	0	0	2	16	2.29
	49-0682	4	4	5	4	4	3	4	28	4.00
Compactor	68-7907	3	0	0	0	2	0	4	9	1.29
Total		**13**	**10**	**10**	**7**	**8**	**3**	**12**	**63**	**9.0**
		Disposal Tonnage (T/d)								
BMC 2WT	74-1732	1.97	1.49	1.43	0.00	1.69	0.00	1.82	8.40	1.20
BMC 4WT	37-6053	15.93	11.85	9.25	10.95	0.00	0.00	8.00	55.98	8.00
	49-0682	8.76	9.27	5.01	8.67	7.31	6.96	8.34	54.34	7.76
Compactor	68-7907	5.06	0.00	0.00	0.00	4.50	0.00	9.00	18.56	2.65
Total		**31.73**	**22.61**	**15.69**	**19.62**	**13.50**	**6.96**	**27.16**	**137.3**	**19.61**

Note: 2WT = two wheel tractor, 4WT = four wheel tractor

[8] Average bottle weight = 0.66kg, obtained by measuring a mixture of 10 arrack and beer bottles, th185se being the most common bottles recycled.

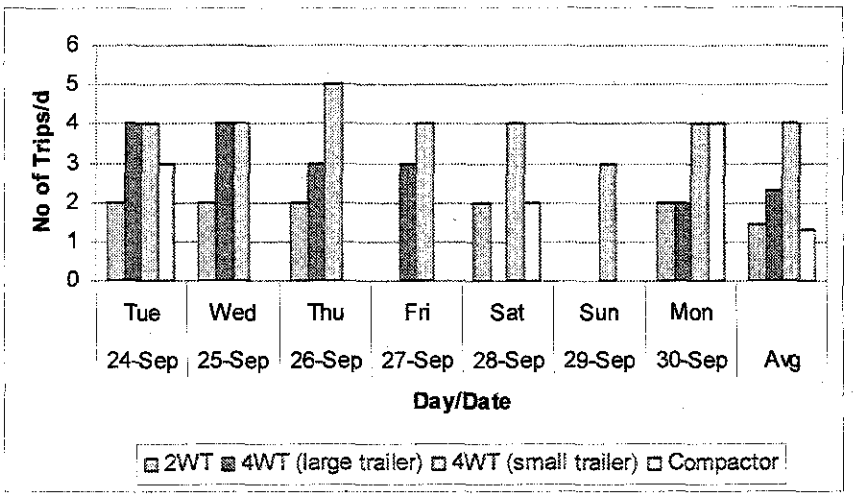


Figure 1-1: BMC Collection Vehicle Trips and Collection Quantities

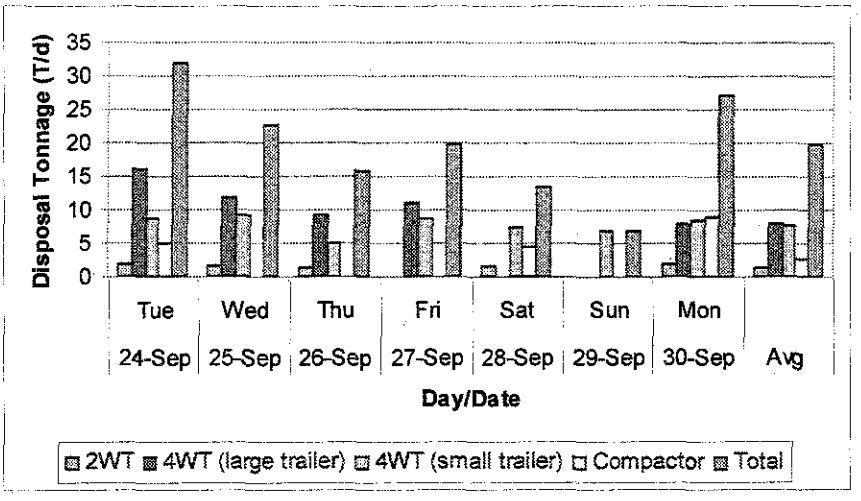


Figure 1-2: BMC Collection Vehicle Trips and Collection Quantities

Some key points from this data are summarized below:

- The average number of trips undertaken by different vehicles during this period is:
  - Two wheel tractor: 1.4 trips/d (range = 0 – 2).
  - Four wheel tractor with small trailer (49-0682): 4.0 trips/d (range = 3 – 5). This tractor operates a two shift system from 7am-9pm. The actual number of trips per shift is 2.71trips/d for the first shift and 1.29trips/d for the afternoon shift.
  - Compactor: 1.3 trips/d (range = 0 – 4). However, the compactor was out of service for 3.5 days during this period. Based on four days in service, the compactor made an average of 2.25trips/d (range = 0-4).
  - Four wheel tractor with large trailer (37-6053): 2.3 trips/d (range = 0 - 4). Inspection of the survey data shows that this tractor was also operating on a two shift system during the 3.5 day period when the compactor was out of service, making a total of six loads during the second shift over this period. Subtracting these six loads means that this tractor actually made an

average of 1.4 trips/d during the first shift over the 7 day survey period. Note, that this tractor did not work over the weekend during the survey period.

- The average daily tonnage of waste disposed of during this period is 19.6T/d. Considerably above average tonnages were collected on Monday and Tuesday during this period. No direct haulage loads by private parties were recorded during this time.
- The current BMC disposal quantity of 19.6T/d is approximately the same as the collection quantity, due to the small quantity (39kg/d) of recyclable materials collected by BMC workers between discharge and disposal. The difference between the amount of waste discharged for collection (20.8T/d) and the amount actually collected is 1.1T/d. This amount is assumed to represent waste that is illegally dumped (in addition to that already counted), waste that is discharged for collection but never collected, or waste that is collected and then disposed of at places other than the BMC disposal site. It has been added to the illegal dumping amount.

1.9 Resource Recovery

The BMC recycling/on-site composting system is illustrated in the following figure, while recycling quantities have already been summarised. This section provides a summary of the recycling sector within BMA in relation to centralised composting and middlemen.

1.9.1 Compost Facility

The Uva Province Chamber of Commerce and Industry (CCI) operated a medium sized compost facility near the BMC disposal site for about 2.5 years from June-July 1999 until operation was stopped in December 2001.

A loan of 1.3M Rs was obtained from the United Nations Development Programme (UNDP) to cover the compost facility capital and operating costs for 2-3 years. Repayments were scheduled to begin in 2000, with UNDP charging 4% interest on the loan. However, UNDP has since transferred its operations in the Uva province to the Uva Enterprises Development Fund, at which time the loan amount was reduced to Rs765,000, with the balance being written off. The loan repayment conditions were revised, with CCI required to pay back a total of 28,000Rs/mth, including interest, from September 2001 over three yrs. CCI is understood to currently be defaulting on this loan.

Initially, CCI was given land to use for the compost facility by BMC for free until 2000, with BMC then leasing the land to CCI at 1000Rs/mth. In December 2001, BMC refused to renew the lease, the main reason being, according to the CCI chairman, that JICA were going to undertake a SWM study for Badulla and the Council didn't want to renew the lease until the JICA study was complete and had made its recommendations known.

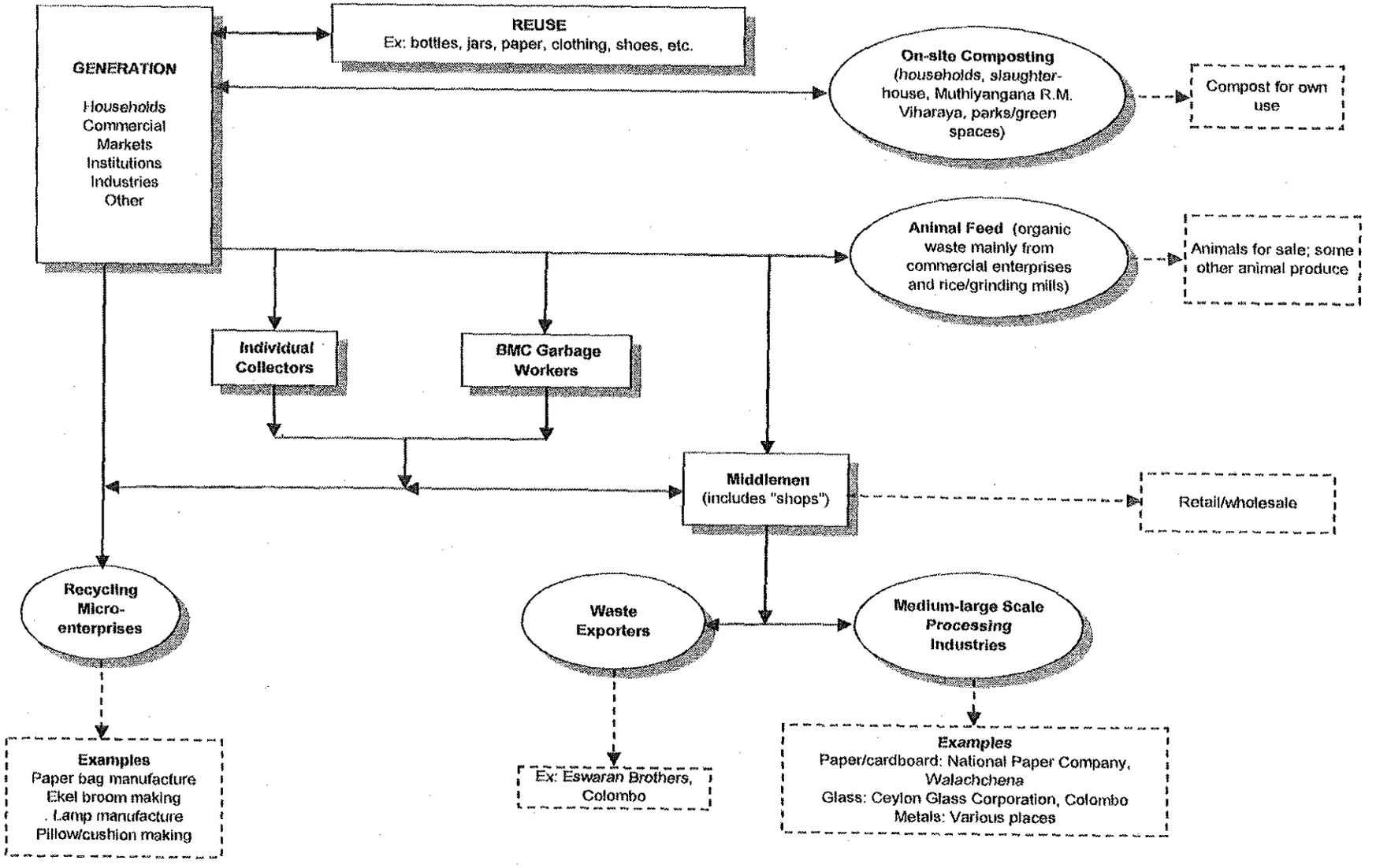


Figure 1-3: BMA Recycling/Composting System