Chapter 4

Field Surveys

4 Field Surveys

4.1 Public Opinion Survey

Since SWM is closely related to the culture, people's way of living, habits, preference, etc., it is very important to understand these aspects of society in Dar es Salaam in order to formulate the SWM master plan. A public opinion survey was, therefore, conducted to understand these.

a. Description of the survey

The main objectives of the public opinion survey were:

- to understand the present general situation of UES and the public demand for UES,
- to understand the present situation of SWM in DSM, and
- to obtain enough data to select proper samples for the waste amount and composition surveys.

The questions on SWM mainly focused on:

- background of household SWM practices;
- waste discharge manner;
- waste collection service;
- recycling
- willingness to pay and other financial matters; and
- public cooperation.

In order to obtain representative data for the present general situation, public opinion and basic information related to UES and SWM in the study area, given that the number of public opinion samples was limited to 500, the sample interviewees were selected according to the following criteria.

- Samples were principally selected in accordance with the present population distribution.
- Since results would be aggregated according to the chosen classifications for the study area, the number of samples to be taken in a ward were adjusted. This means that, the number of samples taken from urban areas were increased to 50 because the number of samples based on population distribution alone would have been too small to be statistically viable.
- Based on the above criteria, the samples were randomly selected.

b. Analysis of Public Opinion Survey

The analyses of these results are presented as follows.

Question 1: General Questions

- In the urban and semi-urban planned areas, on average there are six people per household or business.

- In the semi-urban unplanned area, the number of people per household or business fluctuates considerably between one and 15. However, the most common reply was that there are 5 people per house.
- In the urban area, 48% of the respondents replied that they live in a commercial building with their residence attached. In the semi-urban planned, semi-urban unplanned and rural areas, 73%, 75% and 72%, replied that they live in a detached residential building, respectively.
- In the urban area, 80% replied that they live in rented accommodation. In both the semi-urban and rural areas, 63% and 53% replied that they live in their own accommodation.
- In the urban area, 44% are business categories apart from residence.
- In the semi-urban planned, semi-urban unplanned and rural areas, about 80% live in a business category of residence.
- In all of the areas surveyed, the father is the often the breadwinner of the family.
- In the urban area, there are 1 or 2 children working. In the semi-urban planned area, there are one to three children earning money. In the semi-urban unplanned area, there are on average 2 children working.
- In the urban area, 47% replied that their family expenditure per month is more than 95,000 Tsh. There are no households with a monthly expenditure under 35,000 Tsh. In the semi-urban planned area, 70% of households have a monthly expenditure of less than 95,000 Tsh, of which, 6% have an expenditure of less than 35,000 Tsh/month. In the semi-urban unplanned area, 90% of households have a monthly expenditure of less than 95,000, of which 16% have an expenditure of less than 35,000 Tsh/month. In the rural area, 22% replied that their family expenditure per month is more than 95,000 Tsh. Seven per cent replied that their monthly expenditure is less than 35,000 Tsh.
- In the urban area, 10% replied they have lived there for more than 20 years. Twenty-nine percent replied they have lived there for less than 5 years. In the semi-urban planned, semi-urban unplanned and rural areas, 30% 22% and 29%, respectively, replied they have lived there for more than 20 years. In the semi-urban planned area 26% replied they have lived there for less than 5 years. In the semi-urban unplanned area, 32% replied they have lived there for less than 5 years. In the rural area, 33% replied they lived there for less than 5 years.

Question 2: Present Situation of Public Services

- In the urban area, 65% use private taps in their house as a water source, 19% use a communal tap in the area and 11% buy water from water sellers. In the semi-urban planned area, 31% use private taps in their house as a water source, 16% and 15% use rain water and water bought from a water seller, respectively. Twenty per cent in this area have alternative water sources. In the semi-urban unplanned area, 22% use private taps in their house as a water source, 44% use either a communal tap in the area or communal well/groundwater as a water source. Sixteen percent use rain water as a water source and 20% have an alternative water source.

- In the urban area, 75% of households have flush toilets connected to sewerage pipes. In both of the semi-urban areas this rate is 5%. In the rural area, 6% have a flush toilet connected to the sewerage pipe.
- One hundred percent of households are supplied with electricity in the urban area. In the semi-urban planned area 75% of households have an electricity supply. In the semi-urban unplanned and rural areas, 53% of households are supplied with electricity. TANESCO is the sole supplier of electricity in all four areas.
- In the urban area 40% of the roads are paved with tarmac. Twenty percent of the roads are not paved in this area. In the semi-urban planned area 15% of the roads are paved with tarmac and 41% are gravel/cement/brick pavements. Forty one percent of the roads in this area are not paved. In the semi-urban unplanned area, 5% of the roads are paved with tarmac, and 32% are gravel/cement/brick pavements. In this area, 59% of roads are not paved. In the rural area 10% of the roads are paved with tarmac, 25% are gravel pavements and 63% of the roads are not paved in this area.
- About 50% of respondents living in urbanised areas replied that an adequate water supply was their first priority. 72% of rural inhabitants gave the same reply.
- When asked about the priority of waste collection 30% of urban inhabitants thought it was a 1st priority. In the semi-urban planned, semi-urban unplanned and rural areas, 16%,18% and 7% of the inhabitants thought that refuse collection is a first priority, respectively.

Question 3: Refuse Discharge

- In the urban area nearly 30% of the respondents hand their waste to Multinet, discharge at a market and/or leave their waste outside.
- In the semi-urban planned, semi-urban unplanned, rural areas, nearly 70% of respondents burn their waste.
- The most commonly used vessel to carry waste, in all four areas, is plastic/metallic/ wooden bucket followed by plastic and paper bags.
- Respondents remove refuse mainly to keep the area clean, keep away pests and to prevent foul odours.
- In the urban area, over 50% of respondents are not aware of a regulation for appropriate containers, however, this figure is less than 40% in all other areas.
- Over 90% of respondents in all areas say they will cooperate in refuse collection by carrying their waste to a collection point.
- One of the reasons why some people do not wish to cooperate is because they feel that the present system is much better, also in the semi-urban planned area, respondents said that there is no one to carry the waste to the collection point.
- In the urban area, 58% of respondents do not have a garden. In the semi-urban areas and rural areas, about 50% to 60% of respondents have a small garden i.e. less than 100 sq. m

- In the urban and semi-urban planned areas, over 70% of respondents do not generate garden wastes. In the semi-urban unplanned and rural areas, 44% and 64% generate garden wastes, respectively.
- Fifty percent of city dwellers dispose of their garden wastes by themselves. In the other three areas, more than 65% dispose their garden waste in this manner.
- Over 70% of all respondents will discharge their garden waste if refuse collection is regular.

Question 4: Refuse collection Services

- In the urban area, nearly all respondents have a refuse collection service in their area. In the other three areas, however, nearly all respondents do not have a refuse collection service.
- In 65% of cases in the urban area, Multinet is the provider of refuse collection service. In the other three areas, the city council provides refuse collection in 70% of cases.
- In the urban and semi-urban unplanned areas, 58% of respondents are dissatisfied with the collection service, this figure rises to 83% and 75% in semi-urban planned and rural areas, respectively. (However this statement may not be a true representative of the people's views, especially in the semi-urban planned, unplanned and rural areas, due to the small number of respondents.)
- The two common reasons as to why they are dissatisfied is that the refuse collection is both irregular and the frequency is too little.
- Fifty percent of respondents in the urban and rural areas carry their refuse to a point. This figure rises to 67% and 75% for semi-urban planned and semi-urban unplanned areas, respectively.
- In urban areas, 64% of the respondents receive a daily collection service. In the other areas, the most common replies were that the collection services are conducted from 3 times a week to rarely.
- In the urban and semi-urban planned area, 98% and 83% of the respondents said that collection service was not conducted at a fixed time.
- In the semi-urban unplanned and rural area, 58% and 50% of the respondents said that collection service was not conducted at a fixed time.

Question 5: Resource Recovery and Recycling

- In all of the areas, more than 70% of the respondents said they will cooperate with the new system.
- The reasons as to why they will not cooperate were that the new system requires several containers and that it requires a certain amount of effort.
- Over 70% of respondents in all the areas thought that recourse recovery from waste and recycling was necessary. However, nearly 60% of respondents in all areas replied that no one collects their recyclable waste.

- The most commonly collected recyclable resource in all areas are bottles and aluminium cans.
- Nearly 100% of respondents do not sell recyclable materials to shops.
- Of those that do sell recyclable waste, the most commonly sold materials are bottles and aluminium cans. Respondents who sell materials say that this activity produces profits.
- All the respondents from the urban area (i.e. 100%) do not use food and/or garden waste for compost. In the other three areas, between 70% and 90% of the respondents do not use food scraps/garden waste for compost.
- Most of the respondents in the urban semi-urban planned and unplanned areas are not familiar with producing compost from food/garden waste. However, most people in the rural areas are familiar with this practice.

Question 6: Collection Fee and Financial Matters

- In the urban, semi-urban planned and unplanned areas nearly 90% of the respondents believe that the city council is responsible for solid waste management. In the rural area, 16% believe that a private company is responsible for solid waste management.
- Almost all the respondents in all four areas believe that the present municipal solid waste management system is appropriate.
- Most of the respondents from all four areas thought that a private company should be responsible for solid waste management. However, a significant amount of respondent from semi-urban unplanned and rural areas replied that the central government should be responsible for solid waste management.
- Almost 100% of respondents in all areas do not pay for the current collection service.
- Over 50% of respondents from all areas replied that the collection fee is too expensive or a bit expensive. None of the respondents thought that the collection fee is too cheap.
- In the urban area, most of the respondents replied that the central government should bear the extra cost for refuse collection. In the semi-urban and rural areas, the majority of the respondents replied that the central government should bear the extra costs, however, a significant amount thought that an increase in collection fees and the ward office should bear the extra costs.
- Almost 90% of respondents in all four areas want a refuse collection service.
- The average willingness to pay for waste collection varies greatly from 432 Tsh/month in rural areas to 3,118 Tsh/month in urban areas.

Question 7: Public Co-operation

- Half of the urban dwellers interviewed have received guidance on methods of proper waste discharge. Less than 40% of the respondents have received

guidance in semi-urban areas. In the rural area, nearly 60% of the respondents have received guidance on methods of proper waste discharge.

- Nearly 70% of respondents sweep the road outside their premises daily in the urban and semi-urban planned areas. This figure fall to 64% and 51% for semi-urban unplanned and rural areas respectively.
- Over 90% of respondents in all areas believe that public cooperation is necessary to maintain a beautiful city environment. Almost all the respondents replied that they will cooperate in maintaining the environment clean/beautiful.
- Almost all the respondents believe that public education and campaigning is necessary to maintain the city/ environment clean.
- As to who shall be responsible for taking such action there was a broad spectrum of answers; central government, city council, ward office and the community were some of the more common answers. Also, respondents felt that family members should also be responsible for taking such action.

4.2 Waste Amount and Composition Survey

This section summarises how the *Waste Amount and Composition Survey (WACS)* carried out during this Study in conjunction with data from various other sources provided the necessary information to determine the waste generation amount and composition for the different generation sources studied.

Please refer to Annex 6 for elaboration of the WACS methodology, results and further discussion.

4.2.1 Methodology

a. Waste Generation Amount Determination

WACS was carried out in the second half of June 1996 at the start of the dry season. In this survey, waste was collected and weighed daily over a 8 day period from 79 sampling points in the categories listed below with the waste amount results being used to determine a waste amount generation rate (WAGR) for each category.

- Household waste (low, middle and high income)
- Commercial waste (restaurant and others)
- Institutional waste
- Market waste
- Street sweeping waste

Some important waste generation sources; namely hotels, trunk road maintenance and the informal sector were not included in WACS for practical reasons. Instead, WAGR data for these categories was obtained through interviews with relevant authorities and workers in conjunction with statistical data as explained in Annex 6.

Other statistical data was collected from various sources in order to quantify the total number of generators for each source. This data was then combined with WAGR data to determine the total waste generation amount for each generation source.

The definitions of each type of waste are given below:

Household Waste: Waste arising as a result of domestic activities including food preparation, sweeping, cleaning, fuel burning, gardening, garbage (e.g. old clothing, newspapers, obsolete appliances, etc.) and also waste generated from micro-business (informal sector) activities operated by a family within its house.

Commercial waste: Wastes from retail and wholesale outlets, commercial offices (e.g. travel agents, Bureau de Change) restaurants, guesthouses, hotels, etc. These wastes generally consist of packaging and container materials, used office supplies and food wastes. Guesthouse and hotel wastes also include guest room and garden wastes and in the case of beachfront hotels, "beach sweeping" waste may also be included.

Market waste: Waste from markets (both wholesale and retail). Market waste mainly consists of food/produce waste, grasses and other organic packaging materials and food waste from canteens operating within the markets.

Institutional waste: Wastes from public (e.g. government offices/ministries, parastatals, banks, tourist hotels, insurance companies, hospitals, schools, universities, etc.) and private sector institutions (e.g. religious and charitable organisations, embassies, private banks, schools, hospitals, etc.). In this study, institutional waste is restricted to office/administrative waste which consists mainly of paper with a smaller proportion of food waste from institution canteens. Hence other types of waste from industrial and manufacturing activites produced in institutions such as TAZARA and TIA is excluded with only their administrative waste being included. Similarly, for hospitals and government owned hotels, DSM airport and some other institutions, only waste arising from administrative activities is included here. Waste from army barracks is excluded completely.

Street sweeping waste: Street sweeping waste includes all waste generated by the street sweeping cleansing service operated by Multinet and is mainly dust and litter.

Trunk Road Maintenance Waste: Waste arising from grass cutting, tree/flower cutting/pruning and sand sweeping along trunk roads and silt removal from trunk road drainage channels. These operations are carried out by the Ministry of Works.

Informal Sector Waste: Waste arising from informal sector activities. A large amount of waste of very diverse nature is generated by this sector. In this Study, informal sector waste is restricted to waste from such activities which are conducted outside of a family's home and premises and can be classified as trade/restaurant/hotel or transport/finance/community services enterprises.

b. Waste Composition Analysis

Composition analysis of the generated waste provides much useful information on the type of waste materials generated by different sources as well as identifying the potential for resource and energy recovery. In this Study, physical composition analysis in wet base was carried out for samples from all generation sources while chemical composition analysis, in the form of carbon and nitrogen content analyses, was only carried out for market waste in order to assess it's suitability for compost.

4.2.2 Waste Generation Amount Results

a. Household Waste

For household waste in DSM, 60 sampling points were selected and the dependence of the WAGR and waste composition on *location* and *household income level* was examined.

The weighted average WAGR was measured to be 698 g/cap/d and WAGRs were found to be consistent for households in different locations, being 713, 683, 707 and 755 g/cap/d in RA, SUUA, SUPA and UA areas respectively.

Table 4-1 shows the variation in measured WAGRs with income level. Usually, WAGRs increase with household income level but in this case the middle income WAGR is slightly higher than that for high income households.

These results are consistent with WAGRs for "detached houses" determined in other JICA studies in developing countries throughout the world. Detached houses, meaning houses which are separate from each other, generate increased quantities of waste and hence have an increased WAGR due to the presence of a large proportion of garden and "sweeping" waste. Table 4-7 verifies this, showing that household waste consists of 44.7% grass/wood and soil/ash/sand waste so that approximately half of the WAGR can be attributed to "garden/sweeping" waste.

Table 4-1 also compares the WAGRs measured in this Study with that of Haskoning[1] and those of recent studies carried out by ERL[2] for four towns in Uganda. The methodologies used in these other studies is basically the same as that used here.

Table 4-1: Comparison of WAGRs

unit: g/cap/d

Income group	JICA DSM study (1996)	Haskoning DSM study (1988)	Tororo, Uganda	Masaka, Uganda	Mbarara, Uganda	Mbale, Uganda
High income	744		500	800	700	400
Middle income	780		600	1,100	1,200	700
Low income	511		1,040	600	800	600
Weighted Average	698	377	-	-	-	-

The household WAGR for DSM in 1996 is reasonably consistent with those measured in the Ugandan towns but is 85% greater than Haskoning's 1988 value. The WAGR and waste composition can change very quickly in accordance with changing economic and social conditions and peoples' living conditions, etc. The large increase in the WAGR may partially be attributed to such changes which have been occurring, especially as economic liberalisation has been rapid since 1990.

Table 4-2 shows the total household waste generation amount in terms of income and location.

[1] "Masterplan on SWM for Dar-es-Salaam"; Haskoning and M-Konsult Ltd; Mar. 1989
[2] "GTZ/World Bank Seven Towns Project" Reports, Environmental Resources Limited (ERL), 1990

Table 4-2: Calculation of Household Waste Generation

Income Category		High	Middle	Low	Total
Waste Amount (t/d)	UA	19.9	22.2	0.9	43.0
	SUPA	173.3	284.6	91.2	549.1
	SUUA	64.5	420.6	172.2	657.4
	RA	38.3	102.2	26.3	166.8
	Total	296.0	829.6	290.7	1,416.3

b. Commercial Waste

Commercial waste was classified into three categories: restaurant, guesthouse/hotel and other enterprises waste. Only restaurant and other enterprises waste was collected during WACS with 5 sampling points in each category being selected in the urban area. For guesthouse/hotel waste, waste generation amounts for guesthouses and hotels was estimated separately using statistical data and appropriate WAGRs based on amended household WAGRs. The results are presented in Table 4-3.

Table 4-3: Commercial Waste Generation Amount

Category	Total number of enterprises	WAGR	Waste Generation Amount (t/d)
Restaurant	365	37.45 kg/enterprise/d	13.7
Other	13,241	0.906 kg/enterprise/d	12.0
Guesthouse	322	0.405 kg/bed/d	1.1
Hotel	51	0.744 kg/bed/d	0.5
TOTAL			27.3

Haskoning estimated the waste generation amount for hotels and restaurants through collection data of the City Cleansing Department, monitoring of selected hotels and restaurants during one week and interviews with hotel and restaurant keepers. The waste generated by other commercial enterprises was estimated by multiplying the number of people living in commercial areas (city centre and Kariakoo) by a factor of 0.2 kg/cap/d, this being an average figure derived from other research conducted in major cities. This methodology gave generation amounts of 25 t/d and 20 t/d for restaurant/hotel and shop waste respectively. These values are higher by 63-67% than corresponding values from this Study (15.3 t/d and 12.0 t/d).

c. Institutional Waste

Five institutions were selected for sampling in WACS. Four of these are parastatals whilst the fifth is a NGO non-profit making institution. All are office type institutions located in the central city area with the number of employees ranging from 18-50. The WAGR was expressed on a per worker basis rather than per institution. Statistical data for 1996 listed 429 institutions in DSM with a total of 62,246 employees and the latter figure was used to convert the WAGR to a waste generation amount. The waste produced per worker per day in each of the sampled institutions varied from 19-54 g/worker/d with an average value of 36 g/worker/d, equivalent to a waste generation amount of 2.2 t/d.

Haskoning estimated the institutional waste generation amount to be 10 t/d for city centre institutions (Ministries, offices and banks, etc.) through collection data of the City Cleansing Department and monitoring of selected institutions and using the same

calculation method as in this Study. A rough estimation of the waste generation amount for other institutions (laboratories, university, army, airport and institutions outside the city centre), of 50 t/d was made, of which most was generated by the army. The waste generation amount per worker per day varied substantially between different institutions as found in this Study.

Haskoning's total institutional waste generation amount of 60 t/d is substantially greater than that calculated in this Study. A major reason for this is that Haskoning's definition of institutional waste was much broader than that used here. In particular army wastes were excluded completely from this Study.

However, a further check on the accuracy of the WAGR value was made using Vingunguti disposal site records for two institutions which showed that the measured WAGR was too low and hence the WAGR was suitably amended to give a value of 0.172 kg/worker/d, equivalent to a waste generation amount of 10.7 t/d. Although, this is still considerably less than Haskoning's estimation, the validity of this WAGR was confirmed from Vingunguti weighbridge data obtained during 11-28 February 1997 for the National Bank of Commerce (NBC) institutional waste and the waste generation amount is considered to be a realistic figure in terms of the definition of institutional waste used in this Study.

d. Market Waste

Two markets, Mwananyamala Map and Buguruni, were selected for sampling because these were considered to be representative of typical markets in DSM. WAGRs were estimated both for wholesale and retail operators.

As the two markets surveyed in WACS have very few wholesale operators (2.0-2.5%) the WACS data for these markets was used to calculate the retail WAGR. Discussions with market representatives at the two markets revealed that the operator participation rate in WACS was 90% and 65% respectively and hence the WAGR was adjusted to take this into account, giving a retail WAGR of 3.12 kg/op/d.

Kariakoo Market has the highest number of official wholesale operators compared with any other market in DSM and records the daily collection and disposal of waste from the market. This data was used to calculate a wholesale WAGR of 5.36 kg/op/d.

The number of retail and wholesale market operators in official markets was estimated to be 7,766 and 1,803 respectively. Combining this data with the corresponding WAGRs above gives a total market waste generation amount of 33.9 t/d[3].

Haskoning determined market WAGRs through collection data of City Cleansing, KMC data, interviews with market representatives and field visits. He estimated the number of retail and wholesale market operators to be 4,500 and 2,000 respectively and waste generation rates to be 20 kg/op/d and 30 kg/op/d for retail and wholesale operators respectively, giving a total market waste generation amount of 150 t/d, which represented 25% of the domestic solid waste generation in 1988. The waste generation amount of 33.9 t/d calculated here corresponds to 2.4% of the present domestic solid waste generation, an order of magnitude less than Haskoning's value.

[3] 5.36 x 1,803 + 3.12 x 7,766

ERL[4] estimated the market WAGRs in the towns of Jinja and Tororo in Uganda to be 0.11-0.14 kg/cap/day while the value calculated here of 33.9 t/d is equivalent to 0.017 kg/cap/day which is an order of magnitude less than the ERL values. Their methodology was not stated.

Both these comparisons suggest that the calculated value significantly understates the true market waste generation amount. However, Vingunguti weighbridge data for the period 11-28 February 1997 showed that an average of 9.7 t/d of market waste was disposed of at the Vingunguti disposal site from Kariakoo market. This value verifies that the market retail and wholesale WAGRs are of the correct order of magnitude and validates the calculated market waste generation amount. Furthermore, it suggests other reasons are responsible for the lack of agreement between the data obtained in this Study and that cited above from the other two studies.

One possible reason for the difference is that these calculations are based only on official markets in DSM. Data from the Informal Sector survey carried out for DSM in 1995 states that there are 88,841 operators selling fruit, vegetables, fish and meat and a further 63,022 selling cooked food in the city. Markets are based on the former activities and also contain a smaller proportion of operators selling cooked food. Market operators are counted as part of the informal sector so the total of 9,569 operators in official markets represents 11% of the 88,841 total of "market" operators working in the city. If some allowance is made for cooked food sale then this percentage will be even smaller. Hence, the actual market waste generation amount (official and unofficial markets) will be ten times greater than the calculated value (official markets only), which explains the order of magnitude difference between the results of this Study and those of the other two studies.

Another possibility is that the data of Haskoning is too high. Market waste collection points (WCP) are often used by nearby residents and petty traders as dumping places for their own waste. During WACS, efforts were made to ensure that the market waste collected originated only from market operators. Operators were instructed to store their waste in baskets/boxes and then to bring this waste to the collection vehicle when it arrived where loading was supervised. If the waste from these other sources is also included as market waste, then the market generation rate will be artificially high as illustrated by the following two examples.

- KMC have found a big difference in the amount of waste collected for disposal from the market following the eviction of petty traders from the surrounding area in March 1996. Out of an average of 5.8 trips per day in Feb. 1996, approximately 2.8 trips/day (5.6-7.0 t/d) were attributed to waste contributed by petty traders and possibly some nearby residents. Hence, market waste was being artificially increased by a factor of 1.93.
- Using data from Question 3-1 of POS, the quantity of waste deposited by residents at market collection points was estimated to be 47.1 t/d which if this is added to the 33.9 t/d generation amount calculated above, would artifically increase market waste by a factor of 2.39 to 81 t/d.

[4] "GTZ/World Bank Seven Towns Project" Reports, Environmental Resources Limited

e. Street Sweeping Waste

DCC is responsible for the sweeping of all non-trunk roads in the city. Multinet, under contract to DCC, carries out this work in the wards in which it is operating and their policy is to sweep all tarmaced roads within these wards. At the time of WACS, they were operating in 5 wards in the City centre (urban area) and sweeping streets in 3 of these wards where virtually all the streets were tarmaced. The two streets selected as WACS sampling points were within these 3 wards and were chosen to be representative of the central city area; one (Jamhuri St.) being in a business area; the other (Indira Gandhi St.) in a commercial area. A WAGR of 40.390 kg/km/d was measured which when multiplied by the total length of streets swept (32.79 km) gave a waste generation amount of 1.3 t/d.

Street sweeping of other non-trunk roads is carried out by DCC in some other parts of the city but on an irregular basis and the waste generated from this source is considered to be negligible.

The Ministry of Works is responsible for trunk road maintenance operations such as grass cutting, tree/flower cutting/pruning and sand sweeping along trunk roads, and silt removal from trunk road drainage channels in DSM. It was estimated that 88.5 t/d of waste is produced by these operations of which 97% is recycled. However, as the generation, collection and disposal of waste from these operations is controlled by the Ministry of Works and this situation is unlikely to change in the foreseeable future, the waste generated from such operations was excluded from this Study.

Haskoning used a figure of 35 t/d for street, drain and sewer wastes on the basis of other studies carried out in different countries. This was a very rough estimation, made without separating these wastes into those collected by DCC or by the Ministry of Works as done here. Hence, no comparison with the value obtained in this Study should be made.

f. Informal Sector Waste

The informal sector in DSM is extremely large with an estimated 222,915 operators and 43,755 workers in 1995. The range of enterprises that are included within the informal sector is very wide (e.g. livestock raising, construction activities, produce sale, laundry services, hair salons, etc.) and the sector produces a significant amount of waste of widely varying composition. For practical reasons, informal sector waste was not included in WACS and the waste generation amount was estimated from statistical data for non-home based informal sector activities in two categories only as explained below.

Informal Sector Enterprises were divided into four groups:

1. Reusable Wastes: for livestock, fishing, other agriculture, sand and stone quarrying. The wastes produced by these enterprises are considered to be recycled and hence a WAGR of 0 was used.

2. Manufacturing and Construction Wastes: A high proportion of the wastes produced by these enterprises is thought to be recycled (e.g. brewing wastes for animal feed; paper waste may be sold to paper manufacturing industries, etc.). However, all these enterprises belong to the industrial and manufacturing sectors which are outside the scope of this Study and hence a WAGR of 0 is used.

3. Trade/Restaurant/Hotel Enterprises: These activities are very similar in nature to those found in a typical market. Hence the market WAGR was used to calculate the total waste generation amount for trading informal sector enterprises.

4. Other Wastes: For the transport, finance/insurance/real estate, community and personal services sectors, these enterprises resemble commercial (other) enterprises but typically produce much less waste than commercial (other) enterprises. Hence the commercial (other) WAGR was multiplied by 0.3 to get a WAGR for these enterprises.

The definition of household waste used in this Study included waste generated from micro-business (i.e. informal sector) activities operated by a family within its home. Hence, the amount of waste produced by informal sector non-home based enterprises alone was calculated here as shown in Table 4-4.

Table 4-4: Waste generated by Informal Sector non-home Based Enterprises

Sector	Non-home based Operators as % of total Operators	Total No. of Operators	WAGR (kg/op/d)	Waste Generation Amount (t/d)
Reusable	65.0	8,683	0	0
Manufacturing & Construction	68.3	45,451	0	0
Trade	64.5	153,409	3.12	278.9
Other	71.9	15,372	0.34	3.8
TOTAL	**65.6**	**222,915**		**282.7**

Note:
1. Waste generation amount = fraction of non-home based operators x total no. of operators x WAGR
2. The number of non-home based trading operators (98,949) is adjusted by subtracting the number of market operators (9,569) from it to give 89,380 operators before calculating the waste generation amount. This is done because all market operators are non-home based and the amount of waste generated by them has already been included in the market waste generation amount.

The informal sector waste generation amount is 282.7 t/d. This is a high generation rate, representing 20% of the total domestic waste generation. However, it is thought to be a reasonable estimate when the number of operators and types of enterprises included in this calculation is considered, as discussed below.

The number of operators in the informal sector is very high, constituting 11% of the total population. If their customers are included as well the actual number of people involved as either an operator, worker or customer is very high, possibly over 50% of the population. Economic statistics verify that the number of people utilising this sector is high. In 1995 the informal sector total gross output and total gross value added were 180 billion and 139 billion Tsh[5]. Based upon the high economic activity and number of people involved in this sector it is expected that it will generate a large amount of waste.

The two main generators of waste are the fruit/vegetable/fish/meat and cooked food sub-sectors. Non-home based operators in these sectors constitute 67.5% of the total number of non-home based operators.

The fruit, vegetable, fish, meat sub-sector includes all markets (official and unofficial) and many other independent operators around the city. Essentially, these operators (home based and non-home based) are providing fresh food for the city population.

[5] Data Compilation, 1995 DSM Informal Sector Survey"; J.B. Mwinuka, Planning Commission, DSM, 1996

The cooked food sub-sector includes small canteens ("mamantilie" and migihawa" in swahili), fried food and barbecue vendors who produce a lot of waste. It also includes operators selling small food items, like doughnuts, rice cakes, chapattis, etc. which produce little waste. Such enterprises are scattered throughout the city with the heaviest concentrations being in the city centre, Kariakoo and near many large factories. Essentially these operators (home based and non-home based) are providing cooked food for the city population, particularly at lunchtime and in the evenings.

If all operators are considered (home based and non-home based) then the ratio of operators to residents is 1:23 and 1:32 for the fruit/vegetable/fish/meat and cooked food sub-sectors respectively.

This estimation of the informal sector waste generation amount is based mainly on statistical data and is not considered to be very accurate. It may be possible to carry out a formal survey at a later stage to evaluate the informal sector waste but this would need to be designed very carefully due to the size and diversity of the informal sector.

g. Waste Generation Amount Summary

Table 4-5 summarises the waste generation rates derived from this survey.

Table 4-5: Waste Amount Generation Rates for Surveyed Waste Types

Type of Wastes	Sub-category	Unit	WAGR
Household Wastes		g/cap/d	698
Commercial Waste	Restaurant	g/enterprise/d	37,450
	Others	g/enterprise/d	906
	Guesthouse	g/bed/d	405
	Hotel	g/bed/d	744
Institutional Waste		g/worker/d	172
Market Waste	Retail Operators	g/operator/d	3,120
	Wholesale Operators	g/operator/d	5,360
Street Sweeping Waste		g/km/d	40,390

Table 4-6 summarises the waste generation amounts calculated for the different sources investigated.

Table 4-6: Summary of Daily Waste Generation Amount in 1996

Type of waste	Category	Main Source	Daily Generation Amount (t/d)
Household waste	UA	WACS	43.0
	SUPA	WACS	549.1
	SUUA	WACS	657.4
	RA	WACS	166.8
Commercial waste	Restaurant	WACS	13.7
	Hotel	Statistics	1.6
	Other	WACS	12.0
Institutional waste		WACS	10.7
Market waste		WACS	33.9
Street Sweeping waste		WACS	1.3
Informal Sector waste		Statistics	282.7
Total Daily Waste Generation Amount			1,772.2

4.2.3 Waste Composition Results

The waste composition results from WACS are presented here.

a. Physical Composition

Table 4-7 shows the results for composition of household waste according to income category.

Table 4-7: Analysis Results of Waste Composition for Household Wastes

	Category	Household Waste			
		High income	Middle income	Low income	Weighted Average
Physical composition	Kitchen	44.5 %	41.9 %	39.8 %	42.0 %
	Paper	3.1 %	3.0 %	3.3 %	3.1 %
	Textile	3.8 %	0.5 %	0.6 %	1.2 %
	Plastic	3.4 %	1.9 %	1.9 %	2.2 %
	Grass & Wood	19.8 %	30.9 %	15.0 %	25.3 %
	Leather & Rubber	0.3 %	1.0 %	1.2 %	0.9 %
	Metal	1.8 %	2.1 %	1.8 %	2.0 %
	Glass	8.8 %	2.4 %	1.3 %	3.5 %
	Ceramic & Stone	0.5 %	0.3 %	0.4 %	0.4 %
	Other	14.0 %	16.0 %	34.7 %	19.4 %
	Total	100.0 %	100.0 %	100.0 %	100.0 %
ASG		0.31	0.39	0.49	0.39
Moisture Content		31.47 %	31.07 %	30.57 %	31.05 %

Note: "Other" is mainly soil, ash and sand accumulated from gardening activities.

Table 4-7 shows that garden waste, consisting of grass/wood and "other" (mainly soil/ash/sand), is the largest component of household waste (44.7%) followed by kitchen waste (42.0%). There is little variation in the waste composition between different income categories except:

- high income households have a higher percentage of textiles, plastic and glass waste and a lower percentage of leather/rubber than middle and low income households.
- middle income households have a much higher percentage of grass/wood waste than high and low income households.
- low income households have a higher percentage of soil/ash/sand waste than middle and high income households.

While waste moisture content is very similar for each household income category (31%), apparent specific gravity (ASG) decreases significantly with income, being 0.49, 0.39 and 0.31 for low, middle and high income households respectively. The high percentage of soil/ash/sand (34.7%) in low income household waste explains the high ASG value in this case while for middle income households the ASG value of 0.39 may be due to the high percentage of grass/wood.

The results of the waste composition analysis for commercial (restaurant and other), institutions, market and street sweeping categories are summarised in Table 4-8. No waste composition results for commercial (guesthouse/hotel), trunk road maintenance and informal sector categories were obtained as these categories were not included in WACS.

Table 4-8: Analysis Results of Waste Composition for Other Type of Wastes

		Commercial		Institution	Market	Street Sweeping
		Restaurant	Other			
Physical composition (%)	Kitchen	93.4	0.8	9.2	59.6	23.0
	Paper	1.9	71.6	71.5	3.2	17.5
	Textile	1.2	2.5	2.6	0.5	1.3
	Plastic	1.7	8.4	6.1	0.9	6.4
	Grass & Wood	0.8	1.5	0.9	27.2	19.0
	Leather & Rubber	0.0	0.5	0.0	0.0	2.4
	Metal	0.5	5.3	4.1	0.1	2.5
	Glass	0.6	0.0	3.3	0.3	1.0
	Ceramic & Stone	0.0	0.5	0.7	0.2	0.9
	Other	0.0	8.9	1.7	8.2	26.1
	Total	100.0	100.0	100.0	100.0	100.0
ASG		0.64	0.03	0.05	0.23	0.22
Moisture Content (%)		55.16	22.11	8.78	53.12	15.51

Note: Other is mainly soil, ash and sand.

Some of the main points from this table are summarised below:

- For commercial waste, the main constituents of restaurant and other waste are kitchen waste (93.4%) and paper (71.6%) respectively.
- For institutional waste, paper (71.5%) is the main constituent.
- Market waste primarily consists of kitchen waste (59.6%), grass/wood (27.2%) and other (soil, ash, sand) waste (8.2%) respectively.
- The main components of street sweeping waste are other waste (26.1%), kitchen waste (23.0%), grass/wood (19.0%) and paper (17.5%).

b. Apparent Specific Gravity (ASG)

ASG of household wastes ranged from 0.31 to 0.42 and its weighted average was 0.39 while ASG of the other wastes ranged from 0.22 to 0.64. As household waste constitutes approximately 96% of the total waste amount from the generation sources surveyed in WACS, the overall waste ASG is taken to be equal to 0.39.

c. Moisture Content

The moisture contents of household waste were constant at around 31% while the moisture contents of the other wastes varied from 15% to 55%. As above, the overall waste moisture content is taken to be 31 %, the household waste value.

d. Carbon and Nitrogen Content of Market Waste

The percentages of Carbon and Nitrogen in market waste were analysed and the average C/N ratio was found to be 22.0.

4.3 Compost Market Survey

Compost production with wastes can be an appropriate waste processing option because the composition of wastes in DSM is generally suitable for compost. The viability of compost production with waste is, therefore, dependent on its demand. The compost market survey was conducted to understand the potential demand to compost.

a. Procedure of the Compost Market Survey

No large scale farmers are found in the Dar es Salaam area. Small scale farmers, growing vegetables that are sold in the markets of Dar es Salaam, are found all over the City.

20 farmers in the Dar es Salaam area were visited. Samples of compost from Vingunguti pilot compost plant was presented to the farmers. Main questions to the farmers are presented in Table 4-9, also indicating the general answers.

Table 4-9: Results from Questioning Farmers in the Dar es Salaam Area.

	Question	General answer
1	What do you use for improving the soil ?	Chicken manure
2	What do you pay for chicken manure ?	200 - 300 Tsh/ 70 litters excluding transport (4,000 Tsh/ton, 1996)
3	Is chicken manure always available ?	Yes
4	How much chicken manure is required ? How often is it required ?	An exact answer was not obtained. (350 kg/month each 20 x 20 m^2)
5	Can other material be used as a fertiliser?	Cow dung, but chicken manure is the best. Urea (a chemical fertiliser)
6	Can decomposed waste from waste dumps be used for improving the soil ?	We think so.
7	How much can you pay for compost from waste ?	Very little, We can produce compost ourselves.
8	Are you willing to test this compost on your land (the sample was shown)	Yes

Based on the above described survey and without having enabled the farmers to use the compost it was difficult to establish if there is a market for compost. Therefore, a survey was carried out amongst 5 selected groups of small scale farmers (each group 4 farmers). Compost (in total 80 bags, each 50 kg) from Vingunguti composting plant was supplied and tested by the farmers during a 3 month period.

b. Findings

Main findings from the survey were as follows.

- Four(4) survey points tested the compost by growing African spinach (almanthes) commonly known in Kiswahili as "MCHICHA". This compost was tested on the 'mchicha' because all the sampled survey points are commonly growing 'mchicha', it grows quickly and farmers prefer it because they gain quick money within a short period. During the surveys vegetables like cabbage, egg plants, lady's finger and pumpkins were seen growing in some farms; owners of these farms were asked to test the compost and they were willing but they wanted a large amount of compost, more than the test supply. Therefore, 100% of the test concentrated on the "mchicha".

- The average results has shown that the SW compost is useful and has fertility when applied to the soil. Most of the farmers tested the compost in two stages of vegetable growing namely, planting stage (used as starter) and seedling raising stage (used as raiser), the compost was found to be more useful as a starter than a raiser because of its "low gas content". 78% of the farmers said this compost is fertile and useful, and 22% they said its fertile but not useful due to the above reason.

- Farmers generally prefer chicken manure as fertilisers. Although 91% of the farmers accepted the SW compost, some of them preferred to utilise it as a base for other fertilisers such as chicken manure. However, other farmers recommended some changes to improve the quality of SW compost, one of them being change of the compost bases from saw dust to cereal (e.g. maize) husks and they also thought that smaller particles may increase its quality.

- The general views from the farmers indicates that, 22% think SW compost is poorly produced and doesn't have great importance to their farming, 44% said the compost is doubt-full therefore it should be improved and 33% of them they said the compost is good and is important for their farming.

- The survey has shown that 94% of farmers are willing to use SW compost as a fertiliser to their vegetable farms, the remaining 6% were doubt-full of its quality especially the chemical content. They didn't like its origin because garbage sounds sill to them and they were worried of loosing customers due to use of SW compost manure.

- Although other farmers were doubt-full of the SW compost , but they still asked for more supply of it by 94% of them, the remained 6% of farmers refused the next supply.

- The farmers were too reluctant to state the price or to estimate numerically the amount which they are willing to pay for buying SW compost manure. A further interview has revealed that, 94% of the vegetable farmers values SW compost below the chicken manure's price, that means, its price per bag should be below 300/=, probably between 150/= and 200/= per bag including transportation costs. If the transportation costs will be excluded, the costs per bag will be lowered to even less than 150/=, because, in the same case farmers are sometimes buying chicken manure at 150/= per bag and it happens sometimes to get it free, if happens this case they only incur costs for transportation if they can not carry by themselves.

c. Conclusion

Farmers are willing to take SW compost manure if supplied to them for free, otherwise there is a need to get them well informed on every aspect concerning SW compost manure prior to its utilisation program. This is because farmers have their own priorities and perhaps fertilisers are not their first priority let alone compost, most of the farmers they complained of water supply , they said that is the most important thing they should get first. They complained on the government notice aimed to farmers in the city that they should not use tape water for watering their farms, following that notice NUWA disconnected all the water tapes in their farms. The farmers didn't see the need to equip themselves with fertilisers while there is no water to activate its importance to the soil. The general views has revealed that , farmers doesn't think that fertiliser is a problem to them, because there is plenty of chicken manure and the only matters here is money to buy or for transportation to the farm. However, there is a psychological effect from the fact that the compost is made from the decomposed garbage, they think it may cause infection or intoxication to their farm products. Therefore, the issue of SW compost will remain doubt-full, unless the farming

components are well integrated and farmers became aware and ensured of compost's safety to their farm products.

4.4 Assessment of the Vingunguti Disposal Site

a. Estimation of the Reserve Volume

Following the Vingunguti disposal site survey in June 1996, the topographical map with a scale 1 to 2,000 was produced. The reserve volume of the landfill site was estimated based on this map. Assuming the finishing dimension of the landfill as shown in Figure 4-1, the estimated reserve volume is 166,200 m^3. Assuming the density of compacted waste is 0.9 tons/m^3, the remained life period of the landfill site is estimated as below.

	Case 1	Case 2
Waste collection amount:	200 tons/day	300 tons/day
Soil coverage:	None	10 % of waste in volume
Remained life period:	24 months	13 months

It is most likely that the reserve life period of the Vingunguti disposal site will be 13 to 24 months from July 1996, in other words the life period of the site will be between July 1997 and June 1998.

It should be reminded that this estimation depends highly on various factors such as compaction of waste, coverage soil, waste collection rate, landfilling operation procedure.

In addition, social acceptance is another important conflict for continuous disposal operation. Especially, the great increase in the number of refuse trucks could lead neighbours' protest towards disposal operation.

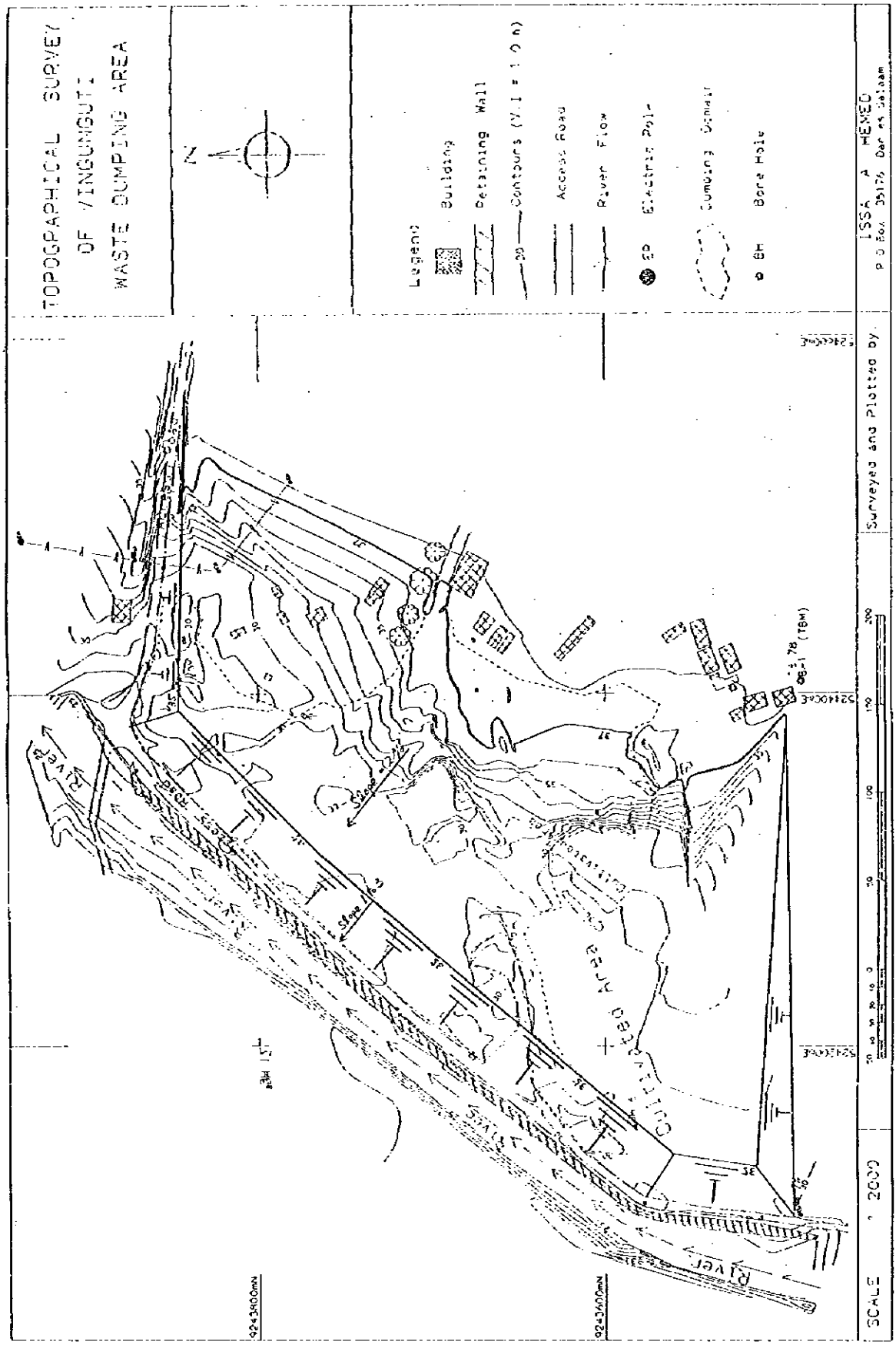


Figure 4-1: Assumed Finishing Dimension of the Vingunguti Site

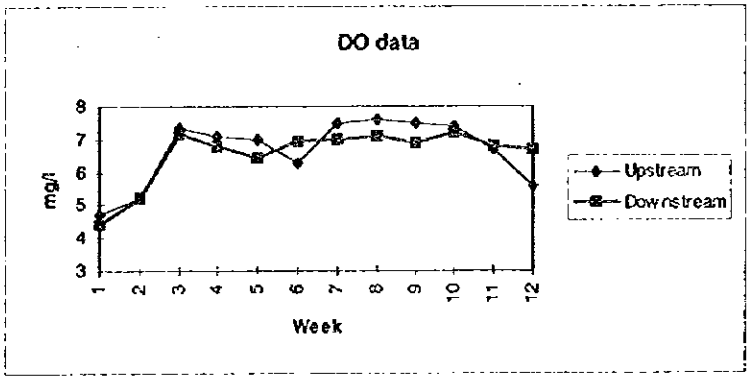
b. Environmental Conditions

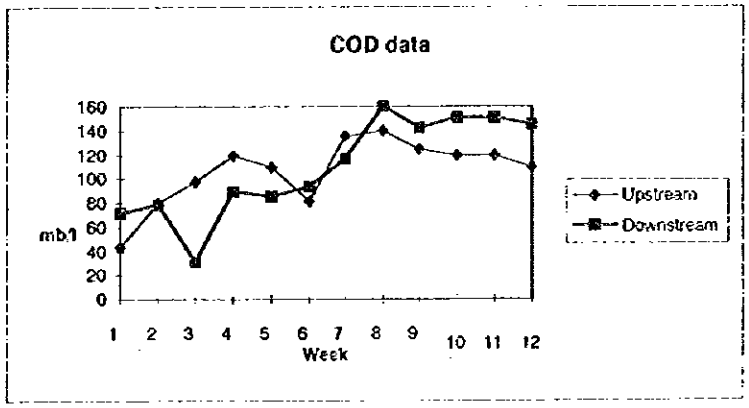
b.1 Water Pollution

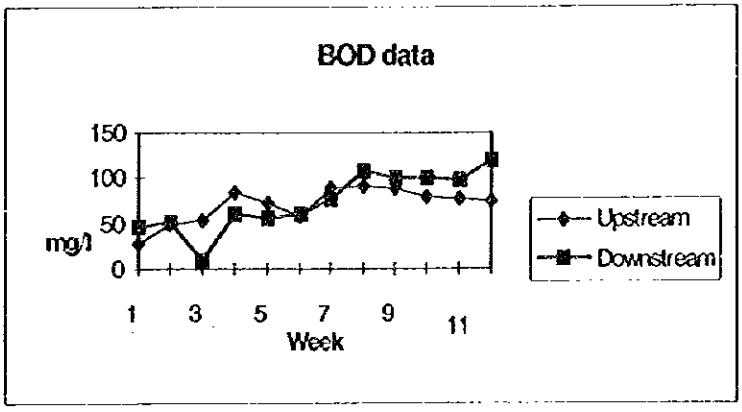
The water quality of Mzimbasi River flowing by the Vingunguti disposal site was measured upstream and downstream of the disposal site to identify the impacts caused by disposal for 12 weeks.

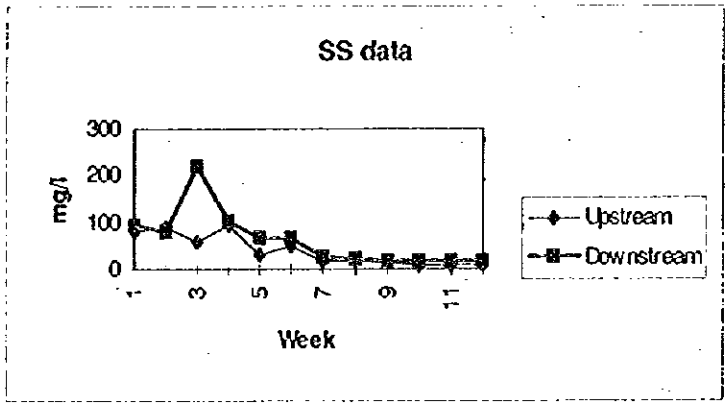
The survey found that the river water had been polluted when it reached to the disposal site. However, according to the general trend of measured data, as shown below DO, COD, BOD and SS which are important indices for water pollution, it was found that the river water was affected by dumping waste.

As for heavy metals, the impacts by disposal could not be seen significantly, although they were detected both upstream and downstream of the site. However, the fact that relatively higher concentrations of heavy metals were found in the water sample of leachate implies that hazardous industrial waste had been dumped.









b.2 Ambient, Noise, Vibration and Traffic Volume

Ambient, Noise, Vibration and Traffic Volume were surveyed at the corner of Nyerere road and Vingunguti road. Impacts on ambient, noise, vibration by refuse collection trucks were not found by the survey. However, from the traffic volume survey, the percentage of traffic volume of refuse collection vehicles to the total traffic volume was found to be 7 %.

c. Review of the Former Report

"Vingunguti Landfill Study, Dar es Salaam Tanzania" was prepared by COWIconsult for Habitat in 1994. This study includes preliminary surveys such as a geological survey, hydrological survey. Water quality survey using 26 boreholes were conducted by Mr Mgana of the Ardhi Institute prior to this study. The study was subsequently conducted in Denmark using the survey data and included calculation of the leachate generation amount; the minimum cost abatement measure for protecting the environment; preliminary design of storm water drainage, leachate control and gas ventilation systems and other basic infrastructure for the site. Appropriate site management procedures were also presented.

This study recommended the establishment of landfill sections, covering of existing wastes, the use of final cover and the use of a cut-off ditch, interceptor trench, gas ventilation pipes at top of the landfill and gas collection wells for gas control and handling. As alternative solutions, a final cover with clay liner or final cover with synthetic liner; a bottom liner of clay with a drainage system or bottom liner of synthetic material with a drainage system; and an evaporation pond with recirculation system were proposed.

The only diversion channel proposed by this study was implemented in 1995. Most other mitigation measures proposed are not implemented because the amount of solid waste deposited has increased significantly since then.

4.5 Time and Motion Survey

Solid waste collection involves intensive work. At the same time, its cost occupies a large portion of the total cost of SWM. Therefore, the following measures are to improve the collection efficiency:

- Maximum use of the truck capacity

- Maximum use of legal working hours

It is necessary to understand precisely the present condition of solid waste and find its problems in order to prepare an improvement plan. This was carried out with such objective.

The survey includes;

- bearing of time, distance and weight on collection and haulage.
- type of dustbin and container used
- working efficiency of collection workers
- collection routes
- level of user cooperation in waste collection activities
- service level
- maintenance and condition of equipment

The time and motion survey were conducted ten times totally as follows.

Date	Operator	Type of Waste Collected
31 Jul. 96	DCC	Residential
31 Jul. 96	DCC	Residential
2 Aug. 96	DCC	Market, Residential
3 Aug. 96	DCC	Market
6 Aug. 96	Multinet	Residential, Hotel, Hospital
7 Aug. 96	Multinet	Residential
8 Aug. 96	Multinet	Residential
8 Aug. 96	Multinet	Residential, Hotel, Hospital, Office
11 Aug. 96	DCC	Market
13 Aug. 96	DCC	Market

The analysis of these data are included in Annex 5.

4.6 Survey on Recycling System

4.6.1 Objectives

- to understand the present recycling system including recent trends and problems.
- to enable the impact of the Master Plan on recycling to be forecast.
- to suggest some measures which could be taken to improve recycling.

4.6.2 General

This survey investigated the recycling system in DSM including:

1. recycling at source (i.e. generation) (see section 4.4.1 and recycling survey).
2. recycling at other points of the waste stream: discharge, illegal dumping and final disposal (see section 4.4.1 and scavenging survey).

3. recycling system for the major waste items recycled.

The methodology and complete results are set out in Annexes 10 and 11. The sources, collectors, main uses and users of the major waste items recycled are shown in Table 4-11.

Overall, it can be said that the recycling system is complex as there are a large number of individuals, businesses, organisations, industries, etc. involved in recycling but there is no formal body or organisation coordinating these activities in the city, apart from some small scale initiatives and contacts between the different parties involved.

4.6.3 Recycling at Source and by Scavenging

The results for items (1) and (2) are summarised here (see sections indicated above for further details). Within the scope of this study, waste materials were commonly collected from household, restaurant and shop/office generation sources by individual collectors. Scavengers also collect recyclable waste materials, particularly from the Vinguguti disposal site, illegal dumps and at discharge points. The amounts of the major waste items recycled were estimated as explained in Annex 10 and are summarised in Table 4-10.

Table 4-10: Recycling Breakdown by Major Waste items

Unit: t/d

Waste Stream Component	paper (sheets, boxes, etc.)	metal (cans, tins, etc.)	glass/ plastic bottles	wood	kitchen waste	garden waste	other	Total
Generation	1.5	4.2	15.4	2.3	13.3	78.2	0.4	115.2
Discharge, illegal dumping, final disposal (by scavenging)	7.9	2.8	1.0	1.3	0.3	0.0	2.0	15.3
Total	**9.4**	**7.0**	**16.4**	**3.6**	**13.6**	**78.2**	**2.4**	**130.5**
Percentage	**7.2**	**5.4**	**12.5**	**2.7**	**10.4**	**59.9**	**1.8**	**100.0**

Note: 1) other includes cereal husks, paint, sacks, textiles, tyres, other plastic and glass (not bottles)

Table 4-11: Sources, Collectors, End Uses and Users of the Major Waste Items Recycled

Item	Sources	Collectors	End Use	User
Paper (sheets, boxes, etc.)	households, shops, offices, commercial printers, construction sites, industries, Vingunguti disposal site, illegal dumps	collectors (from generation sources), scavengers, middlemen (workers and/or themselves)	1) reprocessed into paper products 2) to make paper bags 3) wrapping goods in 4) printing bus tickets (paper used on 1 side)	1) industries 2) markets, petty traders, micro-industries 3) markets, petty traders 4) micro-industries
Metal (cans, tins, etc.)	households, restaurants, hotels, garages, manufacturers, industries, Vingunguti disposal site, illegal dumps	collectors (from generation sources), scavengers, middlemen (workers and/or themselves), micro-industry workers	1) reprocessed into billets, ingots, etc. 2) to make household and other items 3) to make toys and decorations 4) cans/tins used for potting plants	1) industries 2) individuals, micro-industries 3) individuals 4) residents
Glass (broken bottles, bottles, etc.)	households, restaurants, hotels, bottlers, breweries, Vingunguti disposal site, illegal dumps	collectors (from generation sources), scavengers, middlemen (workers and/or themselves)	1) reprocessed into bottles/jars 2) to make security glass barrier on top of concrete walls around premises 3) unbroken bottles are reused	1) industries (broken bottles only) 2) bricklayers/construction companies 3) individuals, shops, petty traders, markets, manufacturers (soft drinks, beer sauces, etc.)
Plastic (bottles, containers, etc.)	households, shops, restaurants, Vingunguti disposal site, illegal dumps	collectors (from generation sources), scavengers, middlemen (workers and/or themselves)	1) reuse 2) making toys, decorations	1) individuals, markets, petty traders, shops, etc. 2) individuals
Tyres	households, garages, transport companies, industries, Vingunguti disposal site, illegal dumps	collectors, scavengers, micro-industry workers	1) to make bushes, sandals, bike brakes 2) as property boundary markers	1) micro-industries 2) individuals, offices, etc.

Note:
1) Each end use is indicated by a number which relates it to the user for that particular purpose.
2) The end use and users of other recycled items (cereals/husks, drums, food leftovers, paint, plastic sheets, sacks, sawdust, textiles, wire mesh and wood) are stated in annex 10.

The major item recycled is garden waste, most of which is composted by households within their property. The amounts of other major items recycled are relatively small and the MSW stream makes up a small proportion of the total waste materials recycled in DSM, especially for waste paper and scrap metals, as explained further below.

4.6.4 Recycling System for Main Waste Items

The results for item (3) are presented here. Diagrams illustrating the recycling system for paper and metal are shown in Figure 4-2 and Figure 4-3 respectively (see Annex 10 for glass, plastic and tyre recycling system diagrams).

a. Paper

In this context, paper refers to all types and grades of paper including cardboard, newsprint, magazines, boxes, books and shredded paper.

The paper supply is very large, easily exceeding the recycling demand, which varies seasonally, being low during the wet season (due to high moisture content of paper) and high during the dry season. The proportion of waste paper obtained from generation sources within the scope of this study is relatively small, consisting mainly of boxes.

There are a large number of small scale middlemen (5-20 workers) involved in paper recycling in DSM and it is estimated that they collect 360-520 t/month, mainly from commercial printers. The waste paper is sold to industries in DSM, Moshi and Nairobi.

There are a number of well established, medium sized micro-industries (17-40 workers) which make paper bags from cement, milk powder and sugar sacks and computer paper obtained from offices, building sites and industries. The major problem faced by them is competition with plastic bags and scarcity of raw materials (sacks).

Details of large industries which utilise waste paper as a feedstock are shown in Table 4-12.

Table 4-12 Large Waste Paper Processing Industries

Industry	Type of Waste Paper Used	Buying Price (Tsh/kg)	Demand (t/month)		Products
			present	peak	
Kibo Paper, DSM	corrugated boxes sack kraft paper assorted paper	25 30-40 10-15	70-100	200	fluting and test liner board for box manufacture, core paper
Tanpak Industries, DSM	assorted paper	50-100	small	450	tissue and toilet paper
Kibo Paper, Moshi	kraft waste paper	30-50 (DSM depot) 70 (Moshi)	160	> 160	no data
Chandaria Industries, Nairobi	other assorted paper newsprint bright white paper	80 (in Nairobi) 90 120 180	no data	no data	no data
Kamongo Industries, Nairobi	no data	no data	no data	no data	no data
TOTAL	(minimum)		230-260	810	

Note: transport cost to Moshi and Nairobi is 60,000/- and 1.2 million Tsh respectively for a 25-30 tonne truck and trailer.

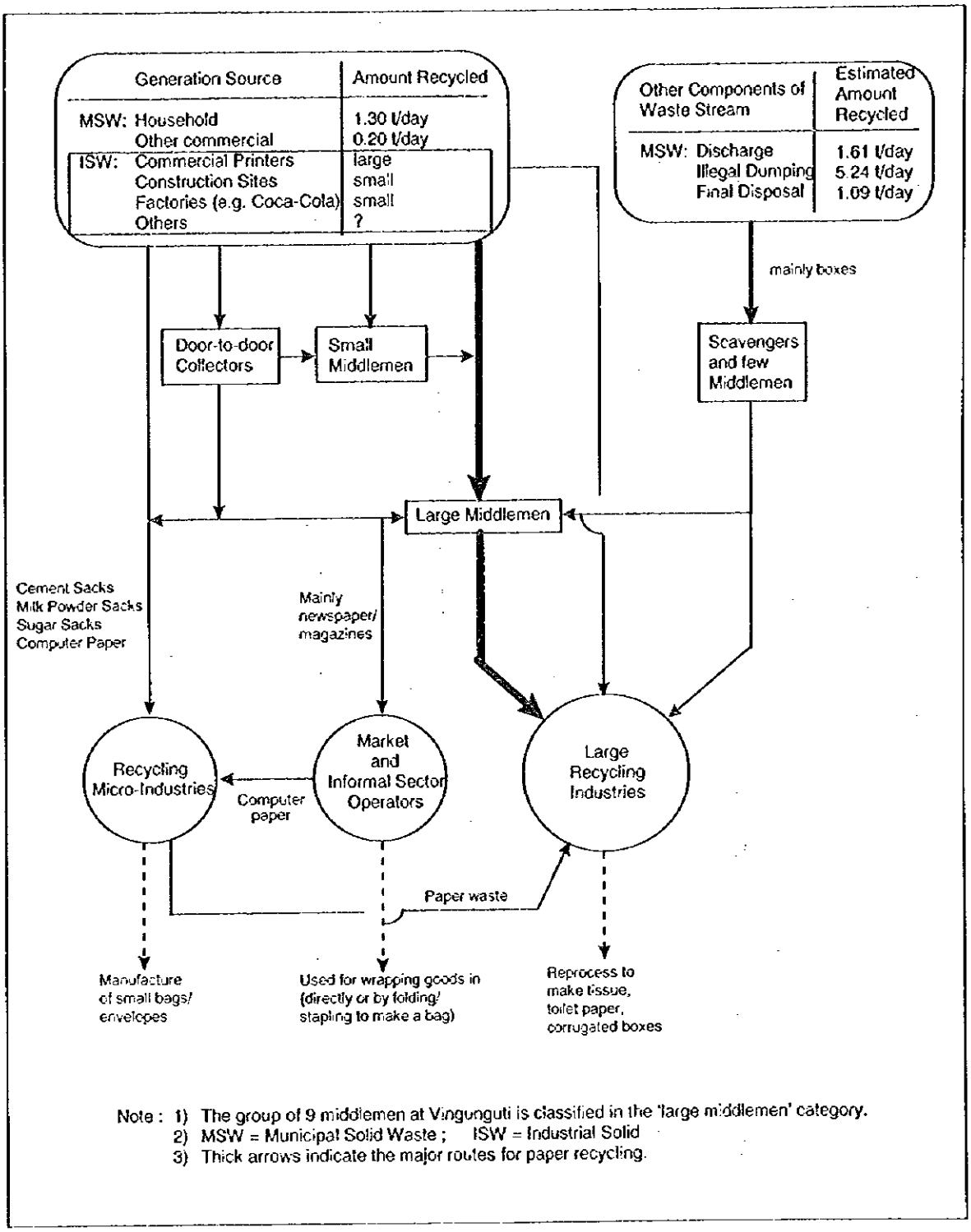


Figure 4-2: Waste Paper Recycling System

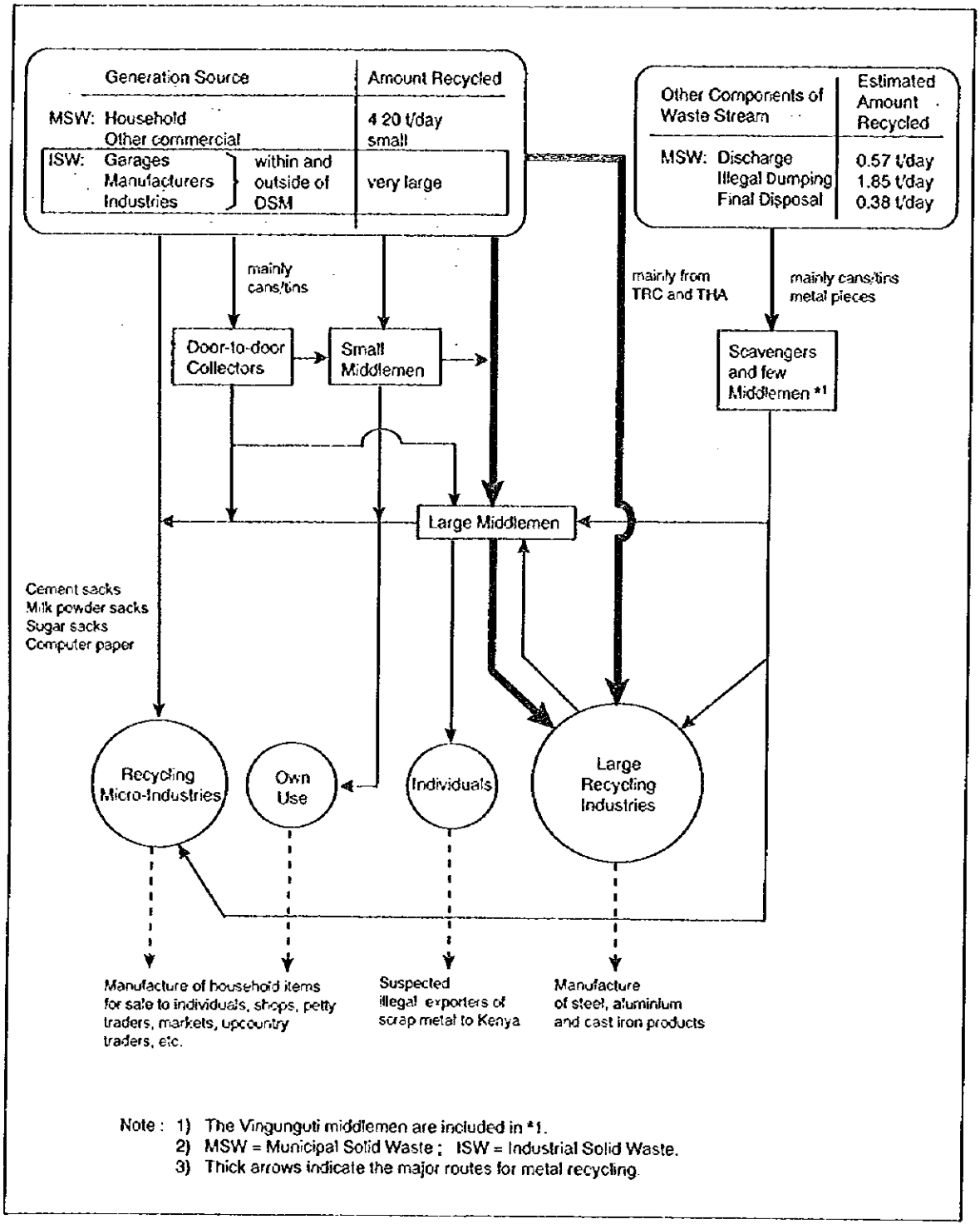


Figure 4-3: Scrap Metal Recycling System

It appears to be highly profitable to recycle paper, according to data obtained from Kibo Paper, DSM: 1 tonne of waste paper purchased at a maximum price of 55,000/- (including transportation costs) will yield 0.9 tonnes of paper which can be sold at 392,000/- per tonne. Even after production costs (labour, electricity, water, etc.) have been included, the profit should be high.

Comparison[6] of the amounts of waste paper produced (2,160 t/month from WACS generation sources as well as large quantities from commercial printers, etc.), collected by middlemen (360-520 t/month) and estimated industrial demand (>810 t/month at peak production) shows that there is potential for expansion of paper recycling if the industries using waste paper in Moshi and Nairobi are included. However, if the comparison is limited to DSM, the potential for expansion is small and depends heavily upon the growth in Tanpak's demand.

Furthermore, there are some major problems hindering development of the paper recycling industry.

- The market is not stable. Reprocessing industry production rates fluctuate significantly and hence so too does the demand for waste paper. Reasons for this given by Kibo Paper, DSM include reliance on public utility suppliers (TANESCO and NUWA) for electricity and water and cash flow problems.
- Paper transportation costs to substantial markets in Moshi and Nairobi are prohibitively high, especially in the latter case, discouraging middlemen from selling paper to these sources.
- Lack of appropriate baling equipment means that a 30 tonne truck can presently only be filled with 15-20 tonnes of baled paper before its volume capacity is completely utilised, making the long distance transportation of paper to Moshi and Nairobi less profitable.

b. Metal

In this context, metal refers to all types of metal including aluminium cans[7], metal tins, iron sheets, vehicle bodies, drums, etc.

The scrap metal recycling industry is large and active in DSM. The proportion of scrap metal obtained from generation sources within the scope of this study is relatively small, consisting of metal items (especially tins) and aluminium cans, which supply the large micro-industrial sector and ALUCO respectively with the bulk of their raw materials. There are a large number of small and medium scale middlemen involved in scrap metal dealing.

The micro-industrial sector is well established. The main items manufactured are small kerosene lamps, charcoal stoves and some household items such as funnels, sieves, pourers and cooking utensils. These products are sold in DSM to individuals, kiosks, shops, markets, etc. and in bulk to traders from upcountry. Little change is expected in demand for these products or mode of operation of these micro-industries in the short term future.

[6] this analysis is somewhat simplistic as it does not take into account the composition of the waste paper nor the different types of waste paper used by industry as raw materials.
[7] only beer is produced in aluminium cans in Tanzania; soft drinks are bottled.

Most micro-enterprises operate independently. However, DASICO (DSM Small Industries Co-op Society Ltd.) is an organisation of many micro-industries based in the Gerezani area and has about 400 members as well as many trainees. Its activities are divided into 5 sections: carpentry, metalwork (manufacture of charcoal stoves, kerosene lamps, kitchen utensils, etc.), carving, welding/mechanical and paper bag manufacturing. The metalwork and paper sections mainly use recycled items for raw materials.

The operations of large scrap metal recycling industries in DSM are described in Table 4-13. The majority of scrap metal is obtained by them from industrial sources mainly in DSM but also from many other parts of the country. The market for scrap metal has been characterised by a lack of stability due to problems experienced by industry, especially Steelcast and ALUCO. Reliance on public utility companies for electricity and water and cash flow problems leading to shortages of essential imported raw materials have affected the productivity of these factories and discouraged middlemen from trading in scrap metals. This applies particularly to ALUCO which virtually has a monopoly on the aluminium can recycling market in DSM.

However, improvements in electricity supply provision and the construction of two new private steel mills[8] should help to bring some stability and competition to the market. Demand for scrap metal is expected to increase once the Iron and Steel Ltd. factory in DSM begins operation towards the end of 1996, which could lead to increases in scrap prices.

Table 4-13: Large Scrap Metal Processing Industries

Details	Types of Scrap metal used	Buying price (Tsh/kg)	Qty bought (t/month)	Use of scrap metal
Steelcast, Tazara	mainly dumped/ abandoned vehicles (e.g. cars, buses, trucks, railway rolling stock, sea vessels)	medium: 27-30 heavy: 35-40	880-990 (target is 1,320; peak is ~2,000)	steel billets
M.M. Integrated Steel Mills Ltd	mild steel scrap (light, commercial, heavy grades)	good: 45-50 poor: 25-30	650-700	mild steel/high tensile steel for construction industry (e.g. building/flat/ construction rods)
Iron & Steel Ltd	mild steel scrap	50	about 1,250	iron bars and rods for construction industry
ALUCO	manufacturing offcuts. trims; soft Al scrap (e.g. beer cans, tins)	400	20	Al ingots & slabs; manufacture of Al circles and sheets
NECO	mainly cast iron, small quantities of bronze and Al scrap	ci: 50 br: 500 Al: 800	ci: 50 br: 2-3 Al: 0.4	cast iron and non-ferrous products; e.g. manhole covers
Tazara Workshops	old/damaged/broken rolling stock and parts (axles, shafts, etc.)	N/A	not known	repair and manufacture of spare parts for rolling stock

Note: Al = aluminium; br = bronze; ci= cast iron

[8] The two new industries are M.M. Integrated Steel Mills (began 1.5 yrs ago) and Iron & Steel Ltd.

Iron and Steel Ltd. is also building a new steel mill in Mwanza. This company's investment in two steel factories in Tanzania displays a certain business confidence that was justified by them as follows:

- There is a large, captive scrap market in Tanzania. Formerly, scrap metals were exported from Tanzania to other countries, especially Kenya, but the law was changed about 1.5 years ago to make this illegal[9]. Market research conducted by the company has shown that the scrap steel supply in Tanzania should be sufficient to meet their needs for at least the next 5 yrs.
- The market is expanding rapidly for steel building rods and bars in Tanzania, with 70% of current demand being imported.
- The technology required to produce building rods and bars is relatively simple and affordable and hence is appropriate to use in Tanzania.
- The cost of the locally produced bars and rods is competitive with that of their imported equivalents. Hence, locally produced bars/rods should reduce the country's reliance on imported bars/rods.

However, this company has expressed concerns about the competitiveness of Tanzanian industry relative to Ugandan and Kenyan industry, especially with the revival of the East African community. There is also some competition with South African companies. Electricity is the major expense incurred in making building rods and electricity charges in Tanzania are approximately 1.5 times those in Kenya and Uganda. They are presently negotiating with TANESCO for electricity tariffs for heavy industrial users to be reduced.

c. Glass

Glass in this context, refers to glass bottles, broken glass, etc.

The glass recycling system is well established, relatively straightforward and appears to suffer from few problems. No significant changes are expected in the short run although the recent introduction of 1.5 l PET soft drink bottles may affect the soft drink market, MSW composition and recycling industry.

Most of the glass waste collected is in the form of unbroken bottles which can be washed and then reused. Glass bottles may then be sold directly to individuals, shops, petty traders, markets, middlemen, etc. No micro-industries utilising glass as their main resource were located during this survey.

Kioo Ltd. is the only factory in DSM which reprocesses broken bottles into bottles and jars. Demand is stable and the supply is sufficient. They pay 100/- per kg for broken bottles delivered to the factory and purchase about 200 t/month, equivalent to 20% of their total bottle production.

Pepsi Bottlers Ltd. and Tanzania Breweries Ltd. both use a deposit/refund system for distributing bottles to their outlets as in most other countries. Over 98.5% of the bottles circulated to customers are returned to them each year. Bottles broken during the manufacturing or distribution processes are sold as cullet to Kioo Ltd.

[9] Although illegal, some exporting of scrap metals does still occur by illegal ('panya') routes.

Coast Canners Ltd. is one of a number of food canning/bottling industries within DSM. It uses glass jars and bottles for making jams, tomato and chili sauces. These products are sold to customers but about 4,000 (80%) jars/bottles are returned to them each month, mainly by middlemen who collect them from various sources.

d. Plastic

Plastic in this context covers plastic bottles, sheets, containers, etc.

The recycling system for plastic bottles focuses on reuse rather than reprocessing and is unlikely to change in the foreseeable future. Most of the plastic waste collected is in the form of bottles which are washed and then reused or sold. No micro-industries using plastic as their main raw material were located during this survey.

The two major plastic companies in DSM, Simba Plastics and Tegry Plastics, do not collect any materials for recycling, primarily due to the difficulty of accurately grading plastics, which is vital in order to avoid processing problems. However, both factories recycle some of their production line rejects.

One potential recycling opportunity concerns 1.5 l PET soft drink bottles, recently introduced in Tanzania. Turnover of this new product is currently relatively small and it is too early to assess their impact on the soft drink market, MSW composition and recycling industry. If this product proves to be popular, these bottles could be collected for reprocessing and it may be possible to utilise the bottle crushing machine at Tegry Plastics for this purpose. A container moulding machine would also be required in this case.

e. Tyres

Most used tyres are obtained by collectors and micro-industry workers directly from source although some are collected from dumping sites. There are thought to be few middlemen involved in the tyre recycling industry.

There are many small micro-industries throughout DSM which use old tyres mainly to make retreaded tyres and some other minor products such as rubber sandals and bicycle brakes. The sandals and bushes manufactured are sold locally and also to traders from other regions (Kondoa, Arusha, Singida). These micro-industries are well established and little change is expected in demand for their products or mode of operation in the short term future. Their products are cheap and in popular demand. However, if their used tyre supply is to decrease, then their survival may be threatened.

One factor threatening their supply is the success of the tyre retreading industry which is a new, rapidly growing industry, dominated by private companies and whose share of the used tyre market rise is increasing. However, this factor is offset by a rapid increase in sales of vehicles in Tanzania in recent years which has increased the used tyre supply. The balance between these two factors will determine the impact on the micro-industries.

NAS Tyre Services Limited is one of the largest tyre retreading businesses in DSM. Approximately 45% of tyres retreaded by them come from DSM while the remainder come from other areas, especially Moshi, Tanga and Mbeya where the company has collection centres. They currently retread 500-600 tyres per month but demand is rapidly growing and their 1996 retreading target was almost double that of 1995. There

are at least three other retreading companies in DSM (Treadsetters, Kassam Retreads, Globe) which are estimated to retread a total of over 600 tyres/month.

f. Other

There are a smaller number of other micro-industrial and middlemen recycling other types of waste items. Typically, these enterprises collect, process (clean, repair, make) and sell items themselves, thus eliminating all other intermediaries between source and customer. For example:

- 'Wito wa Taifa' is a small group of 16 workers, operating since 1978 and based at Mbagala Kizinga, who manufacture mattresses from waste materials which they collect themselves, such as cigarette filter waste, sisal and cotton.
- There are many small trading businesses around DSM which buy used metal and plastic drums (usually 50 gal.) for subsequent resale.
- The 'Nasi Tunajaribu Women's Group' has been in existence for 3 years, has 64 members and deals in the collection and resale of drums, plastics, wooden pallets and firewood.

These enterprises occupy a particular niche in the market place and are relatively independent in that they deal directly with their suppliers and customers. Any assistance to this sector should be given on an individual enterprise basis.

4.6.5 Possible Measures to Improve Recycling

A number of possible measures to solve some of the problems facing recycling in DSM are listed below.

1. Stimulating the demand for recyclable materials through construction of new small-scale industries which would use recyclable waste materials as raw materials (e.g. the use of waste paper for processing into cellulose or for the manufacture of egg cartons).
2. Increase the market stability for recyclable waste materials through improvement in the performance of large industries which reprocess waste materials in DSM. This could partially be achieved indirectly by promoting improved efficiency of the public utilities, especially NUWA and TANESCO.
3. Provision of a number of vehicles that would be available for hire at lower rates than the market rates specifically for use for transporting recycled materials. The lower hire rates can be justified as recycling is reducing the final disposal load and thus disposal costs. For paper, these vehicles could be made available for transport of paper to Moshi or Kenya.
4. Provision of a number of handcarts and other tools that could be available for hire on a similar basis as (3) to assist in the collection of recyclable materials from around the city. In particular for paper recycling, the provision of a number of compressing baling machines on a rental basis to paper middlemen would greatly increase the efficiency of paper transportation, especially to Moshi or Kenya.

5. Establishment of a recycling fund[10] which people engaged in recycling enterprises could apply to for assistance (grants, low interest loans, etc.) for purchasing tools and equipment.

4.7 Survey on Scavengers

4.7.1 Objectives

- to understand the system of scavenging in DSM.
- to understand the organisation of scavengers and their present working conditions.
- to estimate the amount of waste recycled at Vingunguti disposal site.
- to facilitate prediction of the social impact of the Master Plan on scavengers.

4.7.2 Content

The following surveys were conducted:

- at the Vingunguti disposal site: Scavenger Attendance survey (SAS), Scavenger Interview survey (SIS), Scavenging Waste Amount survey (SWAS) and Middlemen Interview survey (MIS). Discussions were also held with DCC disposal site staff.
- at other places in DSM: Scavenger Interview Survey (SIS).

The main results are summarised and discussed below. Survey methodologies and complete results are presented in annex 9.

4.7.3 Scavenging at Vingunguti disposal site

a. The Scavenging System

There are two main places at the Vingunguti disposal site where recyclable materials are removed from waste brought for disposal:

- Most scavenging takes place within the disposal site at the working face, immediately after refuse vehicles have discharged their loads.
- Some refuse truck crews, particularly those of Multinet, partially sort the waste collected on loading, putting recyclable materials (especially boxes) aside. On arrival at the disposal site, they stop near the entrance to offload these materials to waiting scavengers/middlemen.

Almost all scavengers work individually and it is estimated that at least 90% of them sell the materials they collect to middlemen, living nearby at Vingunguti. Some middlemen purchase recycled materials at the disposal site and then transport them to their homes by handcart. Most middlemen however operate from their homes and scavengers bringing materials to them. The materials are stored here and later sold.

[10] Before such a fund is established, full investigation of current sources of funding for recycling initiatives within DSM should be made.

The remaining 10% of scavengers sell collected items directly to individuals at Vingunguti or to individuals/middlemen at other places or use the items themselves. For example, one scavenger uses pieces of sacks, cloth, sponge, etc. to make mattresses. Another collects metal scraps and uses them to make charcoal stoves.

b. Number of Permanent Scavengers

This was determined from the Scavenger Attendance survey, conducted over a 7 day period at the start of the dry season (June 18-24, 1996) with scavenger attendance being recorded three times per day. A total of 294 different scavengers (240 male, 54 female) were recorded during this time, many of whom were part-time scavengers (e.g. 98 people were recorded only once). The average attendance was 60, 41 and 33 during the morning, afternoon and evening respectively. The average overall attendance, corresponding to the average number of scavengers present throughout the whole day (i.e. permanent scavengers) was 45 (estimated error of +/-10%).

During the long rainy season (April - May), DCC staff estimate that the number of scavengers drops by around 20-30%.

c. Scavenger Organisation and Working Conditions

Scavenging within the Vingunguti disposal site is not officially permitted. However, DCC does not discourage nor prevent scavenging here, except that children seen scavenging are chased away. A small number of scavengers even live on the disposal site in makeshift huts, mainly during the dry season.

There is no formal organisation representing the scavengers at Vingunguti. Furthermore, according to DCC staff, scavengers here have little contact with scavengers working in other parts of the city.

In SIS, interviews were held with thirty permanent scavengers at this site. All but three interviewees were male and 80% are aged between 20-39 years. All of them stated that scavenging was their only job; they work for themselves and spend more than 25 days per month scavenging.

Most scavengers have been engaged in this work for a long period with 60% and 17% having worked as scavengers for 6-12 years and over 12 years respectively. It should be noted that the disposal site at Vingunguti has only been in use since 1991-92 so presumably longer term scavengers had been working at the former disposal site at Tabata before this.

Monthly incomes are low, ranging from Tsh 5,000/- - 22,000/-; the average being 11,500/-, compared with the official minimum monthly salary of Tsh 30,000/-.

The working conditions are poor. Scavengers are working close to refuse vehicles and the bulldozer and there are no proper protection measures against dangerous and hazardous waste. The major problems listed by scavengers were risk of injury (67%), lack of working tools (63%) and lack of clean drinking water (47%).

Scavenging is also seen as a low status job and many scavengers talked of being ashamed of doing such work.

d. Middleman Organisation and Working Conditions

In MIS, interviews were held with eleven middlemen operating in the immediate vicinity of Vingunguti disposal site. Seven of the interviewees were male and four female. This is a full-time job for eight of them and they all work for themselves. However, there are nine middlemen (seven of whom were interviewed) dealing with paper who cooperate in the collection of paper (but not transportation and sale).

Seven of the interviewees have been engaged in this type of work for less than three years, one for 3-6 years, one for 6-9 years and two for over 12 years. Thus, most of the middlemen started such activities after the disposal site was shifted to Vingunguti.

Their incomes range from Tsh 15,000 to 65,000 per month; the average income being 27,300 per month, slightly lower than the official minimum monthly salary of 30,000.

Seven middlemen, especially those dealing with paper, require a truck for transporting the materials collected to their customers. At least four use casual labour for various tasks, particularly weighing and sorting. Cleaning, baling and transporting operations are also carried out by some middlemen. One has a milling machine which is used to grind food leftovers to make feed for his livestock.

Eight of the middlemen sell directly to factories; one to a large scale metal scrap dealer and two sell directly to small workshops. Individuals also buy some items from middlemen, particularly sacks and wood.

Their main problems were lack of capital, lack of adequate storage facilities and lack of stable markets, especially for paper and metal (cans/tins and other).

e. Range of Materials Collected

The main materials collected by scavengers and purchased by middlemen are metals (cans/tins and other), glass and plastic bottles, paper (mainly boxes), sacks and wooden materials. Food leftovers, husks and sawdust are dumped less frequently but often in relatively large quantities. Very small quantities of glass (excluding bottles), paint, textiles, plastic sheets, vehicle tyres and wire mesh are collected. There is a large demand for all materials collected.

f. Total Amount of Recyclable Materials collected

Estimates of the total amounts of different recyclable materials collected daily from Vingunguti disposal site were made from the SIS, MIS and SWAS results and are presented in Table 4-14. The average quantity for each item was calculated and summed to get the total amount recycled of 2.1 t/d, equivalent to a scavenger productivity of 46.6 kg/scavenger/d.

Table 4-14: Estimation of Amounts of Different Items Collected

Unit: kg/d

Item	bo	ct	fo	hu	me	pa	pl	pt	sa	ty	wo	oth	Total
SIS	87	132	---	200	162	1256	62	6	126	15	147	---	2193
MIS	---	120	83	---	433	1765	(4)	---	(9)	---	117	41	2572
SWAS	76	165	5	75	136	233	36	34	17	7	260	29	1073
Avg.	82	139	44	138	244	1086	49	20	72	11	175	35	2095

Note: 1 Items in brackets are excluded from calculation of average amounts.
2. bo = glass bottle; ct = cans/tins; fo = food leftovers; hu = cereal/rice husks; me = other metal; pa = paper; pl = plastic; pt = paint; sa = sack; ty = tyre; wo = wood; oth = other.
3. Scavenger productivity is calculated as (total quantity)/(number of permanent scavengers)

g. Buying and Selling Prices

The buying (past and present) and selling prices of the main items collected are shown in Table 4-15. The middlemens` markup ranges from 33 - 150%.

Table 4-15: Buying and Selling Prices of Recyclable Materials

Source: SIS, DCC disposal site staff, MIS

Date	Middlemens' Buying Prices (Tsh) (= Scavengers' selling prices)						
	cans/tins	glass bottles	other metal	paper (boxes)	plastic bottles	sacks	wood
Unit	ea.	ea.	kg	kg	ea.	ea.	kg
up to 31/12/95	2/-	3/-	5/-	5/-	2/-	20/-	
from 15/5/96	3/- (or 150-200/kg)	10/-	10/-	15/-	3/-	50/-	20/-
	Middlemens' Selling prices						
from 15/5/96	4/- (or 200-250/kg)	not stated	15-25/-	25/-	6/-	100/-	~ 40/-
Markup	33%	---	50-150%	67%	100%	100%	100%

Notes:
1. buying price for plastic bottles varies with the bottle size and is 3/-, 5/- or 10/- ea. This also applies to tins. Beer cans and small tins are bought for 3/- ea.; larger tins for 15/- or more. The price of large and small sacks also differs, being 50/- and 20/- ea. respectively.
2. approximate buying prices for some other items are: cereal/rice husks: 20/- per kg; paint: 100/- per kg and tyres: 20/- per kg.
3. Other items collected (plastic sheets, sawdust, textiles and wire mesh) have no fixed price, being sold by scavengers for whatever amount can be obtained.

4.7.4 Scavenging at Other Places

Large numbers of scavengers operate in many other places around the city, particularly at illegal dumping sites but also from discharge points. In annex 8 (also see section 4.4.1), it has been estimated that 217 and 67 scavengers collect waste from illegal dumping sites and discharge points respectively.

In SIS, interviews were held with thirteen such scavengers, all of whom were male. Eleven collect waste from illegal dumping sites and two from discharge points in the city centre. Twelve work for themselves and scavenging was the only job for seven of them. This type of scavenging seems to be more of a part-time activity than at Vingunguti with seven scavengers working less than 10 days per month. Eight have been doing this work for less than 3 years, three for 3-6 years, one for 6-9 years and one for over 12 years. The monthly income range is much higher than that of scavengers at

Vingunguti, ranging from Tsh 10,000- - 70,000/-; the average being 27,800/- per month, slightly less than the official minimum monthly salary of 30,000/-.

The most common materials collected are metals (cans/tins and other), glass bottles, paper (boxes) and wood. There is a large demand for most of the items sorted and they are sold to a wide variety of places: individuals, middlemen, shops, micro-industries and factories. The selling prices are similar to those at Vingunguti, although the price range is much wider and tends towards higher values than at Vingunguti.

The total amounts of different types of recyclable materials was not estimated using the SIS data as the sample size was too small. Instead, it was estimated using a different method (see annex 8) to be 10.1 t/d and 3.1 t/d from illegal dumping sites and discharge points respectively. However, scavenger productivity was calculated from the SIS data to be 54.8 kg/scavenger/d, slightly higher than at Vingunguti.

The common problems experienced by these scavengers are lack of suitable recylcable materials, lack of equipment (gloves, etc.) and walking long distances.

4.7.5 Summary

Scavenging in DSM operates informally and without active support or encouragement from DCC. Nevertheless, a large number of scavengers are involved in this activity, at the Vingunguti disposal site (45) and at other places around the city (~284). They collect a large range of recyclable materials, particularly metals (cans/tins and other), glass and plastic bottles, paper (mainly boxes), sacks and wooden materials.

Scavenging also involves indirectly a large number of small and medium scale middlemen, who purchase goods from many scavengers. These middlemen and some scavengers themselves sell the recyclable materials to individuals, shops, markets, micro-enterprises and factories for reuse and/or recycling. Thus, scavengers are contributing to a reduction in the final disposal and illegal dumping amounts through the recycling of reusable materials (resource recovery).

The majority of scavengers interviewed have been engaged in this work for more than 6 years. It is a low status occupation and incomes are generally low, with scavengers at Vingunguti earning significantly less than the minimum monthly salary of Tsh 30,000/-. Working conditions are poor and dangerous.

4.8 Survey on Private Collectors

A survey of private SWM contractors was made primarily through interviews with DCC, Multinet and Mazingira staff, together with the collection of some written documentation from these sources, especially DCC. The results of this survey are summarised in Table 4-16.

Table 4-16: Private Contractors Survey Summary

Type of Collector	Generation Sources					
	Residential	Commercial	Institutional	Market	Health facilities	Other
Private Contractors	1	1	1	1	1	1
CBOs[11]	2,3	2,3	2	2	2	2
Individual Operators	2,4	2,4	--	4	--	4

Note: 1 = waste collection under DCC contract including collection of the refuse collection charge (RCC)
2 = voluntary waste collection (i.e. without collection of RCC)
3 = waste collection with illegal RCC
4 = illegal waste collection with illegal RCC

In Table 4-16, private contractors have been grouped into three categories, each of which are different in nature and mode of operation as elaborated on in the following sections.

4.8.1 Private Contractors

These are contractors which:

- operate legally under contract to DCC.
- are obliged to collect waste from the officially privatised areas which have been contracted to them.
- have authority under DCC by-laws to collect the refuse collection charge (RCC).

The advent of private contractors as defined above dates back three years to the initiation of the DCC privatisation programme. Under the first phase of this programme, only one company (Multinet Africa Ltd.) was contracted on a concession basis to operate refuse collection services in 10 city centre wards. The contractor was also responsible for street sweeping within the contracted area and for the collection of the RCC from customers. Multinet began operation in September 1994 but a number of disputes subsequently arose between DCC and Multinet, resulting in Multinet being forced to withdraw its operations from 5 wards in January 1996.

In May 1996, following revision of the original contract, the privatisation exercise entered its second phase in which privatisation of refuse collection was expanded to cover more wards and some markets in the city. Under Phase II, five companies were granted contracts to service various wards and markets as indicated in .

Table 4-17: Phase II: Contractors and Contracted Areas

Name of Contractor	Wards/Markets Serviced
Multinet Africa Ltd.	Mchafukoge, Kivukoni, Kisutu, Upanga East, Upanga West, Jangwani, Gerezani, Kariakoo, Ilala, Mchikichini wards
Mazingira (1994) Environmental Protection Ltd.	Msasani, Kawe, Kinondoni, Mwananyamala, Manzese, Tandale wards
Kamp Enterprises	Ubungo and Kagera markets
Allyson Traders	Magomeni, Ndugumbi, Mzimuni
Kimangele Enterprises	Temeke, Magurumbasi and Keko markets

[11] CBO = Community Based Organisation

Multinet remained the major private contractor and was allocated ten wards in total, including the five previously withdrawn wards. It resumed operation in these wards towards the end of July 1996. However, four months later in November 1996, it withdrew operations again from the same five wards (Jangwani, Gerezani, Kariakoo, Ilala and Mchikichini) citing unwillingness of the residents of these wards to pay the RCC as the main reason.

A second company, Mazingira (1994) Environmental Protection Co., was allocated 6 wards - Msasani, Kawe, Kinondoni, Mwananyamala, Manzese and Tandale - and started collecting refuse in these wards in August 1996. However, Mazingira is presently only providing refuse collection services on a point by point basis to the commercial sector within these wards.

Both of the two private contractors currently operating collect waste from all generation sources listed in Table 4-16 and dispose of it at Vingunguti disposal site.

4.8.2 CBOs

There are a few Community Based Organisations (CBOs) which are fulfilling a need in DSM by providing some form of refuse collection services at a local community level in certain areas within the city, particularly those not serviced by DCC or the private contractors listed in section 13.1 above.

These include Kinondoni Moscow Women's Association operating in the Hana Nasifu area and POCA. CBOs such as these primarily collect refuse from households and commercial enterprises on a regular basis.

There are also a number of other small "self-help" type organisations which have been loosely categorised as CBOs here. Their activities include carrying out environmental cleanliness operations, including the removal of solid waste, on an infrequent voluntary basis in a particular locality such as from an institution (e.g. school), market and even health facility. Tanzania Environmental Cleanliness Association (TECA) is one such association and their members were pictured cleaning up Uhuru Girls Primary School in the June 19, 1996 issue of the *Daily News*.

There are primarily two motivating factors for CBOs to be involved in refuse collection:

- improving the cleanliness of the local environment, thus motivating other members of their community to care for the environment and to keep their community clean.
- to collect some revenue in return for providing a refuse collection service which can then be used to support their operations or other activities within the community.

These organisations have few links with DCC, meaning cooperation between DCC and CBOs is often minimal. Some of their activities may conflict with DCC policy and possibly even with the law. Furthermore, their concerns are primarily focused on their target communities and the immediate locality. This can create some problems, one example of this in the context of refuse collection being the issue of final disposal of the waste collected by CBOs. Transportation of the waste to Vingunguti disposal site either by the CBO itself or through arrangement with DCC or a private contractor would

greatly reduce the profitability of a refuse collection service for the CBO. Hence, many CBOs choose to illegally dump the collected waste in relatively close proximity to the communities they serve, thus increasing the amount of illegally dumped waste in the city.

Another issue concerns the acceptance of CBO activities by the communities in which they operate. Some members of these communities do raise questions about certain CBO activities, especially when it comes to the issue of payment and the level of service charges. This is primarily because there is neither an authority informing them nor regulation requiring community members to pay CBOs any service charges.

4.8.3 Individual Operators

Individual operators consists of many contractors, most of whom are self-employed. They operate in all parts of the city and use various methods for the removal of waste including transporting it on foot in baskets on their heads, using bicycles or handcarts.

They are fulfilling a need in the city by providing refuse collection services throughout the city, particularly in areas where there is no refuse collection system or refuse collection is inadequate. The services provided by these contractors are well utilised by the public, especially households, shops, restaurants and hotels. Generally, health facilities and institutions do not use such services. The main reason for their popularity are that such services are normally cheap and readily available and in many areas of the city there is no other alternative.

However, these contractors are regarded as illegal operators and DCC is actively trying to minimise the scale of their operations. This is primarily because they seldom dump the waste collected at Vingunguti disposal site. Instead, the collected waste is dumped anywhere, usually within a 500-1,000 m radius of the area from which it is collected. Typical dumping places include near electrical pylons, at junctions/roundabouts, in open spaces, etc. Hence, these contractors are increasing the amount of illegally dumped waste in the city.

4.8.4 Summary

Multinet and Environmental Protection Co. are considered to be providing an acceptable refuse collection service as they currently collect waste and dispose of it in a legal manner; that is, by dumping at the Vingunguti disposal site. However, both companies experience serious problems with the collection of the RCC, especially from residents in the wards serviced.

Conversely, CBOs and individual operators are not considered to be providing an acceptable refuse collection service as although they are fulfilling a need for refuse collection in many parts of the city, most CBOs and virtually all individual operators subsequently dispose of this waste in an illegal manner.

However, it is acknowledged that CBOs and individual operators do provide a useful collection service, particularly in areas of the city not easily accessible to vehicles. There is considerable potential for utilising such organisations and individual operators in community based refuse collection systems which could link such methods of refuse collection with DCC or private contractors' vehicles to ensure that the waste collected is subsequently disposed of in a legal manner.

4.9 Installation and Operation of a Weighbridge

In order to obtain the current waste disposal amount at the Vingunguti disposal site, a electronic load cell type weighbridge was installed at the corner of Nyerere road and Vingunguti road. Figure 4-4 shows the general plan for the weighbridge installed.

The specification of weighbridge is as follows.

1) Avery Berkel J314 Road Vehicle Weighbridge. Non-self contained modular steel weighbridge for surface mounting. Can also be pit mounted if required. Complete with two steel modules. Incorporating Avery 8701, 100,000lb capacity compression load cells, with 25m integral cables. Platform size 12m x 3m. Capacity 50,000kg x 10kg.

2) Avery Berkel L205 Digital Weighbridge Indicator System. Advanced microprocessor based industrial weighbridge system. Featuring a unique alpha - numeric keyboard. With lightening protection.

3) Avery Berkel K200 Ticket Printer. Free standing microprocessor controlled dot matrix ticket printer. Ticket size 210mm.

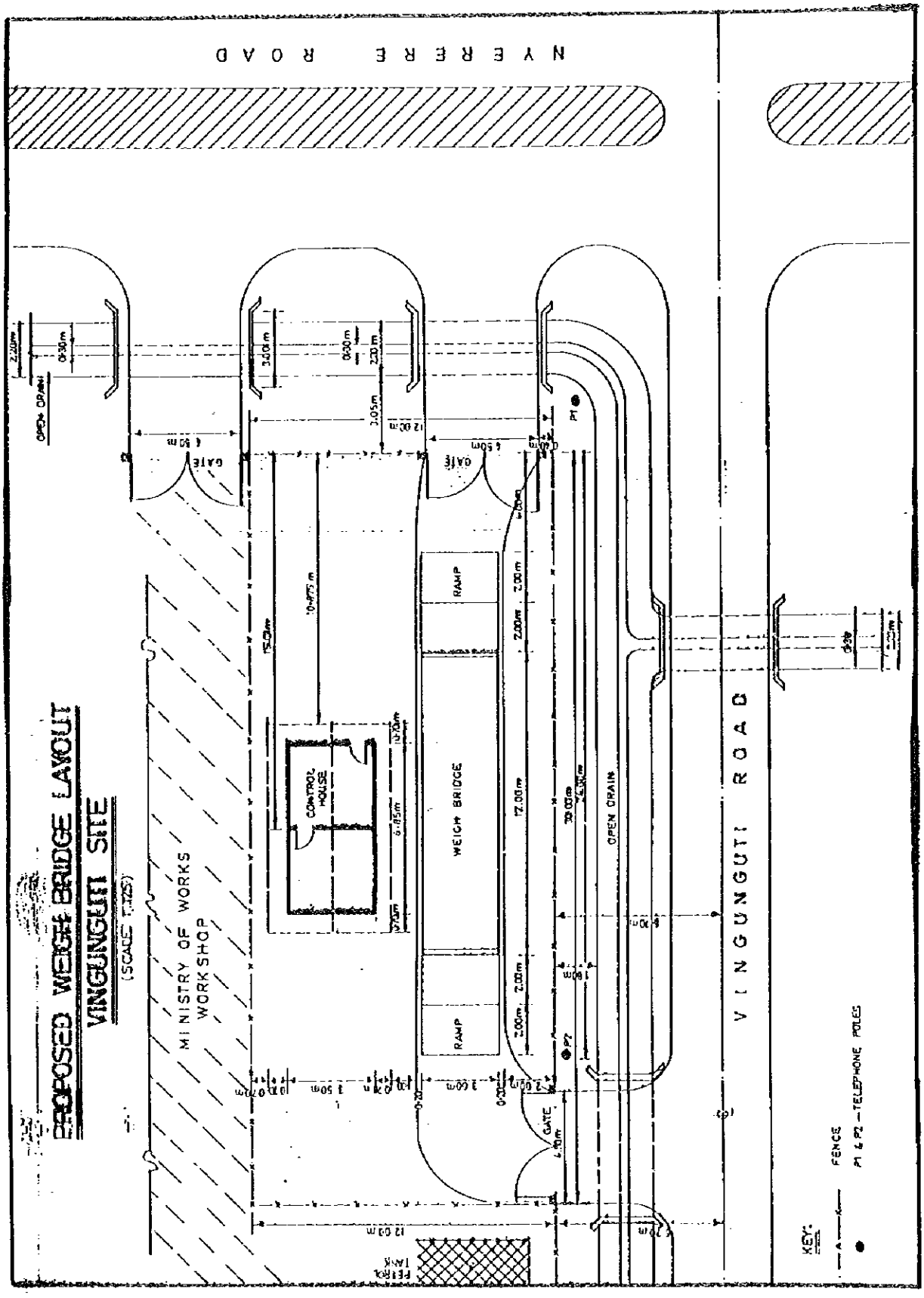


Figure 4-4: General Plan of Vingunguti Weighbridge