Chapter 3

Assessment of Current Urban Environment

3 Assessment of Current Urban Environment Sanitation

3.1 Environmental Measurement Surveys

In order to assess the current environmental and sanitary conditions and to identify issues concerning UES in Dar es Salaam City, measurement surveys and data collection works were conducted. The quantitative surveys consist of the water quality survey, ambient survey, noise, vibration and traffic survey, and soil contamination survey. The data obtained and these analyses is included in the data book.

3.1.1 Water Quality Survey in Rainy and Dry Seasons

Water was sampled at weekly intervals for the water quality analysis from 24th April 1996 to 9th July 1996. Water sampling points were as follows.

W1:	Msimbazi river	area upstream of the Vingunguti disposal site
W2:	Msimbazi river	at the crossing with Nelson Mandela Road
W3:	Msimbazi river	at the crossing with Kigogo Road
W4:	Msimbazi river	at the crossing with Morogoro Road
W5:	Leachate	at the Vingunguti disposal site
W6:	Groundwater	at a well near the Vingunguti disposal site which is suspected of leachate contamination
W7:	Groundwater	at a well a little distance from the Vingunguti disposal site which is not suspected to be contaminated

Analyses were carried out according to two categories.

Analysis items for category "A" were air temperature, water temperature, chromatility, turbidity, pH, electric conductivity, DO, COD, BOD, SS, faecal coliforms, T-N, T-P. Analysis items for category "B" were Fe, Mn, Cl^-, SO_4^{2-}, all Cr, Cr^{6+}, Cd, Pb, CN^-, tetrachloroethylene, trichloroethylene, 1-1-1 trichloroethane. In addition, air and water temperature at the time of sampling were measured and recorded, together with weather conditions. Tetrachloroethylene, trichloroethylene, 1-1-1 trichloroethane were analysed using analysis kits which was brought from Japan by the study team.

Items in category A were analysed once a week for 12 weeks and items of category B were analysed once every two weeks for 12 weeks. All data are included in the data book.

3.1.2 Ambient Survey in Rainy Season

The ambient survey was conducted from 13th May 1996 to 14th July 1996. Survey points were as follows.

A1:	at the intersection of Samora Avenue and Maktaba Road
A2:	at the intersection of Nyerere Road and Nelson Mandela Road
A3:	at the intersection of Bagamoyo Road and Morocco Road
A4:	at the intersection of Nelson Mandela Road and Morogoro Road
A5:	at Vingunguti Road to Vingunguti disposal site

Air temperature, humidity, wind direction, wind velocity, SO_2, NO_X, and CO were measured at each point. All items were measured hourly from 7 am until 7 pm for one week at each of the five points by using gas detector tubes for SO_2, NO_X, and CO which was brought from Japan by the study team. All data are included in Data Book.

3.1.3 Noise, Vibration and Traffic Volume Survey

The noise, vibration and traffic volume surveys were conducted from 13th May 1996 16th June 1996 together with the ambient survey. Survey points were the same as the ambient survey points. During the noise, vibration and traffic volume surveys, hourly weather, type of pavement, shape of the intersection, number of lanes, type of signal, etc. were recorded.

a. Noise survey

Noise levels were measured every second for ten minutes hourly from 7 am until 7 pm for one week at each of the five points with a noise level meter. Noise levels corresponding to 95 %, 50 % and 5 % probabilities of occurring (i.e. L_{95}, L_{50} and L_5) were obtained from this data by calculation.

b. Vibration survey

Vibration levels were measured every second for ten minutes hourly from 7 am until 7 pm for one week at each of the five points with a vibration level meter. Vibration levels corresponding to 10 % and 50 % probabilities of occurring (L_{10} and L_{50}) were obtained from this data by calculation.

c. Traffic volume survey

The number of vehicles which pass all roads at the intersection were measured and recorded hourly from 7 am until 7 pm for one week at each of the five points. The categories of vehicles for counting were large vehicles, small vehicles, motorbikes and refuse trucks.

At the intersections, the total number of vehicles passing all intersected roads were counted. The number of vehicles counted were aggregated hourly and also for ten minutes hourly.

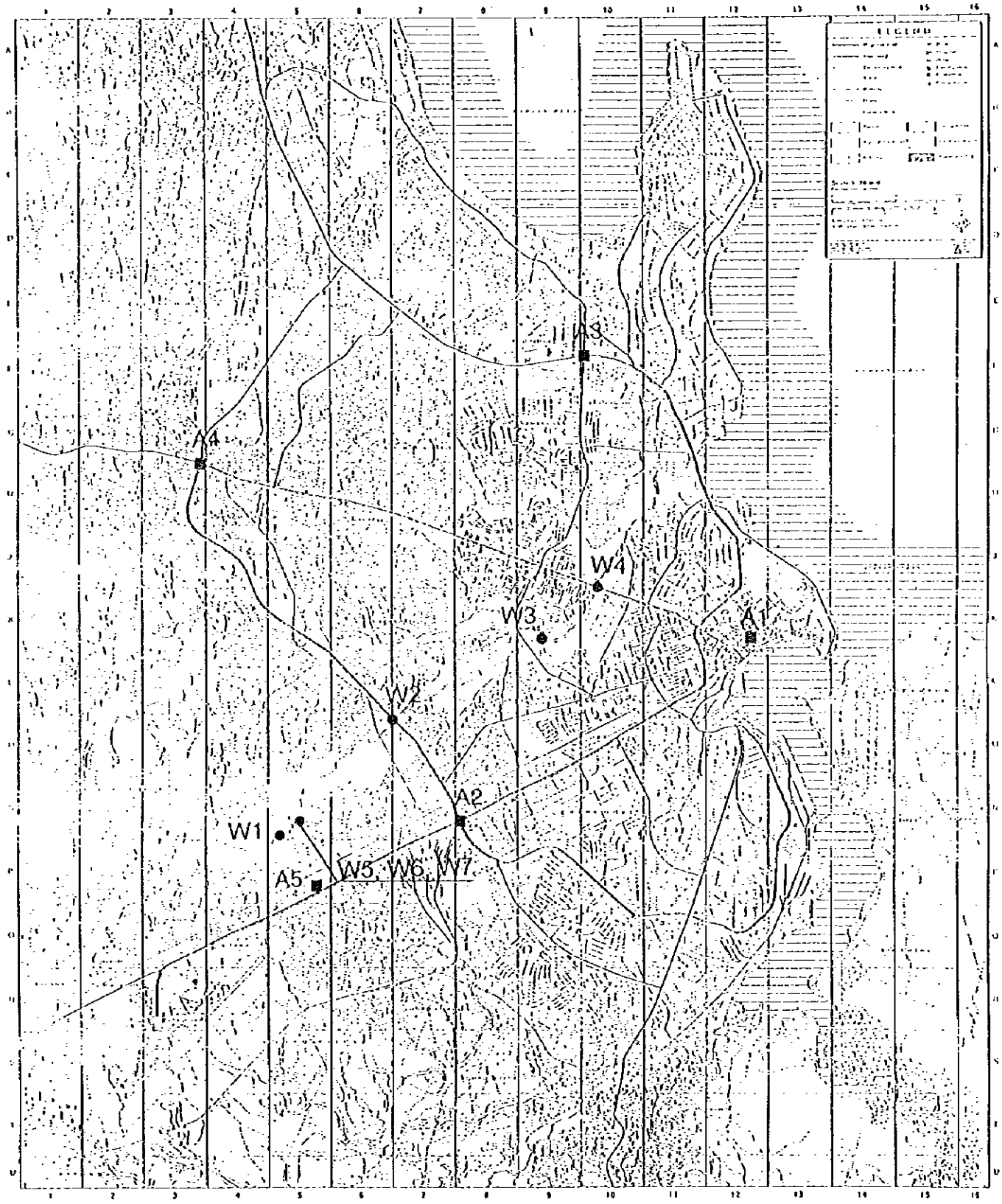

Figure 3-1: Location Map of Survey Points

3.1.4 Soil Contamination Survey

Four soil samples were taken from different points, described below, at the Vingunguti disposal site on 24th April 1996. One sample from each sampling point was analysed, the concentrations of Cd, Pb, all Cr, Cr^{6+}, CN^-, Cu, Zn, Fe, and Mn being measured by elution analysis.

S1: at the ground near the Vingunguti disposal site
S2: at the ground near the Vingunguti disposal site but which is unlikely to be affected
S3: at the river bed of the Msimbazi River on the upstream side of the Vingunguti disposal site
S4: at the river bed of the Msimbazi River on the downstream side of the Vingunguti disposal site

The soil samples were dried overnight in an oven kept at 32 °C. The dried samples were then ground mechanically and sieved (200 mesh size). 5 g of each sample was placed in an Erlenmeyer flask. 20 ml of extracting solution was then added, and the flask was placed in a mechanical shaker for 15 minutes. The solution was filtered through Whatman no.42 filter paper into a 50 ml volumetric flask and diluted to 50 ml with extracting solution. The extracted solution was tested for different metallic ions using an atomic absorption spectrophotometer (Perkin - Elmer Model 2380). The following table shows the wave lengths and slit widths used during the analysis.

Metal ion	Wavelength (mm)	Slit width (mm)
Cr	357.9	0.7
Pb	283.3	0.7
Cd	228.8	0.7
Mn	279.5	0.2
Fe	248.3	0.2
Zn	213.9	0.7
Cu	324.7	0.7
CN	578.0	0.7

Table 3-1: Soil Analysis Data

Parameter	Units	Sampling Points			
		S1	S2	S3	S4
Cadmium (Cd)	mg/kg	0.143	0.176	0.143	0.256
Lead (Pb)	mg/kg	1.410	1.594	2.25	2.952
All Chromium (Cr)	mg/kg	0.002	0.06	0.150	0.384
Chromium (Cr^{6+})	mg/kg	0.001	0.04	0.08	0.200
Cyanide (CN)	mg/kg	2.181	0.423	0.732	0.312
Zinc (Zn)	mg/kg	1.721	2.289	1.721	5.819
Iron (Fe)	mg/kg	96.04	114.24	143.68	288.707
Magnesese (Mn)	mg/kg	15.03	56.912	45.83	72.73

3.2 Survey on Public Services Conditions related to UES

Various public services and infrastructure are closely related to UES. This section focuses on describing the status of relevant services such as water supply, sewerage, solid waste management, drainage and flood control, roads and markets.

3.2.1 Water Supply

The percentage of households obtaining water as a primary source are as follows[1].

Piped connection to house:	22 %
Communal tap:	16 %
Vendor or truck:	14 %
Well or stream :	6 %
Tap inside plot:	22 %
Collect water from neighbours plot:	20 %

The main sources of water supply for DSM are the Ruvu River and the Murale River. The Ruvu River is flowing from about 100 km west of DSM from the south to the north into the Indian Ocean at Bagamoyo. There are two water intakes to water purification plants along the Ruvu River; one is extracting 184 MLD, the other 85 MLD[2]. The third water extraction point is from the Murale river at Mutoni and supplies only 4.5 MLD. The water is treated by a combination of sedimentation, chemical addition, filtration and disinfection. This treatment process aims to produce water, the quality of which satisfies the Tanzanian Temporary Standards established by the Royal Water Health Standards Committee in 1974, derived from WHO standards for the physical and chemical quality of potable water. The water is pumped from the Ruvu sources to the main reservoirs at University Hill and Kimara whilst for the Mtoni supply it is pumped directly into the distribution system which comprises of between 750 and 1,400 mm diameter water mains which supply two pressure zones.

Other sources of water for residents include many shallow wells and more than 50 deep wells distributed across the city which are used primarily as dry season emergency supplies. However, most wells suffer from high salinity and groundwater pollution from pit latrines.

Most water distribution pipes are aged, being laid before the 1970s and the trunk pipes are too small. Pipes are often found to be silted up and also there are many illegal connections observed. Water vendors sometimes break a distribution pipe to collect water. Hence the water leakage rate is estimated to be 40 %.

Water supply in DSM is managed by the Dar es Salaam Branch of the National Urban Water Authority (NUWA) which is responsible to the Ministry of Water, Energy and Minerals. The rural water supply section in the City Regional Offices is responsible for rural ground water supplies in the peripheral areas. DCC has a water department for village water supply as well.

A Water Master Plan was produced for the City in 1980. However a large proportion of the master plan has not been implemented due to lack of finance.

[1] The Urban Housing Sector, An Analysis of the Urban Housing Survey, DSM, 1990
[2] Environmental Profile of the Metropolitan Area, SDP, 1992

COWIconsult estimated 1992 production figures for the City to be 295 million litres per day (MLD). With 95 MLD trunk transmission loss and leakage, the 200 MLD net supply leaves 114 MLD after 70 MLD distribution leakage, and 16 MLD are consumed by the commercial, industrial and institutional sectors. Based on the estimated 1996 urban population of 2.3 million this gives a consumption figure of some 50 l/cap/day, which suggests that improvements in the distribution system to reduce leakage could meet today's demand, although additional source development is necessary for future city needs.

As a result, large areas of the City rely on supplementary tanker services to provide them with water, while poorer households increasingly use polluted well and surface water sources with associated health problems. Extensive rehabilitation and expansion of the water supply system to cope with present and anticipated demands will however, require the extension of and a greater commitment to cost recovery methods.

3.2.2 Domestic Liquid Waste Management (LWM)

There are three types of LWM systems commonly being used in DSM; they are

i. sewerage system,
ii. septic tank + cesspit system, and
iii. pit latrine.

These systems are described in Table 3-2.

Table 3-2: Types of Domestic LWM in DSM

	System of LWM	Facilities used	Household distribution	Remarks on final treatment
1	Sewerage +cesspit system	Flush toilet Sewer	6 %	• waste is transported to oxidation ponds for final discharge into sea • direct discharge into sea(from city centre)
2	Septic tank system	Septic tank with cesspit	9.9 %	waste is treated on site anaerobically and either soaks into ground or is emptied to dispose nearby or is transported to oxidation pond.
3	Pit latrine system	Pit latrine	83.1 %	waste is treated on site and either soaks into ground or is emptied to dispose nearby or is transported to oxidation pond

Source: Population Census in 1988

It should be noted that many residents who use facilities that utilise water have erected latrines also for emergency use due to the unreliability of the water supply.

a. Sewerage System

a.1 Background

The 130 km of sewer grouped in 11 networks systems and supported by 17 pumping stations which were constructed in the late 1950s, during the colonial era, covers the city centre, the Ubungo and Vingunguti industrial areas, and a few outlying residential areas. The sewerage system has been largely unchanged since then. The facilities were rehabilitated and upgraded under the World bank financed DSM Sewerage and Sanitation Project(1980-1988) Stage I.

However, the Stage II Project has not yet been implemented although detailed design and tender documents have been prepared.

The population served is estimated to be 100,000 people. Hence the percentage served by sewers is therefore decreasing due to rapid population growth of DSM city.

a.2 Sewage Treatment

The collected sewage is being discharged into oxidation ponds and directed to the ocean. According to DSSD, about 25 % of the untreated industrial effluent is also discharged directly to the sewer pipes and about 75% to storm drainage systems without treatment in the premises of industries.

Out of 8 oxidation ponds for treatment of liquid waste in DSM, 4 are in operation including DSM university used exclusively, 1 is closed, 3 are in no condition for use.

For operational and climatic reasons the most suitable treatment for DSM sewage is oxidation/stabilisation ponds which, although requiring large tracts of land are comparatively cheap and is appropriate technologically. However, some of the primary oxidation ponds have not been emptied for some time and are filled with sludge.

Table 3-3: Location of Oxidation Ponds and Dumping Stations in DSM

Location	Responsible body	Condition	Remarks
Ukonga Air force	Air force	closed	-due to problems -for air force officers' estate
University of DSM	University of DSM	operating	-exclusively for DSM university
Kurasini	DSSD	operating	-for domestic liquid waste covering residential and harbour commercial area.
Mabibo	DSSD	closed	-closed for about 3 years due to maintenance problems. -previously used for domestic liquid waste covering Morogoro Road commercial area and housing estates
Mikocheni	DSSD	operating	-for domestic liquid waste covering Bagamoyo Road residential area and commercial areas -restricted operation because of too near location to the residential area -receiving industrial liquid waste
Rugalo Military camp	DSSD	closed	-for military camp -oxidation pond is working - no dumping station
Vinguguti	DSSD	operating	-for domestic liquid waste covering (Part of) the Pugu Road commercial area -receiving industrial liquid waste
Gerezani*	DSSD	closed	-used to serve (part of) the Pugu Road commercial area before Vinguguti oxidation pond started to operate
Screen House**	DSSD		City centre area

Note:

* Gerezani is a dumping station without function of oxidation pond.

** Screen house is not an oxidation pond, which is occasionally used as a dumping station located at end station of the City Centre sewer, before feeding into the sea outfall.

b. Septic Tank System

Many housing estates (institutional, employers'), social housing complexes (National Housing Corporation NHC) and some individual commercial and residential plots in planned areas are equipped with septic tanks for flush toilets.

This septic tank system comprises of a flush toilet connected to a impermeable settling tank where wastes are carried away by flushing down a short drain. The septic tank only helps to separate and digest the solid matter, and the liquid effluent flows out of the tank to be disposed of either in a soakage pit or cesspit depending on the nature of the ground water table of the area concerned.

A soakage cesspit receives effluent from septic tanks or wastewater from ablution purposes. It has no actual outlet but is permeable in many cases and is often constructed with porous materials in an area with permeable soil layer that allows waste water to soak away into the ground from the pit.

In the case of DSM city, some areas have a high groundwater table especially during rainy season and soakage cesspits should not be used in this case because ground water tends to enter the cesspit instead of soaking away so that frequent emptying is required.

c. Pit Latrine System

The pit latrine system is used by a big percentage (approximately 80 %) of the residents in the City and is common all over the Country. In its simplest form, it consists of a large hand dug pit 1 m wide, 2 m long and 3-4 m deep. Due to the sandy soil in DSM, the pit is commonly lined with Portland cement blocks or stones with mortar, covered with a squatting slab made of either timber or reinforced concrete and with a Portland cement floor finish. The latrine is always detached, typically located 12-20 m from the main house.

The shelter consists of either Portland cement block walls or screen walls only with a corrugated iron roof. In most of the unplanned settlements there is usually no roof.

The inputs are excreta plus cleaning agents; water is used by Muslims and people originating from the coastal area and other Muslim dominated areas. Banana and other leaves, grass, corncobs, paper, etc. are used by other people.

When the pit latrine is full there are two alternatives. Either, another pit is dug nearby and the waste is allowed to flow shifting from the latrine pit to the new pit by making a hole in the pit lining, or a vacuum cesspit emptying vehicle is requested from the proper servicing Authority to empty the latrine.

d. Cesspit Emptying

There are two common cesspit emptying methods in DSM; one is manual emptying; the other is by using a vacuum cesspit emptying truck. In DSM, only the liquid content without the base sludge in a cesspit or a cesspool is removed by cesspit emptying trucks due to their insufficient suction capacity.

d.1 Manual Cesspit Emptying

There are three manual methods:

i. digging another cesspit and backfilling the former pit.

ii. allowing sewage to flow shifting from the latrine pit to the new pit by making a hole in the pit lining.

iii. Manual Operated Pit Emptying services (MAPET) which are being encouraged by DSSD.

The second method is often used in areas near a stream because liquid waste can flow easily by gravity to the stream after the hole is made. This does pollute the stream however. There are specialists for this work in DSM who charge 3,000-4,000 Tsh per cesspit (1996), which is cheaper than hiring a vacuum cesspit emptying truck (5,000 Tsh in 1996).

d.2 Mechanical Cesspit emptying by Vacuum Trucks

Mechanical cesspit emptying services are operated on a commercial basis by the following three sectors:

2 public organisations

i. Dar es Salaam Sewerage and Sanitation Department (DSSD) in DCC

ii. Malaria Control Unit, Health Department in DCC.

They have a total of 24 trucks donated by the UK, Italy and Japan. 14 out of 24 trucks were in operation in February 1997.

12 parastatal companies

Each of the twelve parastatal companies has a cesspit emptying vacuum truck. Their services are limited within their own estate. All of these trucks are already old.

3 private companies

They started cesspit emptying services with a cesspit emptying vacuum truck in October 1996. All of these three trucks are quite old.

e. Responsible Organisations

The Directorate of Sewerage and Drainage in the Ministry of Water, Energy and Minerals (MWEM) is responsible for the overall design and construction of sewerage systems in the city.

DSSD of DCC which was an autonomous body, only relying on Central Government for basic salaries, was responsible for local connections. Funds for operation and maintenance came from revenues generated by charges for the different services providing by DSSD. Sewerage charges were being collected by NUWA for DSSD with water charges under a joint billing system. However, DAWASA has replaced NUWA and DSSD since February 1997.

The Directorate of Sewerage and Drainage of the MWEM, as well as the DSSD operate low cost sanitation units to upgrade on-site sanitation throughout the city through the use of ventilated improved pit (VIP) latrines but uptake to date has been limited.

The Ministry of Industry and Trade (MI&T), the National Environment Management Council (NEMC) and MWEM can sue water pollutants (under the Water Utilisation Act) and the Ministry of Agriculture, Livestock and Co-operatives is responsible for

and controls pesticide pollution of surface and groundwater systems and provides technical advice on pollution control.

f. Existing Problems

- Lack of a sufficient number of cesspit emptying trucks.
- Most cesspit emptying trucks are very old.
- Most of the DSM City areas have a high groundwater table.
- Most of the DSM City areas are susceptible to flooding because of inadequate proper drainage systems.
- Surface retained water and waste are breeding sources for flies, rats and mosquitoes, and results in the spread of diseases such as malaria, gastroenteritis, etc.
- Some areas, especially unplanned settlements, are not accessible to cesspit emptying trucks.
- Inadequate suction capacity of cesspit emptying trucks for removal of base sludge.
- Irregular supply of fuel for cesspit emptying trucks.
- Poor tyres and other truck accessories results in frequent punctures and breakdown.
- Emptying charges can not be afforded by most residents.

3.2.3 Solid Waste Management

a. Present Condition of SWM

a.1 Collection and Transportation

There are two major organisations and several small companies involved in waste collection.

DCC

DCC is collecting wastes mainly from about 20 markets and also 5 wards which it took over from Multinet in early 1996. The number of operational trucks varies from 4 to 15 trucks a day and greatly depends on the availability of diesel and spare parts and also on the weather as the workshop in the Mwananyamala depot does not function on rainy days due to limited shelter. The operational trucks are all 7 ton tipper trucks which were donated by the Government of Japan in 1987. All compactor trucks donated by the government of Italy are not operational. All of the operational trucks have exceeded their recommended working life, and therefore require very frequent repair.

The common method of loading waste at markets is by a wheel loader. In order to use the wheel loader effectively, waste is collected only when sufficient waste has accumulated, corresponding to 0.5-1 day's work for a wheel loader. This is one of the reasons why DCC can not collect waste at markets more frequently. When the detachable container trucks were operational, waste was collected frequently because

there was no neeed for a wheel loader. The condition of markets concerning waste is described in detail in Section 3.2.6 but it is appropriate to state here that almost all markets suffer from very irregular waste collection services, the collection frequency usually being about once a week and in some cases, once a month or even less.

Concerning residential waste collection services, although DCC withdrew Multinet's contract for waste collection from 5 wards, the collection frequency by DCC is now more irregular than when Multinet was operating in these wards and residents are unhappy with DCC's performance.

Multinet Africa

Multinet is using six 7 ton tipper trucks for refuse collection from 5 wards in the City centre. Multinet is collecting not only residential waste but also street waste and collecting refuse collection charges itself. To give responsibility for street waste collection to Multinet on a concession contract basis is unfair to a private company. Because these five wards are the most urbanised area in DSM, it is the most financially feasible area for a refuse collection service. Multinet uses a bell collection system and this works well. Multinet's trucks make on average, 4 trips per day.

a.2 Final Disposal

The final disposal site for all wastes generated in DSM is located in Vingunguti which is about 10 km west from the city centre and faces the Msimbazi River. In 1995 the watercourse was diverted and the slope was protected with a gabion mattress. The disposal site has no facilities at all, including fences, proper access road and any environmental protection facilities.

The disposal site is not operated as a sanitary landfill. Disposal is by open dumping only. DCC is directly operating the Vingunguti disposal site and there is one D6 bulldozer, 11 DCC staff and also about one hundred scavengers at the site. However, the bulldozer seldom works because lack of fuel. Soil cover is scarcely applied. When used, its prime purpose seems to be to maintain access to the landfill site rather than for environmental protection.

The site is unhygienic and an environmental nuisance to the residential areas near it. Many complaints concerning offensive odour, smoke, flies and mosquitoes caused by the site are received by DCC from local residents.

The access road, Vingunguti Road, from Nyerere Road to the site is not tarmaced and is inadequate for the large number of 7 ton trucks that pass. People often complain about dust, vibration, noise, etc. caused by the passing refuse trucks.

a.3 Privatisation

First Stage

A privatisation strategy was introduced in 1991. In September 1994 a private contractor, Multinet Africa, actually started operating refuse collection services for 10 wards in the City centre after enactment of an appropriate by-law. A concession type of contract was used, which gives the contractor the right to collect waste and to collect refuse collection charges from users in the wards served.

Multinet worked in the 10 wards until January 1996. After this, Multinet was forced to withdraw its operation from 5 wards because of many problems experienced between them and DCC.

Second Stage

In January 1996 the Prime Minister instructed DCC to clean up the city by the end of June because of the poor state of cleanliness in the City. Almost every day, SWM problems were mentioned in the mass media.

In response to this, DCC together with SDP and City Council members decided to expand the privatisation of waste collection to other wards because this was the only available option based on the existing resources. The five contractors selected in May.

a.4 Charge System

The Multinet refuse collection charge is currently set at 900 Tsh per house per month. DCC does not collect the refuse collection charge from residents as it is included in the Development levy paid by them.

DCC collects dumping fees at the Vinguguti disposal site. The rate is currently 800 Tsh per ton. As there were no equipment to weigh the waste dumped, the amount of waste was estimated by considering the capacity of each truck and its load.

b. Present Cleansing Condition in DSM

The waste collection rate in DSM 8.1% of the total waste generated in DSM. This rate is obviously too low to maintain the City in a clean condition. Therefore, heaps of refuse can be seen everywhere in DSM and almost all markets suffer from heaps of waste. The waste collection points in the markets are the only practical points for people to dispose of their wastes in the areas where residential waste collection services are not provided but such action is prohibited. The majority of residents have no waste collection services. Therefore they have to burn, bury, or dispose of their wastes somewhere. This behaviour is creating an environmental nuisance, made intolerable by the high population density area in DSM. Illegal dumping can be seen in many places in the city, especially along the roads and streams. On streets, there is much waste scattered ramdomly around due to the lack of a refuse bin. Some of this waste is generated by petty traders. These wastes block drains and cause floods in many places in the rainy season.

3.2.4 Drainage and Flood Control

The drainage system of DSM is in very poor condition and little attention has been paid to the provision and maintenance of drainage systems. The drainage system in DSM basically consists of storm drainage and road side drainage systems, as shown in Figure 3-3.

a. Storm drainage system

DSM is served by a storm drainage system consisting of major waterways, secondary waterways and a local drainage system. The existing rivers are utilised as major waterways with their tributaries regarded as secondary waterways.

Limited sections of urban areas are served by local drainage systems which are comprised of underground pipe sections fed by roadside channels and open ditches. Some of the sub-urban areas are served by local roadside ditches which have been constructed to drain runoff from adjacent areas. In other areas without drainage systems which dominate in DSM, runoff water is left to run along the ground, and is soaked into the ground or collects as surface water, sometimes flooding areas.

Although rehabilitation and emergency maintenance works for storm water, sewage and sanitation were planned by the Ministry of Lands, Natural Resources and Tourism in 1984, this project has not been implemented yet due to financial constraints. This plan mainly aimed at the rehabilitation and maintenance of the existing storm drainage systems but not the construction of new storm drainage systems.

b. Roadside drainage system

The roadside drainage system of trunk and regional roads located in urban areas such as the Central City area, Kariakoo, Chang'ombe, Ilala and Oysterbay, are generally served properly by lined channels and an underground pipe system. The major roads outside the urban areas are served by drainage ditches along the roads which are usually grass-lined and occasionally concrete or rip-rapped.

No apparent drainage system is found in most of the regional and district roads in rural areas. Surface water on these roads is either absorbed into the ground, or collects in ponds from where it slowly percolates into the ground and/or is evaporated.

The roadside drainage system in urban areas is generally in poor condition due to lack of maintenance work. Surface water on the roads is normally collected by ditches and discharged through a drainage pipe system. Most drainage pipes laid under the carriageways are not working due to blockage by soil and debris. These are supposed to be cleaned during routine maintenance operation.

Figure 3-3 shows the location of flooded areas.

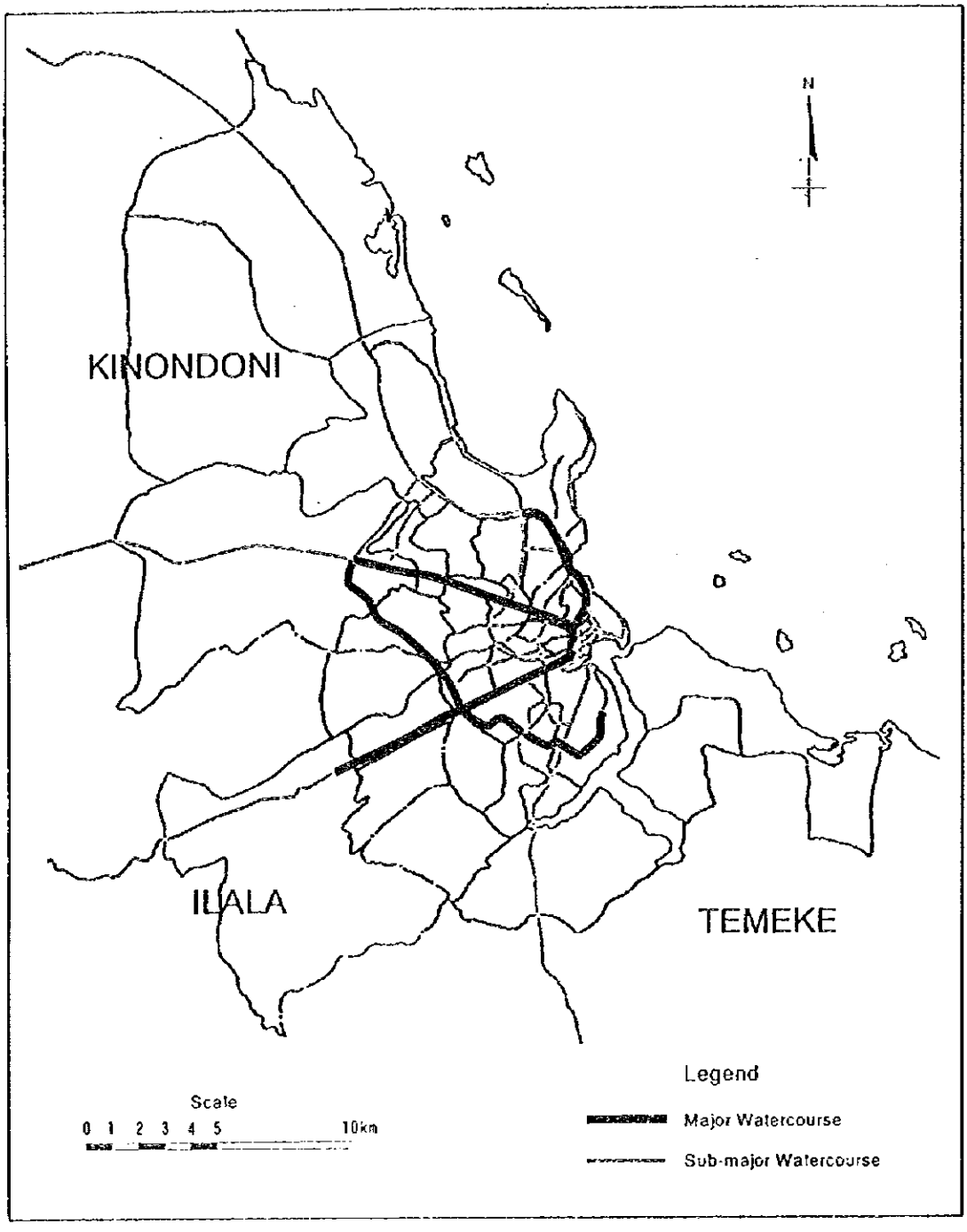

Figure 3-2: Drainage Network of DSM

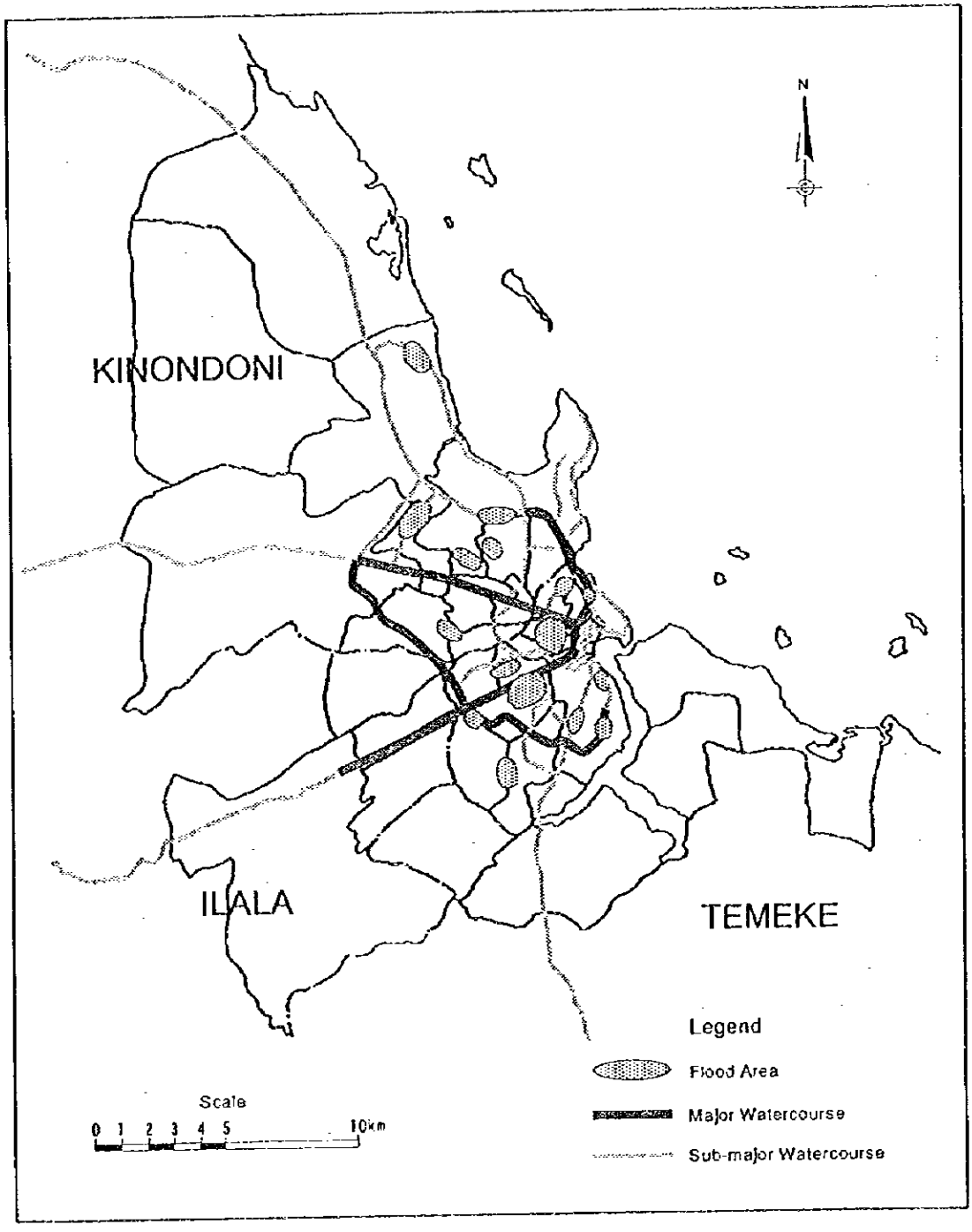

Figure 3-3: Map of Flooded Areas

3.2.5 Road Condition

The road density of DSM inside of the Nelson Mandela road is extremely low and the areas along the Morogoro, Bagamoyo, Nyerere and Kilwa Roads also have very low road densities, as shown in Figure 3-4. There are not enough roads in these relatively densely populated areas.

As for the road condition, poor road surfaces, including bad asphalt, gravel and dirt roads, occupy 76.2 % of the total length in DSM, as shown in Table 3-4. Single lane roads also occupy 69.4 % of the total road length in DSM. Therefore, the majority of roads in DSM are not in good order for common vehicles and this causes low efficiency of vehicles' performance and resulting high transportation costs.

Table 3-4: Summary of Pavement Condition

Category	Total length (km)	Surface condition				
		Asphalt paved			Gravel	Earth
		Good	Fair	Bad		
Trunk road	144.5	38.4	60.4	45.7	0.0	0.0
4 lanes road	39.8	15.1	22.5	2.2	0.0	0.0
2 lanes road	104.7	23.3	37.9	43.5	0.0	0.0
Regional road	314.0	25.6	35.1	0.0	143.8	109.5
2 lanes road	204.5	25.6	35.1	0.0	143.8	0.0
1 lane road	109.5	0.0	0.0	0.0	0.0	109.5
District road	213.1	0.0	0.0	0.0	22.9	190.2
1 lane road	213.1	0.0	0.0	0.0	22.9	190.2
Total	671.6	64.0	95.0	45.7	166.7	299.7
Ratio	100 %	9.5 %	14.2 %	6.8 %	24.8 %	44.6 %

The improvement of roads in DSM has been highly encouraged, mainly by the Japanese Government and World Bank, as the road conditions are deteriorating rapidly due to lack of road maintenance and the rapid increase in traffic volume.

One of the main causes of roads deterioration is improper maintenance of drainage systems. It was often found that drainage was blocked by a large amount of dumped refuse. In the rainy season this causes inundation of roads and rapid deterioration at the sub-base and sub-grade of roads due to infiltration of water. In Kariakoo area where the road was improved in 1994, many gully covers and even some manhole covers have been stolen and wastes dumped into the drainage system. Such behaviour is very serious and causes rapid damage to the drainage system.

This undesirable behaviour of people can partially be blamed by DCC's lack of provision of waste collection systems. If there is no reliable refuse collection system and no public waste containers then people must still dispose of their waste somewhere.

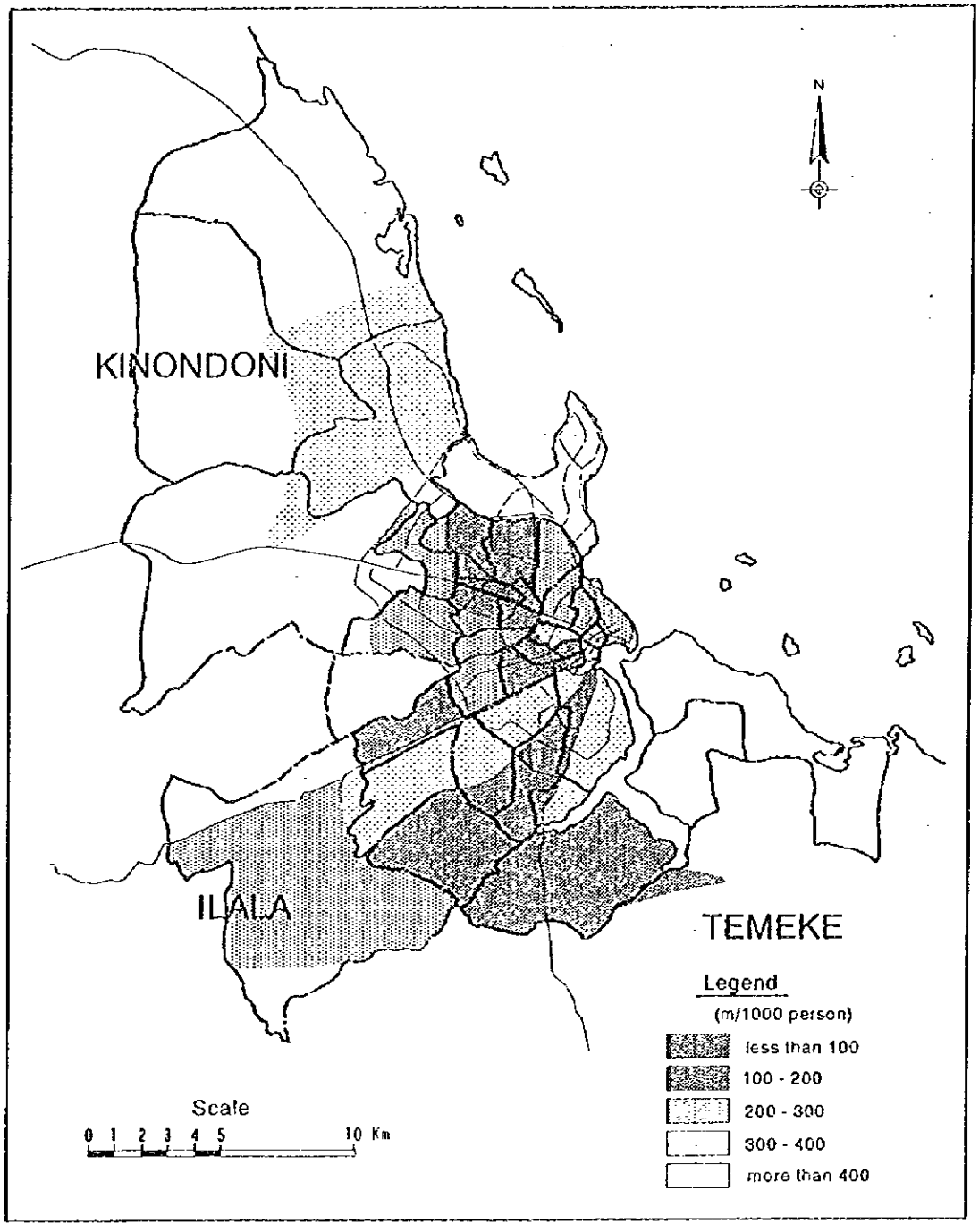

Figure 3-4: Road Density Map

3.2.6 Market Conditions

a. Methodology and Results

The methodology and results of a survey of 19 markets in DSM (see Table 3-5) conducted between 8-16 May 1996 are summarised here. Details of market selection, survey methodology and results are presented in Annex 2.

Table 3-5: Selected Markets for Surveying by District

Ilala	Kinondoni	Temeke
1. Kariakoo	6. Magomeni	14. Mbagala
2. Kisutu	7. Manzese	15. Yombo
3. Kivukoni Ferry	8. Ubungo	16. Mtoni
4. Ilala	9. Kinondoni Tx	17. Temeke
5. Buguruni	10. Mwananyamala	18. Keko
	11. Mtambani	19. Tandika
	12. Tandale	
	13. Mwenge	

This survey focused on three areas:

1. Physical data, including specifying the location, nature (wholesale or retail) and area of each market, the number of stalls and shops[3] and the range of goods sold.
2. Management and administrative systems in each market.
3. Sanitary conditions: water supply, toilets, drainage, waste collection, shelter, vehicle access, electricity and general cleanliness.

The results are presented in Table 3-6 - Table 3-8.

Table 3-6: Market survey results (Ilala district)

Criteria/Market	1. Kariakoo	2. Kisutu	3. Kivukoni Ferry	4. Ilala	5. Buguruni
Nature	W + R	R + chickens	R + fish	R	R
Area (m^2)	17,780	2,500	7,000	6,300	3,000
No. of Wholesalers	2,235	--	--	--	few
No. of Stalls	232	92	374	726	200
No. of Shops	73	1	20-30	20	30
Sanitary Conditions					
Water (3)	3	2	2	2	1.5
Toilets (4)	4	3	1	2	2
Drainage (4)	3	3	1	1.5	1
Waste Collection (4)	4	3.5	2	2	2
Shelter (2)	3	1	1	2	0
Vehicle Access (2)	2	2	2	2	0.5
Electricity (1)	1	0	1	0.5	1
General Cleanliness (1)	1	0.5	0	1	0.5
Total (21)	21	15	10	13	8.5
Classification	A	P	VP	P	VP
Trader Participation					
Total (3.5)	NA	4	3	2.5	3.5
Classification	NA	A	P	P	A

[3] A shop is defined as a semi-permanent or permanent structure within the market while a stall includes all temporary table-like structures, concrete tables and small canteens (see Annex 2).

Table 3-7: Market survey results (Kinondoni district)

Criteria/Market	6. Mag	7. Man	8. Ubu	9. Kin	10. Mwa	11. Mta	12. Tan	13. Mwe
Nature	R	R	R	R	R	R	W + R	R
Area	8,000	2,500	2,200	2,700	4,000	4,000	7,000	1,400
No. of Wholesalers	--	--	--	--	--	--	100	--
No. of Stalls	2,000	220	142-147	80	338	300	264	58
No. of Shops	200	8	10-15	10	?	20	20	0
Sanitary Conditions								
Water (3)	1	2	0	3	3	2	1.5	3
Toilets (4)	4	3.5	1	4	3.5	3.5	2	1
Drainage (4)	2	1	0	0.5	1	0	1	1
Waste Collection (4)	3.5	2.5	2	2	2.5	1.5	2.5	1.5
Shelter (2)	1	1	0	2	1	1	1	0
Vehicle Access (2)	2	1.5	2	2	1.5	2	0	2
Electricity (1)	0	0.5	0	1	0	0.5	1	1
General Cleanliness(1)	1	0.5	0.5	1	0.5	0	0	0.5
Total (21)	14.5	12.5	5.5	15.5	13	10.5	9	10
Classification	P	P	VP	P	P	P	VP	VP
Trader Participation								
Total (3.5)	3	4.5	2	5	4.5	4	1.5	4
Classification	P	A	P	A	A	A	P	A

Table 3-8: Market survey results (Temeke district)

Criteria/Market	14. Mbagala	15. Yombo	16. Mtoni	17. Temeke	18. Keko	19. Tandika
Nature	R	R	R	R	R	W + R
Area	2,400	3,000	2,400	3,060	3,200	7,000
No. of Wholesalers	--	--	--	--	--	--
No. of Stalls	210-215	119	200	50	350	400
No. of Shops	15	18	0	10	50	?
Sanitary Conditions						
Water (3)	1	0	0	0	0	0
Toilets (4)	0	0	2	1	1	1
Drainage (4)	1	0	1	0	0	0
Waste Collection (4)	2	3	2	4	2.5	2
Shelter (2)	1	0	1.5	0	1.5	1.5
Vehicle Access (2)	1	1	0.5	2	2	0
Electricity (1)	0	1	0	1	1	1
General Cleanliness(1)	0.5	0.5	1	0.5	0.5	0
Total (21)	6.5	5.5	8	8.5	8.5	5.5
Classification	VP	VP	VP	VP	VP	VP
Trader Participation						
Total (3.5)	2	3.5	2	2.5	2	1.5
Classification	P	A	P	P	P	P

Notes:

1) W = wholesale; R = retail; A = acceptable; P = poor; VP = very poor; NA = not applicable.
2) The numbers in brackets in column 1 refer to the number of points considered acceptable for each category.
3) In

Table 3-8, the first 3 letters of the name of each market have been used to identify them.

b. Discussion

The sanitary conditions in the markets visited were generally poor with only one market, Kariakoo, having gained "acceptable sanitary conditions" status, according to the criteria used in this survey.

b.1 Ilala District

The sanitary conditions in the markets in Ilala district were similar to those in Kinondoni district apart from Kariakoo. This market is an exception as it was the only market to be given "acceptable sanitary conditions" status in this survey, scoring 21 points.

Kariakoo market was designed and built in the 1970s and its infrastructure is impressive relative to other markets and still in reasonable condition. The main environmental problem here is inadequate ventilation in the basement wholesale area, making working conditions unpleasant especially during hot weather. This market is run as a Corporation which is responsible for all aspects of the markets' operation including market infrastructure and the provision of services. Hence it was not appropriate in this case to assess traders' participation in market management and in the maintenance of sanitary conditions. Their main input in these areas is through their representation on the Board of Directors of the Corporation.

Some general points concerning the other four Ilala markets (i.e. excluding Kariakoo) are summarised below:

- All four markets have a water supply with one outlet only. Water is supplied to three of these 3-4 days per week. Buguruni market receives water only once per week.
- All four markets have some toilet facilities but these are all in poor condition.
- Three markets have installed drainage, only one of which is operational. This is at Kisutu market and drains the chicken slaughterhouse. Kisutu and Kivukoni Ferry markets both have reasonable natural drainage, being located on slight slopes.
- Three markets have waste collection points (WCPs) while at Ilala market, traders store waste in baskets under their stalls. The WCPs at Buguruni and Kivukoni Ferry markets are poorly located and prone to flooding. Multinet collects chicken waste each day from Kisutu market under an agreement reached between it and the Kisutu Poultry Cooperative Society. DCC collects waste at least once per week from the retail section of this market and from Kivukoni Ferry and Buguruni markets. Collection frequency from Ilala varies from once every few days to only once every 2 weeks.
- Only Buguruni market has no permanent buildings.
- Vehicle access is good except for Buguruni market.
- Only Kisutu market does not have an electricity supply. However, the electricity supply to Ilala market has been cut due to non-payment of the bill by DCC.
- Ilala market is reasonably clean while Kisutu and Buguruni markets are dirty. Kivukoni Ferry market is very dirty and maggots could be seen crawling in the sand there.
- Trader participation at Kisutu and Buguruni markets was acceptable.

b.2 Kinondoni District

The sanitary conditions in the eight markets visited in Kinondoni district are similar to those in Ilala district markets apart from Ubungo market which only scored 5.5 points. Three markets were graded "very poor" and 5 as "poor" with scores ranging from 5.5. - 15.5. Some general points are summarised below:

- Seven markets have a water supply. However, all water supplies are subject to rationing with water being available 3-4 days per week for five markets. Tandale market receives water 1 day per week; Magomeni's supply has been cut due to non-payment of the water bill and Ubungo market has no supply.
- Five markets have reasonable toilet facilities. Two of these are run as businesses on a user pays basis.
- Drainage is installed in some parts of four markets. However, all these systems are completely blocked. Natural drainage is good in Magomeni and Mwananyamala markets. Mtambani market has poor natural drainage, being located on flat ground in an area with a high groundwater table and with an open sewer running through the middle of the market.
- Five markets have a WCP while waste is stored in baskets under traders' tables at Magomeni, Ubungo, Mtambani and Mwenge markets. DCC collection frequencies vary considerably: being once per day at Magomeni market, once per week at Tandale market , once every 1-2 weeks at Manzese market and approximately once per month (or less) at the other markets. Mwananyamala market, located less than 100 m from the DCC refuse collection truck depot, has its waste collected between 1-4 times per month.
- Six markets have some permanent buildings.
- Vehicle access is good except at Tandale market where trucks have to drive down a narrow, potholed, busy road and some stalls have to be moved to reach the WCP. Stalls must also be moved at Manzese to provide access for DCC vehicles.
- Electricity is supplied to parts of five markets.
- General cleanliness is reasonable at Magomeni and Kinondoni Tx markets and poor at the other markets. Mtambani and Tandale markets are particularly bad.
- Trader participation is acceptable at five of the markets, with traders having carried out 2 or more sanitary projects at four of these markets. Three of the markets are run as Cooperatives.

b.3 Temeke District

The sanitary conditions in the markets in Temeke district are worse than in other districts. All six markets visited had "very poor" sanitary conditions, with scores ranging from 5.5 - 8.5. Temeke is the poorest district and has the worst provision of Council services of the three districts in DSM and this is a contributing factor to this result. In many markets throughout the city but particularly in Temeke, many of the traders are very frustrated, stating that DCC does not honour its promises to provide services in the district.

Some general points are summarised below:

- Mbagala market is the only market to have its own water supply. However, this is not working due to failure of the City Mains water supply pump.
- Four markets have some toilet facilities. All are in poor condition and only two are actually used by traders.
- No markets have any installed drainage. Four markets have poor natural drainage with Keko and Tandika markets being prone to flooding. Mbagala and Mtoni markets are both built on a slight slope which facilitates natural drainage.
- All markets have WCPs. The WCP at Tandika market is prone to flooding being located in a natural depression. Waste collection frequencies by DCC vary from 1-2 days at Temeke market, 1-2 times per week at Yombo market, once per week at Tandika market to less than once per month at the other three markets.
- Four of the markets have some permanent buildings.
- Vehicle access to Temeke and Keko markets is good. Access is poor to the other markets, particularly Tandika market.
- Electricity is supplied to some parts of four markets.
- The general cleanliness is poor, especially at Tandika market. Of the six markets in this district, Tandika, being a wholesale market is the biggest and busiest and hence more effort is needed to maintain sanitary conditions here.
- Trader participation was poor at all markets except Yombo market, where the Cooperative that runs the market has completed one sanitary project (construction of a toilet block).

c. Market Waste Collection

Some points concerning waste collection are summarised below:

- Only two markets (Kariakoo and Temeke) have an acceptable waste collection service with a suitably located waste collection point and daily waste collection.
- Collection of chicken slaughterhouse waste from Kisutu market is also carried out daily by Multinet, following the recent agreement reached between Multinet and the Chicken Slaughterhouse authorities in early May 1996.
- All markets have a waste collection system. Fourteen markets have a WCP and in the other five markets, waste is stored in baskets under traders' tables.
- WCPs in three markets are prone to flooding. This situation is particularly bad at Kivukoni Ferry market with maggots being observed crawling on the ground near to the waterlogged WCP and at other places throughout the market.
- Access to the WCPs is acceptable in eleven markets. Buguruni, Tandale, Tandika and Mtoni markets have very poor access.
- Most markets are unsatisfied with the DCC waste collection service. The collection frequency is at least once per week for nine markets while in five markets it is less than once per month.

- Many people interviewed referred to the now defunct waste skip/container truck DCC waste collection system. This system appears to have been popular with market traders with collection being much more regular than it is now. However, nearby residents also used to dump their waste in the waste skips, meaning that the waste skips were soon filled.

3.3 Current Urban Environment Sanitation

3.3.1 Water Supply

a. Importance of the Sector

Water is essential for life and all human communities must have some kind of water source. For urban water supplies, water quality is clearly important. Traditional water sources in cities are more liable to water pollution and to infect more people than in rural areas. Many great water-borne epidemics have been caused by defective urban water supplies.

The poor state of the water supply in the City therefore severely affects community health which, when combined with inadequate sanitation, flooding and other factors, increases the economic costs of diseases, medical expenses, loss of earnings, etc. The commercial and industrial sector is also hampered by uncertain supply, poor quality and the costs of establishing alternative "in house" supplies from wells.

b. Environmental Hazards associated with the Sector

Water Supply

- Flooding during the rainy season, coupled with high water tables can lead to pollution of the distribution system through back siphonage, especially when there is an intermittent supply.
- Increased supply demands could be met by damming certain river systems, but this may unbalance river and land ecological systems.
- High leakage contributes to the deterioration of roads as foundations remain saturated.

Other Water Sources

- Most wells in DSM suffer from high salinity and groundwater pollution from pit latrines[4].
- In areas near the coast, groundwater is liable to ingress of saline water.
- The quality of water supplied, other than by NUWA, is not assured at all.
- The daily work of fetching water is a heavy burden for people.

[4] Environmental Profile of the Metropolitan Area, SDP, 1992

3.3.2 Domestic Liquid Waste Management

a. Importance of the Sector

All the diseases in the faecal-oral category, as well as most of the water-based diseases and several others not related to water, are caused by pathogens transmitted in human excreta, normally in the faeces[5]. Those of the excreta-related diseases which are also water-related can be controlled, at least partially, by improvements in water supply and excreta disposal.

As with water supply, the impacts of inadequate sanitation are widespread including occurrences of cholera, typhoid, dysentery, etc. which generates financial and economic costs to individuals, the business community and the government.

b. Environmental Hazards associated with the Sector

Sewerage System

- Improper treatment of wastes in oxidation ponds contributes to the pollution of water and soil and thus increases the risk of spreading water-borne diseases, directly or indirectly.
- Improper operation of oxidation ponds generates offensive odour, mosquitoes, etc., and causes an environmental nuisance to nearby residents.
- Some industries are suspected of discharging toxic chemical and heavy metal wastes directly to the city's sewerage and river systems.

On-Site Facilities

- More than 80% of city households rely on pit latrines. Limited emptying operations and a high water table results in unsanitary wastes flowing in surface drains and gullies to the main rivers and the sea, especially during the short and long rains.
- The high proportion of low lying pit latrines in the city combined with often inadequate construction results in an increased risk of the spread of water-borne diseases through contamination of shallow wells, back siphoning in the water supply, as well as direct contact with faecal coliforms.
- The resulting pollution load on surface drainage systems, groundwater and the ocean is considerable.
- The manual cesspit emptying method which lets sewage in the cesspit flow into streams causes pollution of river water which may be used for other purposes further downstream.
- Intensive cultivation in river catchment areas may introduce toxic chemicals and heavy metal contaminants into the food chain.

[5] Environmental Health Engineering in the Tropics, S. Cairncross & R. Feachem, Wiley, 1993.

3.3.3 Solid Waste Management

a. Importance of the Sector

The public health problems associated with solid waste fall into two categories: disease carried by vermin, and the physical and chemical hazards resulting from certain components in solid waste. Discarded solid waste provides food and a suitable environment for rats, flies, and mosquitoes. Food waste attracts these insects and rodents. The debris associated with the refuse provides shelter as well as breeding environments, especially for insects. Therefore, the population of vermin can be expected to increase if the refuse is not managed. Broken glass, rusty metals, household pesticides, solvents, etc. are the source of chemical and physical hazards associated with solid waste. Therefore the primary objective of SWM is the immediate removal of the refuse from contact with the human population.

b. Environmental Hazards associated with the Sector

Insufficient Waste Collection

- Lack of waste collection services in DSM forces people to dispose of wastes in drainage systems, streets and open spaces. This causes blockage of drainage systems and leads to frequent flooding in the rainy season. Flooding raises the cost of drainage and road maintenance and accelerates the deterioration of roads.
- In addition, floods caused by blockage of drainage systems leads to sewage overflowing from pit latrines and cesspools.
- Mosquitoes breed in the wastewater retained in such blocked channels and pools of rainwater. Some types of mosquito, breeding in the refuse itself (tin cans, old tyres, etc.) can spread viral infections such as yellow fever.
- Leachate produced by contact of waste with rainwater will pollute groundwater and river water.
- Food wastes encourage rats which transmit disease such as plague and typhus fever.
- Scattered wastes cause aesthetic problems and degrades the overall environment and also leads to a decrease in land values.
- Scattered wastes deters tourists and lead to a loss in foreign currency earned from tourism.
- Uncollected waste results in increased scavenging in the city and may cause social problems.
- Many people are being forced to dispose of their wastes themselves. Most do this in an inappropriate manner, for example, by the burning of waste in urban areas which pollutes the air with smoke.

Crude Dumping

- Uncontrolled leachate pollutes river water and ground water.

- NH_3 gas produced by decomposition of wastes spreads offensive odour to surrounding areas.
- CH_4 gas produced by decomposition of wastes can cause explosions.
- Many scavengers working at the disposal site are exposed to health hazards and traffic accident risks.

Along the Access Road to the Disposal Site

- A large number of refuse collection trucks pass along the access road resulting in vibration, noise, dust, and traffic problems for nearby residents.

3.3.4 Drainage and Flood Control

a. Importance of the Sector

Especially in unplanned areas, many poor residents can only afford to live in unsuitable areas such as on steep hillsides or marsh land. The latter is low-lying, marshy and subject to frequent flooding, often with faecally polluted floodwater. Many people have to cope with water or other people's sewage inside their dwellings.

Adequate drainage is therefore a basic requirement for decent environmental health. The absence of drainage as with poor water, sanitation and SWM contribute to community health problems and impede individual, industrial and commercial outputs.

b. Environmental Hazards associated with the Sector

- Existing poor drainage results in the retention of pools of water in which mosquitoes may breed.
- Floods caused by poor drainage leads to sewage overflow from pit latrines and cesspits.
- Overflow of sewage pollutes surface water and groundwater.
- Flooding of pit latrines and cesspits means frequent emptying is required.
- Frequent floods damage roads quickly and increases road maintenance costs.
- Losses associated with floods such as production losses and property losses are enormous.

3.3.5 Roads

a. Importance of the Sector

Roads are the major means of transportation in DSM. Thus traffic delays lead to high vehicle operation costs, environmental pollution, danger to life and regional and national impacts.

b. Environmental Hazards associated with the Sector

- The high proportion of unsealed roads and poorly maintained vehicles give rise to considerable air pollution by particulates as well as hydrocarbons.

- Bad road conditions reduces the efficiency of public services, including for refuse collection services.
- Very narrow roads often seen in unplanned areas, hinder the entry of refuse collection vehicles and cesspit emptying trucks.
- The poor condition of many roads encourages people to dispose of waste on the roads.
- Poor road condition is one of the causes of traffic accidents.

3.3.6 Market

a. Importance of the Sector

The markets in DSM are a focal point for food that has been brought to the city from all parts of the country. Hence, they provide a source of income at a local, regional and national level, directly to many of the people involved in production, distribution and sale such as farmers, transporters, wholesalers, retailers, petty traders, etc. and indirectly to many other people including restaurant and hotel owners, bakeries, market employees, etc. Other traders, such as those selling used clothes, household items, freshly cooked food may be part of the official market or set up business nearby, and also derive their income from market customers.

The markets are the prime source of fresh food for the majority of residents in DSM and businesses which sell food or process it into a wide variety of food products. Both residents and business people want to purchase good quality food so the produce sold should be fresh and safe to eat.

The maintenance of adequate sanitary conditions in the markets is thus essential for economic and financial reasons and for maintaining the general health of the population.

b. Environmental Hazards associated with the Sector

According to the criteria used in the market survey, Kariakoo was the only one of the 19 markets visited that had acceptable sanitary conditions. The sanitary conditions in 7 other markets were classified as poor and very poor in the remaining 11 markets, including all 6 markets visited in Temeke district. This means that the markets in DSM have a large number of environmental hazards associated with them.

Inadequate Water Supply

- Only 4 markets had an acceptable water supply.
- The absence of an acceptable water supply results in poor general hygiene and increases the probability of diseases spreading.
- The quality of water used in markets is poor, increasing the probability of contracting water-related diseases. Apart from rainwater, water from all other sources in DSM (e.g. mains supply, rivers, wells, etc.) is not safe to drink. The bulk of water used in all markets comes from the latter sources.

Inadequate Toilet Facilities

- The absence of hygienic toilet facilities creates a serious health hazard and an increased disease risk. Three markets had no toilets. In this case, people may choose to urinate or defecate anywhere. This practice increases the probability of faecal-oral or excreta-related diseases directly and will also attract flies and other insects. Another 9 markets had toilets which were not well maintained, dirty and/or did not have a water supply.
- The presence of poor or no toilet facilities creates a bad public image.

Inadequate Drainage

- Only Kariakoo market had an acceptable drainage system.
- The absence of adequate installed and/or natural drainage is another serious problem. If there is no installed drainage and natural drainage is poor, rainwater can sit, providing a breeding ground for mosquitoes and increasing the probability of the spread of water-related diseases.
- Surface water in the drains can become contaminated easily and the smell creates a public nuisance.
- The risk of disease is increased further if, as was the case at Mtambani market, there are any open sewers running through the market.

Inadequate Waste Collection

- Only 2 markets had an acceptable waste collection system.
- Inadequate waste collection increases greatly the risk of refuse-related diseases. Market waste rots quickly in DSM, especially if it is animal in origin. The fish and chicken traders at Kivukoni Ferry and Kisutu markets were amongst the most vocal of the Council's critics concerning the inadequacy of the DCC refuse collection service.
- Fly breeding is encouraged, as verified by the maggots observed at Kivukoni Ferry market.
- Diseases associated with rats may be promoted.
- Waste may obstruct streets and drainage channels resulting in greater collection and contamination of surface water and an increase in breeding sites for mosquitoes.
- The smell and sight of decaying market waste may deter customers from coming to the market as well as drawing complaints from nearby residents.

Inadequate Shelter

- Only 3 markets had an acceptable provision of shelter.
- The lack of adequate shelter gives no protection to the traders, customers and produce from the harsh DSM climate. This is particularly important during the rainy season where roofed buildings can prevent surface water from becoming a

problem and during the hottest parts of the day as the provision of shade can reduce the spoilage rate of produce.

- The lack of adequate shelter can lead to poor hygiene. Wooden stalls are difficult to keep clean. Bacteria can survive in the cracks and holes in the wood and dirt also finds its way into such crevices. In contrast, permanent buildings may be designed with concrete floors, stalls and drainage channels which are also much easier to keep clean.

- Permanent buildings are better able to cope with the large numbers of people that pass through a market each day. A dirt floor is less durable than concrete and can break up easily, especially during the rainy season, when muddy conditions are common in many markets. In addition, dirt floors can host a wide range of micro-organisms, some of them harmful to humans.

- Permanent buildings typically have high roofs and create a light, clean, mud free and spacious environment and thus are attractive to the public. Wooden stalls have low roofs and hence these areas of the market are often dark, cramped, muddy and with an uneven ground surface. There is a greater chance in the latter situation of people falling over and injuring themselves.

Inadequate Electricity Supply

- Electricity was considered to be of less importance by the traders than the other environmental factors already discussed.

- The use of refrigeration facilities is not common in DSM markets, apart from Kariakoo. Apparently, traders will make arrangements for meat/fish that is unsold at the end of the day to be put in cold storage until the following day while other traders will store their produce in baskets kept outside overnight. Obviously, the provision of refrigeration could increase trader profitability by reducing spoilage rates as well as discouraging rodents from feeding in the market. There is also a health risk associated with meat hanging in the open air all day until it is sold.

- Electricity was considered important for illumination of the market at night, thus improving market security and reducing the potential for financial losses through petty crime. 10 markets had an acceptable electricity supply, primarily for security purposes and for the use of some small shops (and not for the refrigeration of goods).

Inadequate Ventilation

- Lack of adequate ventilation is not an environmental hazard in all markets visited except in certain sections of Kariakoo and Kisutu markets.

- At Kariakoo market, the present ventilation system for the basement level is inadequate for the large volume of people working in and passing through this level. Working conditions are particularly unpleasant during the hotter months. In addition, there is a constant flow of trucks into the basement where their cargo is unloaded before the vehicles leave. Most of the exhaust fumes from these vehicles are not removed by the ventilation system. The lack of adequate

ventilation and poor environment accelerates the onset of fatigue and increases the possibility of contracting respiratory diseases.

- Similarly in the chicken slaughterhouse at Kisutu market, many people are working under cramped conditions in a small building with poor natural and no artificial ventilation. There are several charcoal stoves in this building which are constantly being used to heat water for plucking chickens and the heat and water vapour produced makes working conditions even more unpleasant. This harsh environment is not conducive to workers' health.

Inadequate Vehicle Access

- The lack of vehicle access is of minor importance for the general public as most people come to the market on foot or by bicycle. Vehicle access in this context is important in terms of facilitating the removal of waste from the market. Poor access increases the wear and tear on refuse collection vehicles as well as decreasing their productivity. 11 markets had acceptable vehicle access.

General Cleanliness

- The maintenance of general market cleanliness is important from a psychological viewpoint. It gives traders pride in their market and people like to shop somewhere that is clean and tidy. 5 markets were judged to be reasonable in this respect; 10 poor and the remaining 4 very poor.

Work Associated Hazards

- Most work done in the markets involves manual labour. Some of the tasks performed are physically demanding, especially for porters who unload heavy sacks from trucks and move them from one place to another around the market. The potential for injury is high amongst these workers.

Associated Financial and Economic Impact

- Loss of income due to ill health caused by poor market sanitary conditions is a problem for both traders and customers (e.g. by eating contaminated fruit).
- Produce may spoil more easily leading to reduced profits.
- Customers may choose to shop elsewhere. However, as virtually all markets have poor sanitary conditions, the choice is limited. Secondly, the issue of choice depends upon a customer's income level. The majority of DSM residents can not afford to buy food from the small number of modern shops with good sanitary conditions.
- Economically, investment in market infrastructure is considered to be cost effective primarily because of the markets being such focal points for the local community. On this basis, it can be argued that given the increased possibility for the outbreak of disease when sanitary conditions are poor and the sheer number of people that frequent the city's markets, an investment in market infrastructure is an investment in the health of the nation.

3.4 Assessment of Current UES

3.4.1 Summary of Current UES Conditions

Based on the importance of different sectors and current conditions of public services, the current negative impacts to UES given by inadequate public services are summarised in Table 3-9.

Table 3-9: Assessment of Current Negative Impacts to UES by Inadequate Public Services

Items	Water Supply	LWM	SWM	Drainage	Road	Market
Spreading of Disease[1]						
Water-related transmission route						
Water-borne	High	Medium	Low	Low	Low	High
Water-washed	High	Low	Low	Low	Low	High
Water-based	High	Low	Low	Low	Low	Medium
Water-related	High	Low	Medium	Medium	Low	High
Excreta-related	Medium	High	Medium	Medium	Low	Medium
Refuse related	Low	Low	High	Low	Low	High
Air-borne	Low	Low	Low	Low	Low	Low[2]
Accidents	Low	Low	Low	Low	Medium	Medium
Others	Low	Low	Low	Low	Low	Low
Poor Health	High	Medium	Medium	Medium	Low	High
Degrading of the Environment						
Water pollution	High	High	High	Medium	Low	Low
Air pollution	Low	Low	Medium	Low	High	Low
Odour pollution	Low	Medium	High	Medium	Medium	Medium
Soil contamination	Low	High	Medium	Medium	Medium	Medium
Noise	Low	Low	Low	Low	Medium	Low
Vibration	Low	Low	Low	Low	High	Low
Social Problems						
Nuisance	High	Medium	High	High	High	High
Aesthetics	Medium	Medium	High	High	High	High
Convenience	High	Medium	High	Medium	Medium	High
Economic Loss	High	Medium	Medium	Medium	High	Medium
Overall Assessment	High	Medium	High	Medium	Low	High

Note: 1: The disease classifications from Table 1-5 have been used here. The terminology used is defined below:

a) Water-borne diseases are transmitted when the pathogen is in water which is drunk by a person or animal which may then become infected. These diseases come in the faecal-oral category, as they correspond to the special case of drinking faecal material in water.

b) Water-washed diseases are those whose transmission will be reduced following an increase in the volume of water used for hygienic purposes, irrespective of the quality of that water. Water-washed diseases, which come in the faecal-oral category, include infections of the intestinal tract, such as diarrhoeal diseases. Other water-washed infections, outside of this catgory, are those of the skin or eyes.

c) Water-based diseases are those in which the pathogen spends a part of its life cycle in a water snail or other aquatic animal.

d) Water-related diseases are those in which the disease is spread by insects which either breed in water or bite near water.

e) Excreta-related diseases are those which are caused by pathogens transmitted in human excreta, normally in the faeces and thus includes all of the diseases in the faecal-oral category mentioned above as well as most of the water-based diseases and several others not related to water. In the above table, excreta-related diseases refers only to such diseases that are not related to water, the majority of which are worm type infections.

f) Poor refuse disposal will encourage fly-breeding and may thus promote the transmission of faecal-oral infections. It can also promote disease associated with rats, such as plague, leptosirosis, salmonellosis, endemic typhus and rat-bite fever.

g) Air-borne diseases are those spread by discharges from the mouth, nose, throat or lungs of an infected individual.

h) Accidents and other are self-explanatory.

2: The impact is Medium at Kariakoo and at the chicken slaughterhouse at Kisutu market.

3.4.2 Findings from Public Opinion Survey on UES

a. Analysis of POS on UES

Water source

Many households are using more than one water source. The percentage of households in different areas using more than one water sources in increasing order is:

1. urban
2. semi-urban planned
3. semi-urban unplanned
4. rural

Many people answered 'others' for water source. In most cases 'others' means using a neighbour's water tap. The percentage of households having a water supply in the house is 94%, 50% and 40% in the urban, semi-urban planned and semi-urban unplanned areas respectively. The percentage of households obtaining water from a tap, whether it be inside the house or from a nearby communal water supply tap or a neighbour's tap, is 70-80% in semi-urban planned and the semi-urban unplanned areas and about 50% in rural areas.

Except in urban areas, sources of water are numerous. 25% of interviewees in all areas except urban areas use rain water as well. Hence, obtaining water is a very serious problem for people in areas other than urban areas and various avenues are used by them to get water.

Type of toilet facilities used in premises

The total percentage of households using a flush toilet, whether it be connected to a sewer pipe or a septic tank is 88% in urban areas and 19%, 10% and 6% in the semi-urban planned, semi-urban unplanned and rural areas respectively.

The rate of pit latrine use is 80 to 90% in areas other than urban areas.

The percentage of households with no toilet is only 3% and 4% in semi-urban unplanned areas and rural areas respectively. In other areas, all households have toilets.

Electricity

The electricity service rate is 100% in urban areas and 75%, 53% and 53% in semi-urban planned, semi-urban unplanned and rural areas.

TANESCO is the sole supplier of electricity. No interviewees use generators.

Type of pavement on road to premises

In urban areas, only 40% of the roads are tarmaced and 20% have no pavement.

Gravel and unpaved roads each contribute 41% of the total roads in semi-urban planned areas while only 15% of the roads are tarmaced.

In semi-urban unplanned areas, only 5% of the roads are unpaved, 32% have a gravel pavement and 50% have no pavement. A further 12% of replies indicated 'other' pavement types, other in this case being mainly sand roads which should be included in the no pavement category, bringing this to 62%. Similar trends are shown in rural areas.

These results show that the road condition is generally bad in urban areas and very bad in other areas.

First priority for Improvement of Public Services

Water supply was given as the first priority for improvement by interviewees in all areas. Second priority was given to either storm water drainage or refuse collection in the semi-urban planned and unplanned areas, the percentages for these 2 categories being very similar. Even in the urban area where 95% of interviewees have water taps in the house, most interviewees gave the improvement of water supply as a first priority. This implies that the water supply is unreliable and/or water quality is poor.

In urban areas, the second priority was given to refuse collection and the third to sewer pipe drainage but a low priority was given to storm water drainage. This is because the condition of storm water drainage in urban areas is better than in other areas.

No interviewee gave electricity as a first priority, showing that either people are satisfied with the present service or that other services are considered more important.

Improvement of access roads was also given a low priority although the present general condition of roads is bad.

Improvement of septic emptying services was given a low priority with sewer pipe services being higher. This means that people would prefer improvements of the sewer system rather than the cesspit emptying service.

b. Major Findings from POS on UES

The major findings from POS concerning UES are summarised below.

- Water supply was given as the first priority for improvement by interviewees in all areas, even in the urban area where 95% of interviewees have water taps in the house. This implies that the water supply is unreliable and/or water quality is poor.
- Refuse collection service was given as the first or second priority by 53-62% of interviewees in each area.
- Drainage and sewer pipe provision were given as the third or the fourth priorities by most interviewees.
- Cesspit emptying, roads and electricity supply were given low priority.

Water supply was given as the first priority by 58% of all interviewees. Considering its importance and the present poor service level of water supply, this result is realistic.

Improvement of refuse collection was also a major priority for many people especially in the urban area where people faces difficulties to dispose of their wastes themselves in a sanitary manner.

3.4.3 Identification of the Importance of SWM in UES

Improvement of solid waste management is only one of the measures required for improving urban environmental sanitation because it is related to various public services such as water supply, liquid waste management, drainage, roads, etc. In order to find a cost effective strategy for improving urban environmental sanitation it is necessary to consider the overall balance of present levels of various public services. To spend more resources on the solid waste management service alone and not on other public services in the city can not be justified.

It is therefore necessary to identify the magnitude of the importance of solid waste management in urban environmental sanitation, taking present conditions of various related public services into account, as discussed below.

Water Supply

Water supply was assessed to be very poor even though 80% of households have access to a water supply. The percentage of households having a tap in the house is only 22%. 20% of people rely on a water source of unassured quality such as a well, stream, water vendor, etc. Even the water supplied by tap is not reliable due to rationing and inadequate treatment. The average consumption of water is only 50 litre per person per day. As water is essential for life, first priority should definitely be given to the improvement of the water supply for DSM.

Domestic Liquid Waste Management

For domestic liquid waste management, although the sewerage service rate is very low (only 5%) the percentage of households having no toilet is estimated to be low also (around 5%) based on the census in 1988 together with the POS results. This is because the percentage of people using on-site facilities such as septic tanks, pit latrines, cesspits, etc. is high, around 80%. This implies that the minimum requirement for LWM has been satisfied.

However, the widespread use of such on-site treatment facilities although being the most affordable option for the majority of the population in DSM is not the most appropriate solution. There is an associated high potential of groundwater contamination due to the high population density and high groundwater table in many areas of the city.

Solid Waste Management

The percentage of households receiving refuse collection was 8.1%, much lower than the 80% and 80-90% of households having access to a water supply and using some LWM facilities respectively. This figure (8.1%) is too low for DSM, considering its urbanised condition, population density, etc. Current living conditions in DSM do not allow many people to dispose of their waste in a sanitary manner themselves. However, the majority of people (80-90%) are forced to practice self-disposal of waste due to no provision of waste collection services.

The primary objective of SWM is the immediate removal of waste from contact with the human population, and waste collection, transportation and disposal are essential to do this. However, the Vinguguti disposal site is located very near to residential areas and the current crude dumping mode of operation of the disposal site means that to

transport waste to the Vingunguti site does not remove waste from contact with the population - hazards are just being concentrated at the disposal site near residential areas.

The inadequacy and instability of the DCC SWM system means that people experience waste disposal problems daily, a situation which is different from that of water supply and LWM. Furthermore, the current inadequate waste collection service and lack of other means of disposal adversely affects drainage and flood control systems, road conditions and market sanitary conditions as described below.

Drainage and Flood Control

Drainage and flood control are not matters of daily concern for most people. However, current frequent flooding in the rainy season proves that the condition of drainage and flood control systems in DSM is very poor. This results in overflow of sewage, polluting surface and ground water sources. Improvement of drainage and flood control systems is being encouraged by community based projects and has been part of the many road improvement projects recently carried out in DSM. However these efforts are being hindered by people dumping waste in drainage systems, due to insufficient waste collection services. This causes blockage of the drains and flooding and flooding accelerates road deterioration.

Roads

Roading is not as important for UES relative to the other public services, although the current poor road condition contributes to air pollution and hinders the efficiency of other public services, especially the waste collection and cesspit emptying services. Bad road conditions also affect business productivity. Therefore, road conditions contribute indirectly to UES.

Markets

Maintaining hygiene in the markets is essential because markets are focal points for foods in DSM. In addition, markets are particularly vulnerable to inadequate waste collection services because they produce a large amount of organic wastes which attract flies, rats, mosquitoes, etc. Therefore, immediate removal of waste from markets is absolutely essential and this is definitely a cost effective avenue for the improvement of UES.

Overall

Every public service is important for UES and they are closely interrelated. Therefore, it is necessary to improve all public services in a balanced way to improve UES. Looking at the current conditions of public services, improvement of the water supply should be given first priority followed by improvement of SWM.

In fact, improvement of SWM will contribute to a reduction in flooding due to fewer cases of blocked drains; to reduce water pollution of surface and ground water sources; to increased road life by decreasing flooding; to reduced incidence of disease by reducing the number of flies, mosquitoes, rats, etc.; and to making markets more hygienic. Moreover, the improvement of SWM is strongly demanded by the public according to the POS results which implies that lack of SWM is seen as a serious problem.

Consequently, it can be concluded that following improvement of the water supply as a first priority, improvement of SWM should follow due to inadequacy of the present waste collection service and strong public demand. Furthermore, improvement of SWM is highly cost effective due to its associated benefits on other aspects of the urban environment.