THE STUDY
ON
REHABILITATION OF
DAR ES SALAAM WATER SUPPLY
IN
THE UNITED REPUBLIC OF TANZANIA
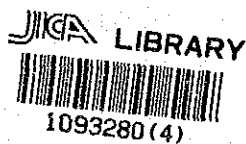
FINAL REPORT
VOLUME 3: SUPPORTING REPORT

JULY 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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LEGEND

- ▩ Water Treatment Plant
- ● Reservoir
- --·--· Trunk Transmission Line
- ▥ Study Area

N

0   5KM   10KM

INDIAN OCEAN

BAGAMOYO

BAGAMOYO ROAD

Ruvu River

LOWER RUVU WATER
TREATMENT PLANT

UPPER RUVU WATER
TREATMENT PLANT

MLANDIZI

MOROGORO ROAD

KIBAHA

Mpiji River

UNIVERSITY
RESERVOIRS

KIBAHA
RESERVOIRS

Ruvu River

Dar es Salaam

KISARAWE

MTONI WATER
TREATMENT PLANT

Kizinga River

Mzinga River

KILWA ROAD
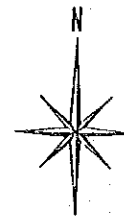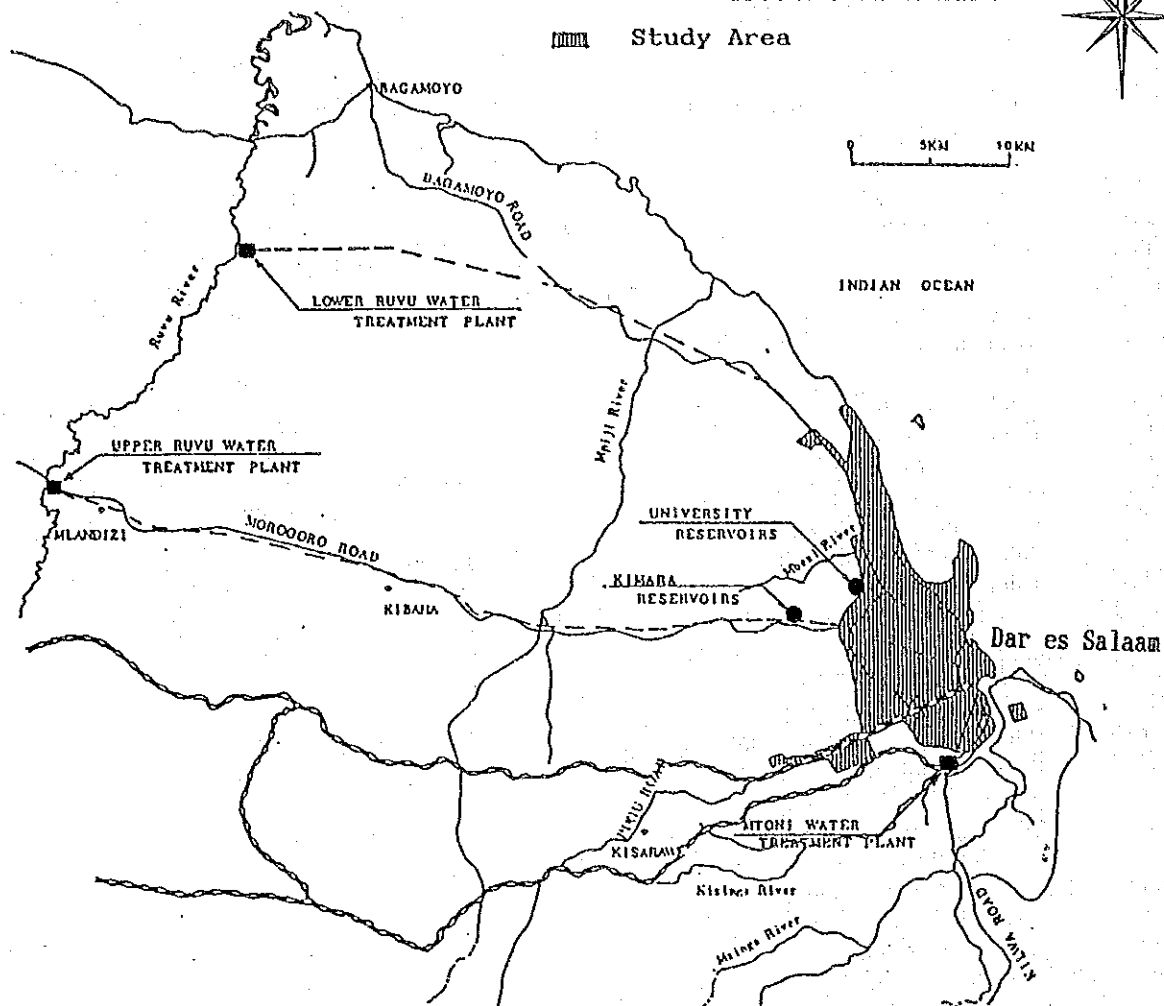
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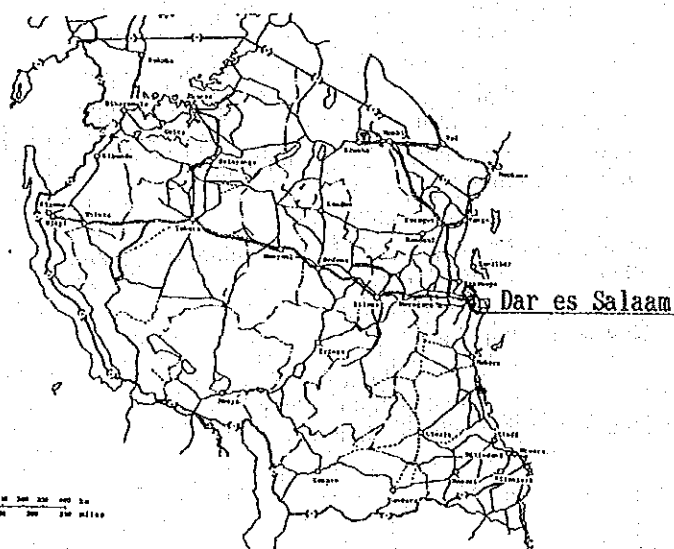
Dar es Salaam

LOCATION MAP OF THE PROJECT

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

ABBREVIATIONS

AC	advisory committee
AOM	NUWA accounts operating manual
"	inch = 25.4 mm
B/C	benefit cost ratio
BHN	basic human needs
BM	Dar es Salaam branch manager of NUWA
BS	British standard
CCM	Chama Cha Mapinduzi (revolutionary party)
CIP	cast iron pipe
cu.m	cubic meters
d	day
DI	ductile iron pipe
DIP	ductile iron pipe
DF	director of finance
DG	director general
DE	distribution engineer of NUWA
DPS	data processing section
DSM	Dar es Salaam
DSMB	Dar es Salaam branch of NUWA
DTC	Technical Colleges in Dar es Salaam
F.C.	foreign currency portion
EL	elevation
FIRR	financial internal rate of return
F.R.P.	fibered-glass reinforced pipe
ft	foot = 30.5 cm
FTC	full technician certificate
gallon	British gallon = 4.546 liters
GDP	gross domestic product
GP	galvanized steel pipe
gpm	gallons per minute
ha	hectare = 10,000 m^2
HP or hp	horse power = 0.746 kw
HQ	headquarters
hr	hour
IDA	International Development Association
IDM	Institute of Development Management
IDWSS	International Drinking Water Supply and Sanitation Decade
IMF	International Monetary Fund
IRR	internal rate of return
ISO	International Standards Organization
JICA	Japan International Cooperation Agency
JTU	Jackson Turbidity Unit
km^2	square kilometer
KW or kw	kilowatt
L.C.	local currency portion
lcd	liter per capita per day
lpcd	liter per capita per day
l.s.	lump sum
m	meter
min	minute
m^2	square meters

m³	cubic meters
ME	mechanical engineer of NUWA
mg/l	milligrams per liter
mgd	million gallons per day = 4,546 m³ per day
MLD	million liters per day
mm	milimeter
MNF	minimum night flow
MB	megabyte
MOW	Ministry of Water
n.a.	not available
No.	number
NPV	net present value
NUWA	National Urban Water Authority
NSTI	Nyengezi Social Training Centre
NVTC	National Vocational Training Centre, Ministry of Labour & Manpower Development
OECD	Organization for Economic Cooperation and Development
PE	plant engineer of NUWA
PGS	"parastatal general scale" pay scale
POS	"parastatal operational scale" pay scale
PRS	"parastatal rare scale" pay scale
PSCP	pre-stressed concrete pipe
PSS	"parastatal special scale" pay scale
PVC	poly-vinyl chloride pipe
RWSD	Rural Water Supply Department
s	second
SAP	Structural Adjustment Programme
SCOPO	Standing Committee of Parastatal Organization
SIDA	Swedish International Development Agency
SP	steel pipe
sq.km	square kilometers
sq.m	square meters
TAC	Tanzanian Audit Corporation
TANESCO	Tanzania Electric Supply Company Limited
TBS	Tanzania Bureau of Standards
TF	Task Force
T.Shs.	Tanzanian Shillings (U.S.$1=T.Shs.200 at November,1990)
UWASA	Urban Water Supply Act
WHO	World Health Organization
WRI	Water Resources Institute, Ministry of Water, Energy and Minerals

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A.

APPENDIX TO CHAPTER 2

A. APPENDIX TO CHAPTER 2

1 WATER DEMAND*

1.1 GENERAL

Greater DSM encompasses an area of 1393 sq. km., with a population of 1,360,850 (Preliminary Census, 1988). DSM is divided into 3 administrative districts , viz., Kinondoni, Ilala and Temeke. Each of the districts is further sub-divided into wards. Water supply in DSM is largely handled by the National Urban Water Authority (NUWA), with the DSM Rural Water Supply Department (RWSD) handling outlying, rural areas within the Greater DSM region.

NUWA has classified DSM into 5 sub-branches. The Kinondoni administrative district is divided into Kawe, Kinondoni and Magomeni sub-branches, while Ilala and Temeke sub-branches conform to their namesake administrative districts.

Water supply for most of the densely populated areas of DSM is managed by the NUWA through a distribution network supplied from reservoirs at the University of DSM, Kimara and Mtoni. In the northern region, along the Bagamayo road, transmission mains convey water treated at the Lower Ruvu Water Treatment Plant to the University Reservoir. In the western region, along the Morogoro Road, a transmission main conveys water treated at the Upper Ruvu Water Treatment Plant to the Kimara Reservoir. In the southern region, a small amount of water is treated at the Mtoni Treatment Plant and pumped into the distribution network.

Some wards in the northern and western regions are served, in part, by pipelines tapped from these two transmissions. Apart from these, outlying wards in the northern, western and southern regions are also served by a system of shallow wells, under the administration of the RWSD.

Table A.1.1 gives pertinent information about districts and wards of DSM - area, population and population density. It also gives an idea about which of the three sources supplies water to the ward - 1) the NUWA distribution system from the three reservoirs at Kimara, University & Mtoni, 2) the Lower and Upper Ruvu Transmission Mains along Bagamayo and Morogoro roads, respectively and 3) shallow wells, under the administration of RWSD.

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* The contents of this section are summarized in section 2.3, Main Report. They are also used for "network analysis", section 5.2, Appendix C.

The prime concern of this study is with the distribution system under NUWA administration. Figure A.1.1 gives an idea of the areas in DSM that come within the purview of this system and those that fall outside.

Water demand on the system can be divided into its component parts, viz., domestic demand and other demands, e.g.industrial, commercial and institutional. These component parts are evaluated individually.

TABLE A.1.1 GENERAL INFORMATION ABOUT WARDS IN GREATER DAR ES SALAAM (1988)

Sr. No.	Ward	Type	Area, sq.km.	Population (1988)	Population Density	Number of of House- holds	Source of Water Supply
ILALA SUB-BRANCH							
101	Ukonga	M	47.2	45,203	958	10,127	#
102	Pugu	R	51.8	6,226	120	1,178	# T R
103	Msongola	R	18.3	13,351	730	3,058	R
104	Tabata	U	5.5	18,465	3,357	3,780	#
105	Kinyerezi	R	17.4	3,048	175	730	# R
106	Ilala	U	2.2	35,048	15,931	8,241	#
107	Mchikichini	U	1.1	15,040	13,673	3,372	#
108	Vingunguti	U	49.3	33,690	683	8,731	#
109	Kipawa	U	8.8	36,910	4,194	9,282	#
110	Buguruni	U	3.5	48,247	13,785	13,198	#
111	Kariakoo	U	0.4	12,569	31,423	2,499	#
112	Jangwani	U	0.9	15,320	17,022	2,908	#
113	Gerezani	U	0.9	7,487	8,319	1,557	#
114	Kisutu	U	0.4	8,358	20,895	1,699	#
115	Mchafukoge	U	0.5	8,547	17,094	1,604	#
116	Upanga East	U	1.2	9,807	8,173	752	#
117	Upanga West	U	1.5	11,020	7,347	1,633	#
118	Kivukoni	U	2.1	5,372	2,558	781	#
SUB-TOTAL			213.0	333,708	1,567	75,130	
TEMEKE SUB-BRANCH							
201	Kigamboni	M	33.8	26,078	772	6,197	# R
202	Vijibweni	R	12.4	2,557	206	520	# R
203	Kibada	R	14.2	3,003	211	752	R
204	Kisarawe 11	R	49.6	2,821	57	697	R
205	Somangira	R	98.9	6,730	68	1,596	R
206	Kimbiji	R	199.6	6,465	32	1,457	R
207	Mbagala	M	24.3	40,866	1,682	9,539	# R
208	Chamazi	R	66.5	5,452	82	1,261	R
209	Yombo Vituka	R	13.1	13,408	1,024	2,876	# R
210	Charambe	M	6.9	18,624	2,699	3,974	R
211	Toangoma	R	37.4	6,652	178	1,553	R
212	Miburani	U	44.2	72,892	1,649	16,793	#
213	Temeke 14	U	44.2	91,144	2,062	22,271	#
214	Mtoni	U	2.6	39,417	15,160	9,745	#
215	Keko	U	43.9	42,868	976	10,493	#
216	Kurasini	U	48.2	26,776	556	5,781	#
SUB-TOTAL			739.8	405,753	548	95,505	

Note: Type U = Urban, R = Rural, M = Mixed
Source of Water Supply # = NUWA distribution system,
T = NUWA feeder mains, R = Rural Water Supply Department

FIG. A.1.1   WARDS OF DAR ES SALAAM INSIDE AND OUTSIDE DITRIBUTION NET WORK

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

TABLE A.1.1 CONTINUED

Sr. No.	Ward	Type	Area, sq.km.	Population (1988)	Population Density holds	Number of of House-Supply	Source of Water
KINONDONI sub-branch							
301	Msasani	U	152	51,293	3,375	10,839	#
302	Kinondoni	U	3.3	42,387	12,845	9,526	#
303	Mwananyamala	U	3.5	72,508	20,717	16,943	#
SUB-TOTAL			22.0	166,188	7,554	37,308	
KAWE sub-branch							
401	Goba	R	54.4	4,753	87	1,186	T
402	Kawe	U	27.4	44,085	1,609	10,527	# T
403	Kunduchi	R	75.8	22,743	300	5,452	T
404	Mbweni	R	22.6	2,159	96	551	T
405	Bunju	R	83.0	9,977	120	2,493	T
SUB-TOTAL			263.2	83,717	318	20,209	
MAGOMENI sub-branch							
501	Magomeni	U	8.3	16,944	2,041	4,361	#
502	Makurumla	U	2.2	53,991	24,541	12,987	#
503	Ndugumbi	U	1.1	32,736	29,760	7,933	#
504	Tandale	U	4.1	58,413	14,247	13,380	#
505	Mzumuni	U	0.9	23,985	26,650	5,807	#
506	Kigogo	U	1.2	21,222	17,685	4,693	#
507	Mabibo	U	2.1	45,963	21,887	10,761	#
508	Manzese	U	3.8	54,499	14,342	12,834	#
509	Ubungo	U	18.9	46,980	2,486	9,521	#
510	Kibamba	R	112.1	16,751	149	3,875	T
SUB-TOTAL			154.7	371,484	2,401	86,152	
TOTAL			1,393	1,360,850	977	314,304	

Note: Type U = Urban, R = Rural, M = Mixed
    Source of Water Supply # = NUWA distribution system,
    T = NUWA feeder mains, R = Rural Water Supply Department

1.2 DOMESTIC WATER CONSUMPTION

1.2.1 PER CAPITA CONSUMPTION

The social structure in DSM, as in many Third World cities, gives rise to a water consumption pattern that lends itself to division roughly based on the socio-economic status of the residents. Consequently, three types of water supply service levels exist in DSM. These are based on the availability of water connection on the premises of the consumer and the number and location of taps in the premises.

(1) House connection - in this type, the household has available within the housing unit numerous taps, viz., bathroom, toilet, kitchen, etc. This type of connection exerts the maximum water demand on a per capita basis, and this is due to the ready availability of taps at convenient locations within the house.

(2) Yard connection - in this type, the household has only one (or two) taps within the premises, usually in the yard at the back of the house, from which water is taken by buckets and containers to other parts of the house. Water demand in such households are usually less than where house connections exist, because of the extra effort required in conveying water from the yard to the point of consumption.

(3) No connection - as the name implies, there is no water connection within the house and residents have to go nearby water kiosks, or standpipes or to other people's houses to fetch water in buckets. Water demand in such houses is least due to the distances water has to be conveyed from such kiosks and standpipes to the point of consumption and the effort required to be expended in the process.

Estimation of liters per capita water per day (lpcd) of consumed at each service level was estimated from observation of monthly water consumption values in selected 'model' areas of DSM. Details of the analysis were given in section 2 of this Appendix A. The LPCD values according to each service level is given below.

    - House connection:
        high   400 lpcd
        middle   250 lpcd
        low   160 lpcd
    - Yard connection: 85 lpcd
    - No connection: 22 lpcd
      (kiosk/standpipe)

1.2.2 WATER DISTRIBUTION AREA AND WATER CONSUMPTION

As was mentioned earlier, some areas in the outlying regions of DSM are served by the RWSD by shallow wells. Some areas are served by offtakes from the transmission mains, viz., the Upper Ruvu Transmission Main and the Lower Ruvu Transmission Main. In these areas, there is no service from the distribution network of NUWA. These areas are Bunju, Mbweni, Goba, Kunduchi, Kibamba, Msongola, Pugu, Charambe, Chamazi, Kibada, Toangoma, Somangira, Kisarawe II and Kimbiji.

In the case of Pugu, although there is no distribution system, the pumping station at Gongo La Mboto has 2 pumps - one pumping water to the Kisarawe Brick Factory and the other pumping water to TPDF, Pugu Secondary School and Pugu Kajiungea. The first pump has a discharge of 12 liters/sec, while the second has a discharge of 34 liters/sec. Both pumps are to be operated between 5 a.m. and 10 a.m.. Together, the two pumps are capable of pumping a maximum of 828 m³/day of water. This pumping station is, however, essentially idle at the present time due to lack of sufficient water.

Some areas between the center of the city and the outlying regions are served from the NUWA distribution network, by the RWSD and from the Transmission Mains. Accordingly, in such wards, the population served by NUWA has been adjusted in consultation with RWSD. Such wards include Kigamboni, Vijibweni and Kinyerezi. In Kawe, part of the area is served by the Lower Ruvu Transmission Main, through the offtake at Lugalo, the point where the Old Bagamayo Road meets the New Bagamayo Road. This supply accounts for 30 % of the overall demand of Kawe ward.

At Yombo-Vituka, the RWSD has sunk in shallow wells to serve a population of 4000. There also exists a pipe network that used to draw water from Mtoni and from the main line along Pugu Road. Due to low pressure, however, no water flows into this network and parts of the system within this ward have fallen into disrepair. Some sections of pipes have been subjected to pilferage. Therefore, although this ward exerts no demand at the current time, sufficient pressure availability in the future would enable this ward to receive water, after some repair work is done, to replace the missing pipe sections.

To develop the water demand in each ward, it is necessary to sub-divide the ward population into those having and those not water connections, and the former is further divided into those with house and those with yard connections.

To accomplish this, members of the Study Team went through the wards of DSM that are being served by the NUWA distribution system. Going through each ward, its by-lanes and streets as well as the main roads, viewing the ward from geographical vantage points like the top of a hill onto a valley, discussions with NUWA engineers, technicians at the NUWA branches, the Study team arrived at a

ward-wise proportion having house, yard and no connections. Tables A.1.2 and A.1.3 give population and households, respectively, according to service levels in each ward. These tables reflect 1990 population and household levels and formed the basis for calculating the water demand for each ward, using the lpcd values generated earlier.

Table A.1.4 gives the water demand for each ward in the service area, derived by dividing the ward population into those with house, yard and those without connections and multiplying the respective lpcd values.

The domestic water demand for the entire service area is 128,185 (113,551 old) m³/day.

1.2.3 REGISTERED AND UNREGISTERED CONNECTIONS

NUWA has a list of domestic connections in DSM, arranged by wards. This list has been updated in 1989 and 1990. But a lot of connections remain unregistered with NUWA, due to which, there is under-billing and a lot of distributed water is unaccounted for. In 1989, a study done by Price Waterhouse and Associates estimated that the ratio of accounted to unaccounted connections was almost 1:1. NUWA has commissioned the Ardhi Institute to undertake a house-to-house survey to, among other things, assess the magnitude of unregistered connections and their locations. The results of this study is due to be submitted later in 1990.

Given this state of affairs, the current study did not directly utilize the NUWA list of registered connections to arrive at the water demand figure. The Preliminary census released in 1988 gives the number of households in DSM on a ward-to-ward basis. The survey conducted in each ward by the members of the Study Team to determine the proportion of households having house, yard and no water connections was described earlier.

As is shown in Table A.2.12, Appendix A, the number of households per yard connection in the three model areas of Kariakoo, Magomeni and Kinondoni has been determined to be 3.6 households/yard connection. This was obtained from the survey in Kariakoo, Magomeni and Kinondoni model areas. Based on this, the estimated number of households and population in each water connection category from this study is given in Table A.1.5 along with the registered connections with NUWA in 1990 to enable comparison.

TABLE A.1.2 POPULATION ACCORDING TO SERVICE LEVEL BY WARD (1990)

Type of connection Sr. No. Ward name	Total	House Low class People (%)	Middle class People (%)	High class People (%)	Yard People (%)	Kiosk/Standpipe People (%)
ILALA Sub-branch						
ILALA Sub-branch						
101 Ukonga	49,647	4,965 (10) l			9,929 (20)	34,753 (70)
102 Pugu						
104 Tabata	20,280	3,042 (15) l			3,042 (15)	14,196 (70)
105 Kinyerezi	536	375 (70) l			54 (10)	107 (20)
106 Ilala	38,493	23,096 (60) l			11,548 (30)	3,849 (10)
107 Mchikichini	16,518	6,607 (40) l			6,607 (40)	3,304 (20)
108 Vinguguti	37,002	3,700 (10) l			3,700 (10)	29,602 (80)
109 Kipawa	40,538	4,054 (10) l			4,054 (10)	32,430 (80)
110 Buguruni	52,990	21,196 (40) l			15,897 (30)	15,897 (30)
111 Kariakoo	13,805	8,283 (60) l			2,761 (20)	2,761 (20)
112 Jangwani	16,826	2,524 (15) l			5,889 (35)	8,413 (50)
113 Gerezani	8,223	6,990 (85) l			1,233 (15)	0 (-)
114 Kisutu	9,180		9,180 (100) m		0 (-)	0 (-)
115 Mchafukoge	9,387		9,387 (100) m		0 (-)	0 (-)
116 Upanga East	10,771			10,771 (100) h	0 (-)	0 (-)
117 Upanga West	12,103			12,103 (100) h	0 (-)	0 (-)
118 Kivukoni	5,900		5,900 (100) m		0 (-)	0 (-)
SUB-TOTAL	342,199	84,832 (25) l	24,467 (7) m	22,874 (7) h	64,714 (19)	145,312 (42)
TEMEKE Sub-branch						
201 Kigamboni	26,064	2,606 (10) l			7,819 (30)	15,639 (60)
202 Vijibweni	1,292	129 (10) l			388 (30)	775 (60)
207 Mbagala	44,883	2,244 (5) l			8,977 (20)	33,662 (75)
209 Yombo Vituka	10,750	538 (5) l			2,150 (20)	8,062 (75)
212 Miburani	80,058	16,012 (20) l			16,012 (20)	48,034 (60)
213 Temeke 14	100,104	30,031 (30) l			30,031 (30)	40,042 (40)
214 Mtoni	43,292	6,494 (15) l			10,823 (25)	25,975 (60)
215 Keko	47,082	16,479 (35) l			4,708 (10)	25,895 (55)
216 Kurasini	29,408	11,763 (40) l			2,941 (10)	14,704 (50)
SUB-TOTAL	382,933	86,296 (23) l			83,849 (22)	212,788 (56)
KINONDONI Sub-branch						
301 Msasani	56,335	28,168 (50) l		28,167 (50) h	0 (-)	0 (-)
302 Kinondoni	46,554			18,622 (40) h	13,966 (30)	13,966 (30)
303 Mwananyamala	79,636	19,909 (25) l			35,836 (45)	23,891 (30)
SUB-TOTAL	182,525	48,077 (26) l		46,789 (26) h	49,802 (27)	37,857 (21)
KAWE Sub-branch						
402 Kawe	37,767	16,995 (45) l			7,553 (20)	13,219 (35)
SUB-TOTAL	37,767	16,995 (45) l			7,553 (20)	13,219 (35)
MAGOMENI Sub-branch						
501 Magomeni	18,610	3,722 (20) l			5,583 (30)	9,305 (50)
502 Makurumla	59,299	14,825 (25) l			14,825 (25)	29,649 (50)
503 Ndugumbi	35,954	10,786 (30) l			10,786 (30)	14,382 (40)
504 Tandale	64,155	6,416 (10) l			19,247 (30)	38,492 (60)
505 Mzimuni	26,343	5,269 (20) l			10,537 (40)	10,537 (40)
506 Kigogo	23,308	5,827 (25) l			8,158 (35)	9,323 (40)
507 Mabibo	50,481	15,144 (30) l			15,144 (30)	20,193 (40)
508 Manzese	59,856	2,993 (5) l			14,964 (25)	41,899 (70)
509 Ubungo	51,598	33,539 (65) l			10,320 (20)	7,739 (15)
SUB-TOTAL	389,604	98,521 (25) l			109,564 (28)	181,519 (47)
Total	1,335,028	334,721 (25) l	24,467 (2) m	69,663 (5) h	315,482 (24)	590,695 (44)

Note: Class L = Low, M = Middle, H = High

TABLE A.1.3 HOUSEHOLD ACCORDING TO SERVICE LEVEL BY WARD (1990)

Sr. No.	Ward name	NUWA Total	House Number (%)	Connection class	Yard Connec. Number (%)	Kiosk/Standpipe Number (%)
ILALA Sub-branch						
101	Ukonga	11,123	1,112 (10)	L	2,225 (20)	7,786 (70)
102	Pugu					
104	Tabata	4,152	623 (15)	L	623 (15)	2,906 (70)
105	Kinyerezi	128	90 (70)	L	13 (10)	25 (20)
106	Ilala	9,051	5,431 (60)	L	2,715 (30)	905 (10)
107	Mchikichini	3,703	1,481 (40)	L	1,481 (40)	741 (20)
108	Vinguguti	9,589	959 (10)	L	959 (10)	7,671 (80)
109	Kipawa	10,194	1,019 (10)	L	1,019 (10)	8,156 (80)
110	Buguruni	14,495	5,798 (40)	L	4,349 (30)	4,348 (30)
111	Kariakoo	2,745	1,647 (60)	L	549 (20)	549 (20)
112	Jangwani	3,194	479 (15)	L	1,118 (35)	1,597 (50)
113	Gerezani	1,710	1,454 (85)	L	256 (15)	0 (--)
114	Kisutu	1,866	1,866 (100)	M	0 (-)	0 (-)
115	Mchafukoge	1,762	1,762 (100)	M	0 (-)	0 (-)
116	Upanga East	826	826 (100)	H	0 (-)	0 (-)
117	Upanga West	1,794	1,794 (100)	H	0 (-)	0 (-)
118	Kivukoni	858	858 (100)	M	0 (-)	0 (-)
	SUB-TOTAL	77,190	20,093 (26)	L	15,307 (20)	34,684 (45)
			4,486 (6)	M		
			2,620 (3)	H		
TEMEKE Sub-branch						
201	Kigamboni	6,193	619 (10)	L	1,858 (30)	3,716 (60)
202	Vijibweni	263	26 (10)	L	79 (30)	158 (60)
207	Mbagala	10,477	524 (5)	L	2,095 (20)	7,858 (75)
209	Yombo Vituka	2,306	115 (5)	L	461 (20)	1,730 (75)
212	Miburani	18,444	3,689 (20)	L	3,689 (20)	11,066 (60)
213	Temeke 14	24,460	7,338 (30)	L	7,338 (30)	9,784 (40)
214	Mtoni	10,703	1,605 (15)	L	2,676 (25)	6,422 (60)
215	Keko	11,525	4,034 (35)	L	1,153 (10)	6,338 (55)
216	Kurasini	6,349	2,540 (40)	L	635 (10)	3,174 (50)
	SUB-TOTAL	90,720	20,490 (23)	L	19,984 (22)	50,246 (55)
KINONDONI Sub-branch						
301	Msasani	11,905	5,953 (50)	L	0 (-)	0 (-)
			5,952 (50)	H		
302	Kinondoni	10,462	4,185 (40)	H	3,139 (30)	3,138 (30)
303	Mwananyamala	18,609	4,652 (25)	L	8,374 (45)	5,583 (30)
	SUB-TOTAL	40,976	10,605 (26)	L	11,513 (28)	8,721 (21)
			10,137 (25)	H		
KAWE Sub-branch						
402	Kawe	9,018	4,058 (45)	L	1,804 (20)	3,156 (35)
	SUB-TOTAL	9,018	4,058 (45)	L	1,804 (20)	3,156 (35)
MAGOMENI Sub-branch						
501	Magomeni	4,790	958 (20)	L	1,437 (30)	2,395 (50)
502	Makurumla	14,264	3,566 (25)	L	3,566 (25)	7,132 (50)
503	Ndugumbi	8,713	2,614 (30)	L	2,614 (30)	3,485 (40)
504	Tandale	14,695	1,470 (10)	L	4,409 (30)	8,816 (60)
505	Mzimuni	6,378	1,276 (20)	L	2,551 (40)	2,551 (40)
506	Kigogo	5,154	1,289 (25)	L	1,804 (35)	2,061 (40)
507	Mabibo	11,819	3,546 (30)	L	3,546 (30)	4,727 (40)
508	Manzese	14,096	705 (5)	L	3,524 (25)	9,867 (70)
509	Ubungo	10,457	6,797 (65)	L	2,091 (20)	1,569 (15)
	SUB-TOTAL	90,366	22,221 (25)	L	25,542 (28)	42,603 (47)
DAR-ES-SALAAM		308,270	77,467 (25)	L	74,150 (24)	139,410 (45)
			4,486 (1)	M		
			12,757 (4)	H		

Note: Class L = Low, M = Middle, H = High

- A.1.9 -

TABLE A.1.4 DOMESTIC WATER DEMAND BY WARD (1990)

(Uniit:m³/day)

Sr. No.	Ward name	House		Yard	Kiosk/ Standpipe	TOTAL
ILALA Sub-branch						
101	Ukonga	794	L	844	765	2,403
102	Pugu			828		828
104	Tabata	487	L	259	312	1,058
105	Kinyerezi	60	L	5	2	67
106	Ilala	3,695	L	982	85	4,762
107	Mchikichini	1,057	L	562	73	1,692
108	Vinguguti	592	L	315	651	1,558
109	Kipawa	649	L	345	713	1,707
110	Buguruni	3,391	L	1,351	350	5,092
111	Kariakoo	1,325	L	235	61	1,621
112	Jangwani	404	L	501	185	1,090
113	Gerezani	1,118	L	105	0	1,223
114	Kisutu	2,295	M	0	0	2,295
115	Mchafukoge	2,347	M	0	0	2,347
116	Upanga East	4,308	H	0	0	4,308
117	Upanga West	4,841	H	0	0	4,841
118	Kivukoni	1,475	M	0	0	1,475
	SUB-TOTAL	13,572	L	6,332	3,197	38,367
		6,117	M			
		9,149	H			
TEMEKE Sub-branch						
201	Kigamboni	417	L	665	344	1,426
202	Vijibweni	21	L	33	17	71
207	Mbagala	359	L	763	741	1,863
209	Yombo Vituka	86	L	183	177	446
212	Miburani	2,562	L	1,361	1,057	4,980
213	Temeke 14	4,805	L	2,553	881	8,239
214	Mtoni	1,039	L	920	571	2,530
215	Keko	2,637	L	400	570	3,607
216	Kurasini	1,882	L	250	323	2,455
	SUB-TOTAL	13,808	L	7,128	4,681	25,617
KINONDONI Sub-branch						
301	Msasani	4,507	L	0	0	15,774
		11,267	H			
302	Kinondoni	7,449	H	1,187	307	8,943
303	Mwananyamala	3,185	L	3,046	526	6,757
	SUB-TOTAL	7,692	L	4,233	833	31,474
		18,716	H			
KAWE Sub-branch						
402	Kawe	2,719	L	642	291	3,652
	SUB-TOTAL	2,719	L	642	291	3,652
MAGOMENI Sub-branch						
501	Magomeni	596	L	475	205	1,276
502	Makurumla	2,372	L	1,260	652	4,284
503	Ndugumbi	1,726	L	917	316	2,959
504	Tandale	1,027	L	1,636	847	3,510
505	Mzimuni	843	L	896	232	1,971
506	Kigogo	932	L	693	205	1,830
507	Mabibo	2,423	L	1,287	444	4,154
508	Manzese	479	L	1,272	922	2,673
509	Ubungo	5,366	L	877	170	6,413
	SUB-TOTAL	15,764	L	9,313	3,993	29,070
	DAR-ES-SALAAM	53,555	L	27,648	12,995	128,180
		6,117	M			
		27,865	H			

Note: Class L = Low, M = Middle, H = High

TABLE A.1.5 COMPARISON BETWEEN DOMESTIC WATER CONNECTION FROM CURRENT STUDY AND NUWA RECORDS

Sr. No.	Ward	(A) Current Study House	@Yard	Total	(B) 1990 NUWA record	Ratio B/A
ILALA Sub-branch						
101	Ukonga	1,112	618	1,730	236	14%
102	Pugu					
104	Tabata	623	173	796	568	71%
105	Kinyerezi	90	4	94	94	100%
106	Ilala	5,431	754	6,185	2,312	37%
107	Mchikichini	1,481	411	1,892	82	4%
108	Vingunguti	959	266	1 225		
109	Kipawa (1)	1,019	283	1,302	567	22%
110	Buguruni	5,798	1,208	7,006	213	3%
111	Kariakoo	1,647	153	1,800	1,607	89%
112	Jangwani	479	311	790	757	96%
113	Gerezani	1,454	71	1,525	744	
114	Kisutu (2)	1,866	0	1,866	3,483	82%
115	Mchafukoge	1,762	0	1,762		
116	Upanga East(3)	826	0	826	2,045	248%
117	Upanga West	1,794	0	1,794	1,534	86%
118	Kivukoni	858	0	858	444	52%
	SUB-TOTAL	27,199	4,252	31,451	14,686	47%
TEMEKE Sub-branch						
201	Kigamboni (4)	619	516	1,135	139	12%
202	Vijibweni	26	22	48		
207	Mbagala	524	582	1,106	872	79%
209	Yombo-Vituka	115	128	243		
212	Miburani	3,689	1,025	4,714		
213	Temeke 14	7,338	2,038	9,376	5,364	57%
214	Mtoni	1,605	743	2,348	1,862	79%
215	Keko	4,034	320	4,354	1,253	29%
216	Kurasini (5)	2,540	176	2,716	1,087	15%
	SUB-TOTAL	20,490	5,551	26,041	10,577	41%
KINONDONI Sub-branch						
301	Msasani	11,905	0	11,905	2,920	25%
302	Kinondoni	4,185	872	5,057	3,420	68%
303	Mwananyamala	4,652	2,326	6,978	2,632	38%
	SUB-TOTAL	20,742	3,198	23,940	8,972	38%
KAWE Sub-branch						
402	Kawe	4,058	501	4,559	4,216	93%
	SUB-TOTAL	4,058	501	4,559	4,216	93%
MAGOMENI Sub-branch						
501	Magomeni (6)	958	399	1,357	2,290	30%
502	Makurumla	3,566	991	4,557	385	8%
503	Ndugumbi	2,614	726	3,340	921	28%
504	Tandale	1,470	1,225	2,695		
505	Mzimuni	1,276	709	1,985		
506	Kigogo	1,289	501	1,790	1,680	94%
507	Mabibo	3,546	985	4,531	1,197	26%
508	Manzese	705	979	1 684		
509	Ubungo	6,797	581	7,378	7,345	100%
	SUB-TOTAL	22,221	7,095	29,316	13,818	47%
DAR ES SALAAM		94,710	20,598	115,308	52,269	45%

Notes : @ Yard connections = No. of households having
yard connections (refer to Table A.1.3) divided
by 3.6 families per yard connection
(1) NUWA's Kipawa includes Vingunguti
(2) NUWA's Gerezani & Kisutu also includes Mchafukoge
(3) No. of NUWA connections in Upanga East
exceed total number of households
(4) NUWA's Kigamboni includes Vijibweni
(5) NUWA's Kurasini includes Miburani
(6) NUWA's Magomeni includes Tandale, Mzimuni and Manzese

1.3 INDUSTRIAL, COMMERCIAL AND INSTITUTIONAL WATER CONSUMPTION

Estimation of water demand by industrial, commercial and institutional consumers is clubbed together, as the methodology used is very similar.

NUWA has assigned account numbers to consumers, as in the case of domestic consumers. These account-holders include all consumers who consume more than 50 m^3/d. The NUWA accounts also include a portion of consumers who consume less than this value. As in the case of domestic consumers, there are a number of connections which are not registered with NUWA, and therefore without account numbers. This is significant only in the case of commercial consumers, though.

In addition, NUWA has also installed water meters in about 750 establishments for research purposes in 1989. NUWA, however, does not classify non-domestic consumers into the above-mentioned categories.

Meter readings of the water consumption of the 750 establishments for 1989 were used as the basis for estimation of water demand by industrial, commercial and institutional establishments. The Study Team, in consultation with the sub-branch offices, as well as NUWA officials, classified all this data into the three categories, to facilitate data analysis.

Consumption by all metered establishments, in each category, are as follows;

Industrial consumers	-	2,000 m^3/d
Commercial "	-	900 m^3/d
Institutional "	-	930 m^3/d

'Large' consumers in all three categories are all included in the 750 metered establishments. Therefore, total demand in each category is the sum of the water consumption by 'large' consumers and 'small' consumers. The former are all account-holders and metered, hence this consumption can be easily determined, since it is the actual consumption values observed through meter readings.

In the case of 'small' consumers, as mentioned before, since there may be a number of establishments which are not metered, a water consumption per day per consumer value was calculated. This value was derived from the consumption of the metered establishments. However, for the sake of matching the magnitude of consumption, consumption values of establishments with consumption greater than 50 m^3/d were excluded, so as to ensure that the calculated value is representative of smaller establishments. This was done separately for each of the three categories and the results are as follows ;

Industrial consumer   - 6.2 m³/d/consumer
Commercial   " - 1.2   "
Institutional   " - 4.1   "

Determination of the demand of 'small' consumers involves firstly, the estimation of the number of 'small' consumers over and above those registered with NUWA. After that, the sum of this unregistered numbers and the registered numbers is multiplied with the per establishment water consumption discussed earlier.

In the case of industrial and institutional consumers, NUWA billing accounts include all consumers in each category, i.e. there are no unregistered consumers. Unlike domestic consumers, since industrial units have to be registered before setting up shop, it is difficult for such industries to tap lines illegally although the possibility exists. In the case of institutions, it is even more unlikely that there are unregistered, illegal connection.

'Large' consumers' demand is obtained from the meter records. 'Small' consumers' demand is determined by multiplying the per consumer demand by the difference between the total number of account holders and 'large' consumers. This, when added to the actual consumption figures of 'large' consumers, gives the total water consumption for industrial and institutional consumers, and given in Tables A.1.6 and A.1.8, respectively.

The total industrial demand estimated above is confirmed by another method, since it is remotely possible that there may be small industrial units which may tap illegally into water lines.

The two main industrial belts in DSM are 1) along Pugu Road, between the city center and the airport, and 2) in Ubungo. In these two industrial regions, the area of the industries, where water meters are installed, are known as well as the areas of all industries.

	Area of industries with meters	Area of all industries
Pugu Industrial belt	0.98	3.04
Ubungo " "	0.48	0.53
T O T A L	1.46	3.57

Industrial demand is estimated by the method of proportions, on the assumption that industrial demand is proportional to the area occupied. From this, the total industrial demand can be calculated as given below

$$2000 \times 3.57 / 1.46 = 4,900 \text{ m}^3/\text{d}$$

This figure for the total industrial consumption matches well with that obtained from the previous analysis, 4,612 m^3/d and given in Table A.1.6. Hence the value of 4,600 m^3/d is adopted as the industrial demand.

However, in the case of commercial consumers, it appears that there are a considerable numbers of unregistered consumers. According to a survey conducted by the Ardhi Institute, the ratio of the total number of commercial consumers to the total number of registered commercial consumers (i.e. with account numbers) is of the order of 1.8.

Therefore, the total number of commercial consumers can accordingly be estimated as 1.8 times the total number of commercial accounts, i.e.,

Total number of commercial connection = 1.8 x No. of consumers with account numbers

The ward-wise breakup of commercial water demand is given in Table A.1.7, along with calculations above.

In summary, total consumption in each category is as follows :

Industrial consumers - 4,600 m^3/d
Commercial " - 6,300 m^3/d
Institutional " - 5,400 m^3/d
T O T A L = 16,300 m^3/d

1.4 TOTAL WATER DEMAND, SUPPRESSED AND UNSUPPRESSED DEMAND

In the previous sections, the water demand for each component of consumption - domestic, industrial, commercial and institutional - was determined on a ward-by-ward basis. The total demand in each ward is the sum of the individual components which is shown in Table A.1.9.

However, at the present time, demand is suppressed in some areas in DSM due to the unavailability of sufficient water pressure. This suppression affects all components of water demand - domestic, industrial, commercial and institutional - and has to be accounted for in the calculation of the present water consumption figures.

Present water consumption figures are input data for calibration of the network model of DSM, which will be expounded in greater detail in the next chapter. Hence, it is necessary to develop factors to account for demand suppression on a ward-to-ward basis.

Theoretically, the degree of water demand suppression is a direct function of the effective water pres-

sure (absolute pressure minus ground level elevation) in the distribution system.

However, due to insufficient water pressure and flow round the clock, residents and establishments in DSM have circumvented their water shortage problems by installing pumps and storage tanks on their premises and pumping water into the tanks during periods of water availability. This has an effect on the degree of water demand suppression.

Water pressure measurements were made in January and August 1990 on the primary distribution system in DSM. The measured values were superimposed on the map of DSM, so as to enable evaluation of the water pressure profile within each ward. Based on the effective water pressures in the different wards of DSM, and taking into consideration the suppression circumvention mentioned earlier, suppression factors have been developed for each ward in DSM.

The condition used was that an effective pressure of 10 m and above would ensure sufficient water was available and therefore, demand suppression was non-existent. Lower effective water pressures would impose demand suppression, the magnitude of which would increase progressively with decreases in effective pressure. Wards having sufficient pressure were assigned a factor of 0.95, implying no suppression. Factors of 0.8, 0.7, 0.6 and 0.5 were assigned for decreasing effective pressures.

On the basis of the factors so developed, the actual water consumption (suppressed demand) in DSM in 1990 is shown in Table A.1.10. Wards where there is no consumption at present (Gongo La Mboto Pumping Station and Yombo-vituka ward) have been assigned a factor of 0, implying that there is no demand in that ward.

The water supply and demand balance for DSM is as given in Table A.1.11. From this, it can be seen that the overall leakage within the NUWA distribution is 35 %. The overall current suppression factor for DSM is 87 %, signifying that in 1990, insufficient water pressure causes the water consumption to drop 13 % from what would normally be consumed had water pressure not been a constraining factor.

The 87% is a value on a daily average base. Considering peak hour on a daily maximum demand day, this value will decrease. Assuming that peak hourly factor is 1.36 and that ratio of daily maximum demand to daily average one is 1.25, only 51% can obtain water during peak periods.

TABLE A.1.6 INDUSTRIAL CONSUMPTION

Sr.No. Ward name	A (B)	C (D)	E (F)	G	H	I	J
ILALA Sub-branch							
101 Ukonga	0 (0)	0 (0)	0 (0)	2	2	12	12
104 Tabata	0 (0)	0 (0)	0 (0)	2	2	12	12
105 Kinyerezi	0 (0)	0 (0)	0 (0)	0	0	0	0
106 Ilala	623 (2)	623 (2)	0 (0)	5	3	19	642
107 Mchikichini	0 (0)	0 (0)	0 (0)	0	0	0	0
109 Kipawa & Vingunguti	17 (5)	0 (0)	17 (5)	36	31	192	209
110 Buguruni	0 (0)	0 (0)	0 (0)	4	4	25	25
111 Kariakoo	0 (0)	0 (0)	0 (0)	4	4	25	25
112 Jangwani	0 (0)	0 (0)	0 (0)	2	2	12	12
113 Gerezani & Mchafukoge	0 (0)	0 (0)	0 (0)	7	7	43	43
114 Kisutu & Mcahfukoge	1 (1)	0 (0)	1 (1)	12	11	68	69
116 Upanga East	0 (0)	0 (0)	0 (0)	0	0	0	0
117 Upanga West	0 (0)	0 (0)	0 (0)	0	0	0	0
118 Kivukoni	0 (0)	0 (0)	0 (0)	3	3	19	19
SUB-TOTAL	641 (8)	623 (2)	18 (6)	77	69	428	1,068
TEMEKE Sub-branch							
201 Kigamboni & Vijibweni	140 (1)	140 (1)	0 (0)	4	3	19	159
207 Mbagala	0 (0)	0 (0)	0 (0)	1	1	6	6
213 Temeke 14	222 (29)	80 (1)	142 (28)	285	256	1587	1809
214 Mtoni	0 (0)	0 (0)	0 (0)	0	0	0	0
215 Keko	1 (1)	0 (0)	1 (1)	29	28	174	175
216 Kurasini & Miburani	0 (0)	0 (0)	0 (0)	12	12	74	74
SUB-TOTAL	363 (31)	220 (2)	143 (29)	331	300	1860	2223
KINONDONI Sub-branch							
301 Msasani	2 (1)	0 (0)	2 (1)	3	2	12	14
302 Kinondoni	0 (0)	0 (0)	0 (0)	3	3	19	19
303 Mwananyamala	0 (2)	0 (0)	0 (2)	2	0	0	0
SUB-TOTAL	2 (3)	0 (0)	2 (3)	8	5	31	33
KAWE Sub-branch							
402 Kawe	44 (4)	0 (0)	44 (4)	38	34	211	255
SUB-TOTAL	44 (4)	0 (0)	44 (4)	38	34	211	255
MAGOMENI Sub-branch							
501 Magomeni & Tandale	0(0)	0(0)	0(0)	0	0	0	0
502 Makurumla	0(0)	0(0)	0(0)	0	0	0	0
503 Ndugumbi	0(0)	0(0)	0(0)	0	0	0	0
506 Kigogo	0(0)	0(0)	0(0)	2	2	12	12
507 Mabibo	0(0)	0(0)	0(0)	0	0	0	0
509 Ubungo	953(8)	862(2)	91(6)	19	11	68	1021
SUB-TOTAL	953(8)	862(2)	91(6)	21	13	81	1033
TOTAL	2003(54)	1705(6)	298 (48)	475	421	2610	4612

NOTE : A Total metered consumption in m^3/day
B Total meter number
C Big consumers' metered consumption in m^3/day
D Big consumers' meter number
E Small consumers' metered consumption in m^3/day
F Small consumers' meter number
G Number of consumers registered to NUWA
H Number of consumers without meter
I Consumption of consumers without meter in m^3/day
J Total consumption in m^3/day = (A) + (I)

TABLE A.1.7 COMMERCIAL CONSUMPTION

Sr.No. Ward name	A (B)	C (D)	E (F)	G	H	I	J	K
ILALA Sub-branch								
101 Ukonga	0(0)	0(0)	0(0)	9	16	16	19	19
104 Tabata	0(0)	0(0)	0(0)	36	65	65	78	78
105 Kinyerezi	12(1)	0(0)	12(1)	1	2	1	1	13
106 Ilala	17(24)	0(0)	17(24)	158	284	260	312	330
107 Mchikichini	0(0)	0(0)	0(0)	0	0	0	0	0
109 Kipawa & Vingunguti	0(0)	0(0)	0(0)	63	113	113	136	136
110 Buguruni	13(12)	0(0)	13(12)	56	101	89	107	119
111 Kariakoo	41(33)	0(0)	41(33)	128	230	197	237	278
112 Jangwani	91(16)	72(1)	19(15)	53	95	79	95	187
113 Gerezani & Mchafukoge	13(12)	0(0)	13(12)	65	117	105	126	139
114 Kisutu & Mcahfukoge	35(41)	0(0)	35(41)	505	909	868	1042	1076
116 Upanga East	0(0)	0(0)	0(0)	4	7	7	9	9
117 Upanga West	3(1)	0(0)	3(1)	4	7	6	7	11
118 Kivukoni	128(8)	94(1)	34(7)	47	85	77	92	220
SUB-TOTAL	**354 (148)**	**166 (2)**	**188 (146)**	**1129**	**2032**	**1884**	**2261**	**2615**
TEMEKE Sub-branch								
201 Kigamboni & Vijibweni	0(0)	0(0)	0(0)	3	5	5	6	6
207 Mbagala	3(1)	0(0)	3(1)	6	11	10	12	15
213 Temeke 14	110(51)	71(1)	39(50)	192	346	295	354	463
214 Mtoni	1(6)	0(0)	1(6)	47	85	79	94	95
215 Keko	82(10)	0 (0)	82(10)	79	142	132	159	240
216 Kurasini & Miburani	175(4)	174(2)	1(2)	49	88	84	101	276
SUB-TOTAL	**370 (72)**	**245 (3)**	**125 (69)**	**376**	**677**	**605**	**726**	**1095**
KINONDONI Sub-branch								
301 Msasani	24(10)	0 (0)	24(10)	134	241	231	277	302
302 Kinondoni	21(50)	0 (0)	21(50)	287	517	467	560	581
303 Mwananyamala	20(23)	0 (0)	20(23)	222	400	377	452	472
SUB-TOTAL	**65 (83)**	**0 (0)**	**65 (83)**	**643**	**1157**	**1074**	**1289**	**1355**
KAWE Sub-branch								
402 Kawe	12(11)	0 (0)	12(11)	90	161	150	180	192
SUB-TOTAL	**12 (11)**	**0 (0)**	**12 (11)**	**90**	**161**	**150**	**180**	**192**
MAGOMENI Sub-branch								
501 Magomeni & Tandale	41(35)	0 (0)	41(35)	140	252	217	260	302
502 Makurumla	1(3)	0 (0)	1(3)	7	13	10	12	12
503 Ndugumbi	6(11)	0 (0)	6(11)	41	74	63	75	81
506 Kigogo	1(1)	0 (0)	1(1)	25	45	44	53	54
507 Mabibo	4(3)	0 (0)	4(3)	10	18	15	18	22
509 Ubungo	49(53)	0 (0)	49(53)	263	473	420	504	554
SUB-TOTAL	**101 (106)**	**0 (0)**	**101 (106)**	**486**	**875**	**769**	**923**	**1025**
Total	**901 (420)**	**411 (5)**	**490 (415)**	**2724**	**4902**	**4482**	**5379**	**6282**

Note : A Total metered consumption in m³/day
  B Total meter number
  C Big consumers' metered consumption in m³/day
  D Big consumers' meter number
  E Small consumers' metered consumption in m³/day
  F Small consumers' meter number
  G Number of consumers registered to NUWA
  H Estimated number of consumers = G x 1.8
  I Number of consumers without meter
  J Consumption of consumers without meter in m³/day
  K Total consumption in m³/day = (A) + (J)

TABLE A.1.8 INSTITUTIONAL CONSUMPTION

Sr.No. Ward name	A (B)	C (D)	E (F)	G	H	I	J
ILALA Sub-branch							
101 Ukonga	0 (0)	0(0)	0(0)	15	15	62	62
104 Tabata	0 (0)	0(0)	0(0)	2	2	8	8
105 Kinyerezi	0 (0)	0(0)	0(0)	0	0	0	0
106 Ilala	36 (3)	0(0)	36 (3)	37	34	139	175
107 Mchikichini	0 (0)	0(0)	0(0)	0	0	0	0
109 Kipawa & Vingunguti	0 (1)	0(0)	0(1)	58	57	234	234
110 Buguruni	5(2)	0(0)	5(2)	8	6	25	30
111 Kariakoo	0 (0)	0(0)	0(0)	9	9	37	37
112 Jangwani	0 (0)	0(0)	0(0)	2	2	8	8
113 Gerezani & Mchafukoge	1(1)	0(0)	1(1)	10	9	37	38
114 Kisutu & Mchafukoge	2(3)	0(0)	2(3)	69	66	271	272
116 Upanga East	15 (3)	0(0)	15 (3)	55	52	213	228
117 Upanga West	15 (2)	0(0)	15 (2)	120	118	484	499
118 Kivukoni	24 (6)	0(0)	24 (6)	163	157	644	667
SUB-TOTAL	97 (21)	0 (0)	97 (21)	548	527	2161	2258
TEMEKE Sub-branch							
201 Kigamboni & Vijibweni	0 (0)	0(0)	0(0)	9	9	37	37
207 Mbagala	0 (0)	0(0)	0(0)	0	0	0	0
213 Temeke 14	9(7)	0(0)	9(7)	153	146	599	607
214 Mtoni	0 (0)	0(0)	0(0)	7	7	29	29
215 Keko	15 (5)	0(0)	15 (5)	65	60	246	261
216 Kurasini & Miburani	126 (1)	126 (1)	0(0)	50	49	201	327
SUB-TOTAL	149 (13)	126 (1)	23 (12)	284	271	1111	1261
KINONDONI Sub-branch							
301 Msasani	5(2)	0(0)	5(2)	64	62	254	259
302 Kinondoni	7(5)	0(0)	7(5)	57	52	213	220
303 Mwananyamala	0 (0)	0(0)	0(0)	18	18	74	74
SUB-TOTAL	12 (7)	0 (0)	12 (7)	139	132	541	553
KAWE Sub-branch							
402 Kawe	610 (9)	559 (1)	51 (8)	126	117	478	1088
SUB-TOTAL	610 (9)	559 (1)	51 (8)	126	117	478	1088
MAGOMENI Sub-branch							
501 Magomeni & Tandale	35 (2)	0(0)	35 (2)	2	0	0	35
502 Makurumla	0 (0)	0(0)	0 (0)	0	0	0	0
503 Ndugumbi	0 (0)	0(0)	0 (0)	2	2	8	8
506 Kigogo	0 (0)	0(0)	0 (0)	1	1	4	4
507 Mabibo	1(1)	0(0)	1 (1)	1	0	0	1
509 Ubungo	24 (8)	0(0)	24 (8)	38	30	123	147
SUB-TOTAL	61 (11)	0(0)	61 (11)	44	33	135	195
TOTAL	928 (61)	685 (2)	243 (59)	1141	1080	4427	5355

NOTE : A   Total metered consumption in m³/day
B   Total meter number
C   Big consumers' metered consumption in m³/day
D   Big consumers' meter number
E   Small consumers' metered consumption in m³/day
F   Small consumers' meter number
G   Number of consumers registered to NUWA
H   Estimated number of consumers = Number of consumers without meter
I   Consumption of consumers without meter in m³/day
J   Total consumption in m³/day = (A) + (I)

TABLE A.1.9 UNSUPPRESSED WATER DEMAND, 1990

(Unit: m³/day)

No. Ward Name	Domestic	Industrial	Commercial	Institutional	Total
101 Ukonga	2,403	12	19	62	2,496
102 Pugu	828				828
104 Tabata	1,058	12	78	8	1,156
105 Kinyerezi	67	0	13	0	80
106 Ilala	4,762	642	330	175	5,909
107 Mchikichini	1,692	0	0	0	1,692
108 Vingunguti	1,558				1,558
109 Kipawa	1,707	209	136	234	2,286
110 Buguruni	5,092	25	119	30	5,266
111 Kariakoo	1,621	25	278	37	1,961
112 Jangwani	1,090	12	187	8	1,297
113 Gerezani	1,223	43	139	38	1,443
114 Kisutu	2,295	69	1,076	272	3,712
115 Mchafukoge	2,347				2,347
116 Upanga East	4,308	0	9	228	4,545
117 Upanga West	4,841	0	11	499	5,351
118 Kivukoni	1,475	19	220	667	2,381
SUB-TOTAL	38,367	1,068	2,615	2,258	44,308
TEMEKE Sub-branch					
201 Kigamboni	1,426	159	6	37	1,628
202 Vijibweni	71				71
207 Mbagala	1,863	6	15	0	1,884
209 Yombo Vituka	446				446
212 Miburani	4,980				4,980
213 Temeke 14	8,239	1,809	463	607	11,118
214 Mtoni	2,530	0	95	29	2,654
215 Keko	3,607	175	240	261	4,283
216 Kurasini	2,455	74	276	327	3,132
SUB-TOTAL	25,617	2,223	1,095	1,261	30,196
KINONDONI Sub-branch					
301 Msasani	15,774	14	302	259	16,349
302 Kinondoni	8,943	19	581	220	9,763
303 Mwananyamala	6,757	0	472	74	7,303
SUB-TOTAL	31,474	33	1,355	553	33,415
KAWE Sub-branch					
402 Kawe	3,652	255	192	1,088	5,187
SUB-TOTAL	3,652	255	192	1,088	5,187
MAGOMENI Sub-branch					
501 Magomeni	1,276	0	302	35	1,613
502 Makurumla	4,284	0	12	0	4,296
503 Ndugumbi	2,959	0	81	8	3,048
504 Tandale	3,510				3,510
505 Mzimuni	1,971				1,971
506 Kigogo	1,830	12	54	4	1,900
507 Mabibo	4,154	0	22	1	4,177
508 Manzese	2,673				2,673
509 Ubungo	6,413	1,021	554	147	8,135
SUB-TOTAL	29,070	1,033	1,025	195	31,323
TOTAL	128,180	4,612	6,282	5,355	144,429

TABLE A.1.10 SUPPRESSED AND ACTUAL WATER DEMAND, 1990

(Unit : m³/day)

Sr. No.	Ward	Suppression Factor	Domestic	Industry Large*	Industry Small	Commercial Large*	Commercial Small	Institutional Large*	Institutional Small	Total
ILALA Sub-branch										
101	Ukonga	0.50	1,202	0	6	0	10	0	31	1,249
102	Pugu	0.00	0	0	0	0	0	0	0	0
104	Tabata	0.50	529	0	6	0	39	0	4	578
105	Kinyerezi	0.50	34	0	0	12	1	0	0	47
106	Ilala	0.80	3,810	623	15	0	264	30	116	4,858
107	Mchikichini	0.80	1,354	0	0	0	0	0	0	1,354
108	Vingunguti	0.60	935	0	0	0	0	0	0	935
109	Kipawa	0.60	1,024	0	125	0	82	0	140	1,371
110	Buguruni	0.95	4,837	0	24	0	113	0	29	5,003
111	Kariakoo	0.95	1,540	0	24	0	264	0	35	1,863
112	Jangwani	0.95	1,036	0	11	72	109	0	8	1,236
113	Gerezani	0.95	1,162	0	41	0	132	0	36	1,371
114	Kisutu	0.95	2,180	0	66	0	1,022	0	258	3,526
115	Mchafukoge	0.95	2,230	0	0	0	0	0	0	2,230
116	Upanga East	0.95	4,093	0	0	0	9	0	217	4,319
117	Upanga West	0.95	4,599	0	0	0	10	13	462	5,084
118	Kivukoni	0.95	1,401	0	18	119	96	12	622	2,268
	SUB-TOTAL		31,966	623	336	203	2,151	55	1,958	37,292
TEMEKE Sub-branch										
201	Kigamboni	0.60	856	140	11	0	4	0	22	1,033
202	Vijibweni	0.60	43	0	0	0	0	0	0	43
207	Mbagala	0.70	1,304	0	4	0	11	0	0	1,319
209	Yombo Vituka	0.00	0	0	0	0	0	0	0	0
212	Miburani	0.80	3,984	0	0	0	0	0	0	3,984
213	Temeke 14	0.80	6,591	167	1,314	71	314	0	486	8,943
214	Mtoni	0.80	2,024	0	0	0	76	0	23	2,123
215	Keko	0.95	3,427	0	166	59	172	0	248	4,072
216	Kurasini	0.80	1,964	0	59	174	82	126	161	2,566
	SUB-TOTAL		20,193	307	1,554	304	659	126	940	24,083
KINONDONI Sub-branch										
301	Msasani	0.95	14,985	0	13	0	287	0	246	15,531
302	Kinondoni	0.95	8,496	0	18	0	552	0	209	9,275
303	Mwananyamala	0.95	6,419	0	0	0	448	0	70	6,937
	SUB-TOTAL		29,900	0	31	0	1,287	0	525	31,743
KAWE Sub-branch										
402	Kawe	0.95	3,469	31	213	0	182	599	465	4,959
	SUB-TOTAL		3,469	31	213	0	182	599	465	4,959
MAGOMENI Sub-branch										
501	Magomeni	0.80	1,021	0	0	13	231	29	5	1,299
502	Makurumla	0.95	4,070	0	0	0	11	0	0	4,081
503	Ndugumbi	0.95	2,811	0	0	0	77	0	8	2,896
504	Tandale	0.95	3,335	0	0	0	0	0	0	3,335
505	Mzimuni	0.95	1,872	0	0	0	0	0	0	1,872
506	Kigogo	0.70	1,281	0	8	0	38	0	3	1,330
507	Mabibo	0.70	2,908	0	0	0	15	0	1	2,924
508	Manzese	0.80	2,138	0	0	0	0	0	0	2,138
509	Ubungo	0.95	6,092	943	74	0	526	16	124	7,775
	SUB-TOTAL		25,528	943	82	13	898	45	141	27,650
	TOTAL	0.87	111,056	1,904	2,216	520	5,177	825	4,029	125,727

* more than 10 m³/day (more than 50 m³/day in case of unsuppressed demand).

TABLE A.1.11 WATER SUPPLY AND DEMAND BALANCE IN DAR ES SALAAM
(1990, DAILY AVERAGE BASE)

(A) Gross Supply:		296,300 m³/day
(Lower Ruvu Treatment Plant)	207,500	
(Upper Ruvu Treatment Plant)	82,000	
(Mtoni Treatment Plant)	6,800	
(B) Net Supply:		193,400 m³/day
(C) Leakage Ratio:		35 %
(D) Unsuppressed Consumption (Daily average)		144,429 m³/day
(E) Unsuppressed Demand: (D)/{1-(C)}		222,200 m³/day
(F) Overall Suppression Factor: (B)/(E)		87 %
(G) Suppressed Consumption (Daily average)		125,727 m³/day
(H) Suppressed Demand: (G)/{1-(C)}		193,400 m³/day

1.5 PEAK FACTOR

1.5.1 PRESENT PEAK FACTOR

Peak factors in the distribution system were estimated from the total flow from the three water sources at University, Kimara and Mtoni, which were available from NUWA records and Study Team investigations.

At the university reservoir, NUWA only records the inflow into the reservoir. There are two outflows - through the 54" and 33" pipes. The study team investigated the outflow fluctuation through the 54" and the fluctuation pattern for the entire volume was based on this fluctuation observed for the 54" pipeline.

At Kimara Reservoir, there are no inflow records with NUWA, but the outlet is controlled by a valve for most of the day. When the valve is closed,the water level in the reservoir rises and the water inflow is calculated from the rise. This inflow is assumed to be constant, and applicable for the period when the valve is opened. The outflow from the reservoir has been estimated to be the difference between the inflow volume and the drop in the rise in the water level, when the valves were open.

At Mtoni, the outflow volume has been estimated from NUWA records. The outflow from all the three water sources are shown in Figure A.1.2. From this figure, it can be seen that the outflow volume is 182,000 m³/day and the hourly peaking factor is 1.47, which was obtained on 3rd, August,1990 .
It can also be seen that the Kimara curve reflects the condition when the valve is open. It is flat at all other times. The period when the valve is closed is the period when demand suppression occurs.

1.5.2 PEAK FACTOR FOR UNSUPPRESSED DEMAND

Since the rehabilitated system will eliminate demand suppression, peaking factors for unsuppressed demand in each component of demand - domestic, industrial, commercial and institutional - need to be developed.

In the case of domestic demand, the consumption pattern observed by flow meter measurements in the 3 model areas is used to obtain the peak flow curve for domestic consumption and given in Figure A.1.2. Since leakage has been included in the current consumption pattern, leakage is removed and the actual domestic consumption is estimated. To determine the leakage as a function of water pressure, the lowest flow rate in the curve is considered to represent leakage. Leakage flows at other times is obtained as a proportion of this flow, based on the respective water pressure.

For industrial, commercial and institutional demand, the leakage is assumed to be constant during the entire operational period. The operational periods for each component is as given below. Outside these times, leakage is considered to be non-existent.

Industrial.......8 to 16 hours
Commercial....7 to 21 hours
Institutional....8 to 15 hours

The overall leakage coefficient is obtained from summation of the components. Comparing unsuppressed and suppressed demand, it can be seen that during the period of peak demand, i.e. in the morning hours of the day, there is relatively little demand suppression and it is around noon time that demand suppression is observable.

During the unsuppressed period, the peak factor is calculated to be 1.50.

TIME
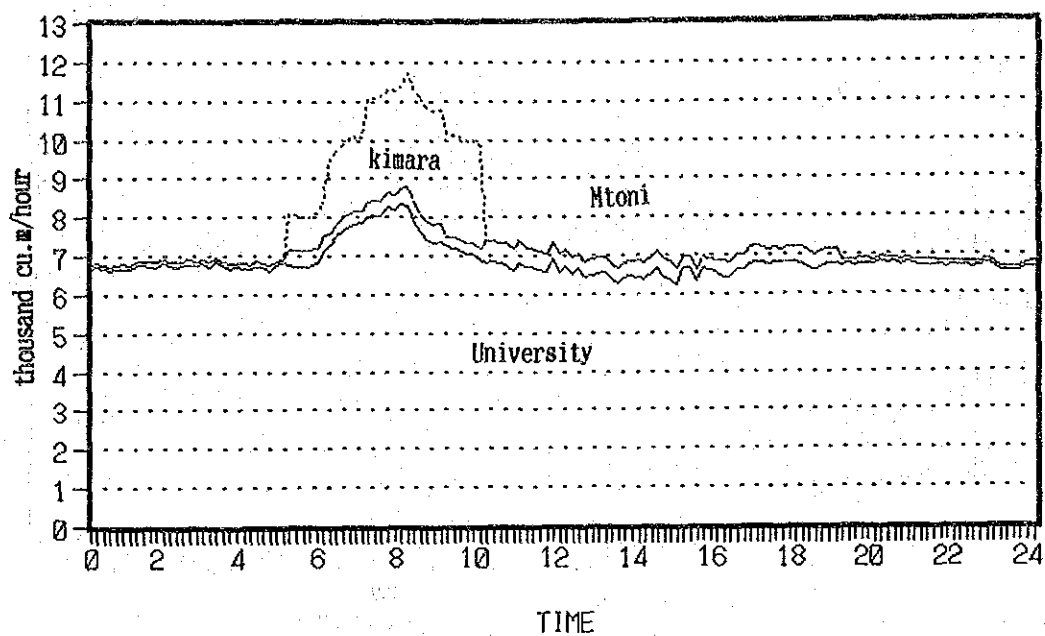
HOURLY FLUCTUATION IN OUTFLOW
FROM RESERVOIRS IN 1990

TIME

Leakage=35%
Wastage= 5%
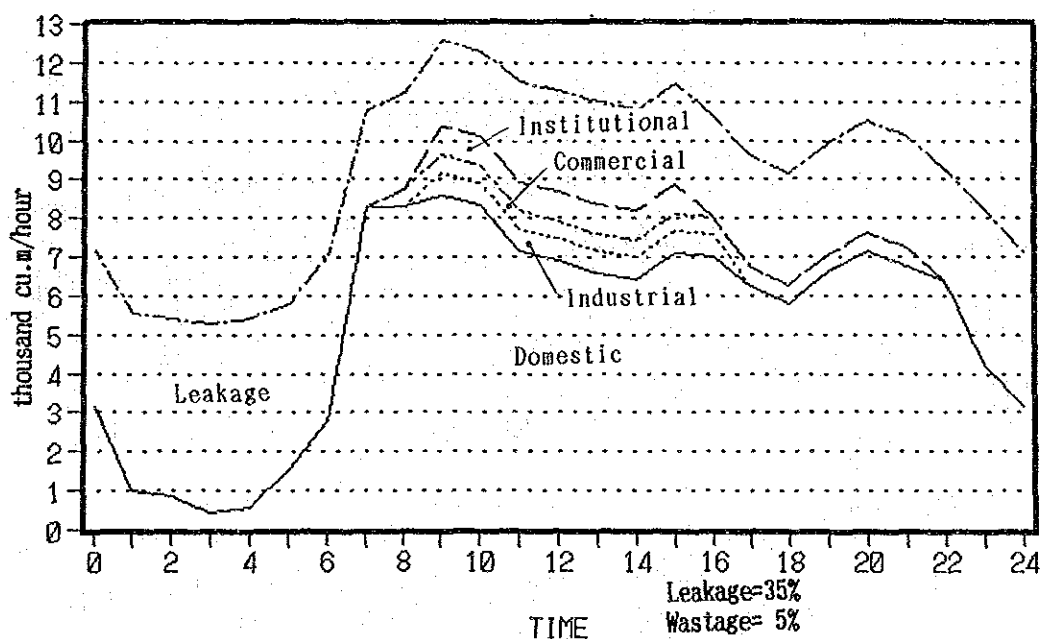
HOURLY UNSUPPRESSED DEMAND PATTERN
IN 1990

FIG. A.1.2	HOURLY DEMAND PATTERN IN 1990

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY
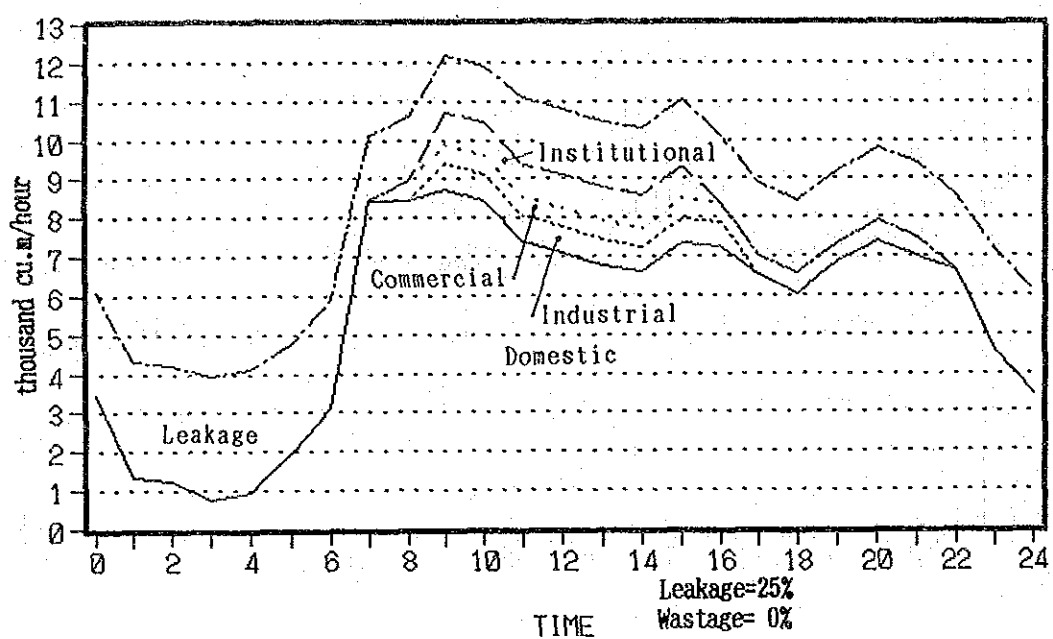
HOURLY DEMAND PATTERN IN 1995

FIG. A.1.3	HOURLY DEMAND PATTERN IN 1995

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

2 PER CAPITA CONSUMPTION*

2.1 PURPOSE

The purpose of this study is to estimate the per capita consumption in each service class - house and yard connections. This per capita consumption value is used to calculate the non-suppressed consumption in the city and, to evaluate the demand distribution in the City.

2.2 AREAS INVESTIGATED

Three types of studies were conducted. Meters were installed to obtain per capita consumption data.

- TYPE A

About 20 meters were installed in 5 model areas - Magomeni, Kariakoo, Ilala, Kinondoni and Miko-cheni (see Figure A.2.1) - in March and April, 1990. About 40 meters were installed in Kisutu (city center). Meter readings were recorded every month.

- TYPE B

In addition, approximately 20 meters were also installed between July and August, 1990 in each of the following areas - Kariakoo, Magomeni, Kinondoni, Ilala and Sinza. Among the five areas, results were obtained in three areas (Kariakoo, Magomeni and Kinondoni). These points are observed to evaluate the effect of meter installation on water conservation.

- TYPE C

Per capita consumption data was measured at the same time as leakage measurements were conducted in the 3 model areas - Kariakoo, Magomeni and Kinondoni.

2.3 PROCEDURE

The following procedure is for types A and B survey. Procedure for type C survey is described in section 4.5, Appendix C.
(1) Install meter.
(2) Read meters every month in type A areas and every day in type B areas.
(3) Investigate number of inhabitants per tap connection.

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* The contents of this section is used in section 2.3.3 "1990 unsuppressed water consumption", Main
    Report.

FIG. A.2.1   MODEL AREA FOR PER CAPITA CONSUMPTION

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

2.4 EQUIPMENT USED

- pipe locator
- "Portaflow" flow meter
- consumer meter

2.5 RESULT

Results are tabulated in Table A.2.1, which gives the per capita consumption for house connection (Type A), and Table A.2.2, which gives the per capita consumption for yard connection (Type A).

Two other tables are analysis based on data measured during the first on-site study; Table A.2.6 gives the per capita consumption for households not having access to water connections in the Kinondoni Model area, while Table A.2.7 gives a similar analysis for the Magomeni model area

Further, analysis of other types of survey are given in the following tables.

Table A.2.8 Per capita consumption in 3 model areas (Type C)
Table A.2.9 Per capita consumption in kariakoo area (Type B)
Table A.2.10 Per capita consumption in magomeni area (Type B)

Per capita consumption was estimated for each of the three types of water connection patterns;
- house connection
- yard connection
- no connection (standpipe/kiosk)

2.5.1 PER CAPITA WATER CONSUMPTION - HOUSE / YARD CONNECTIONS

Per capita water consumption figures for house and yard connections was done through a study of water consumption patterns in six selected model areas - in Kariakoo, in Kisutu (city center) and in Ilala wards of Ilala sub-branch, in Magomeni ward of Magomeni sub-branch, in Kinondoni ward of Kinondoni sub-branch and in Mikocheni area and in Kawe ward in Kawe sub-branch. These model areas were chosen with the view that the water consumption in model areas should not be constrained by water pressure, for otherwise, representative values of per capita water consumption would only reflect suppressed demand rather than unsuppressed demand. The latter is required since this will be the design basis for the rehabilitated system.

Mikocheni and Kinondoni represent well-to-do, upper class residential areas, with wide open spaces around the housing units serving as gardens, with mostly house connection type water supply. Kisutu also represents upper class residential areas, with the difference being that, being right in the center of the city, there are no open spaces around houses, and most housing units are apartments rather than houses, which are prevalent in Mikocheni and Kinondoni. Magomeni, Ilala and Kariakoo represent not-so-well-off residential areas, where there is a greater preponderance of the so-called "Swahili" housing units.

In these model areas, about 20 houses were chosen in each area (40 in the case of Kisutu) as representative of the said area. In these houses (some were commercial or institutional establishments), water meters were attached to the incoming pipe connection in March 1990. Meter readers at the Ilala sub-branch were requested to record the meter readings in the Ilala, Kisutu and Kariakoo model areas on a monthly basis. Meter readers at the Kinondoni sub-branch were requested to record similar monthly readings in the Kinondoni and Mikocheni model areas, while Magomeni sub-branch handled the work in the Magomeni model areas.

Monthly meter reading records and the date of reading were input for data analysis. Study team personnel accompanied by NUWA technicians visited all the houses in the Kariakoo, Magomeni and Kinondoni model areas in March 1990 to find out the number of people resident in each house so as to estimate the number of water consumers for each meter. At the same time, the number of taps and type of houses in each household were also recorded; 1) swahili-type house is classified as a yard connection and 2) non-swahili-type house is classified as a house connection.

The monthly water consumption volume in liters per capita per day, henceforth referred as lpcd, along with information for identification of each household (house number, street name and meter size), and the number of people in each household is given in Table A.2.1 (for house connection) and in Table A.2.2 (for yard connection).

The frequency distribution of per capita consumption values for house connections obtained from the survey is given in Figure A.2.2. To account for variation in the number of people in the households in the survey, a weighting average method was used. Overall average lpcd value for each household was multiplied by the number of members in the household. The total of this product of all households divided by the total number of people in all household gives a weighted lpcd value of 227 liters.

It is, however, found that house connection values vary considerably with model areas; 405 l/d in Kinondoni, 254 l/d in City center and 159 l/d in other areas (Ilala, Kariakoo, Magomeni and Mikocheni). These differences are derived from different usage levels of fittings and equipment. Then, in order to know the nature (like cooking, washing, gardening, neighbors' use) of water use, incremental

consumption of each water-use equipment was analysed following supplementary interviews, which were conducted in October, 1990. Table A.2.3 gives distribution of water-use equipment tabulated from Tables A.2.1 and A.2.2.

Data which has more than 15 samples (types A to C in Table A.2.4) were firstly used and per capita consumption is estimated. Base consumption is estimated as 83 l/d from type (A) of Table A.2.4. Shower consumption is 25 l/d by subtracting type (A) from type (B). Flush toilet and sink consumption is 61 l/d, obtained by subtracting (B) from (C). Flush toilet is assumed to consume 30 l/d, based on observations in Japan. Therefore, sink consumption is 30 l/d. Estimated water used by other types of fittings and equipment are given below, although the results are less reliable, due to the smaller number of samples.

Bathtub : 143 l/d (D-C)
Sprinkler : 82 l/d (G-D)
Car washing : 52 l/d (F-D)

As a result, base and incremental consumption of each fitting and equipment is estimated and given in the left-hand column of Table A.2.5.

House connections in Dar-es-Salaam are subdivided into three categories; high, middle and low. From site inspection and interviews, the following distribution has been deduced; 1) house connection (high) is in all house connections in Upanga and Kinondoni and 50 % of Msasani, 2) house connection (middle) is all house connections in Kisutu, Mchafukoge and Kivukoni and 3) house connection (low) is 50 % of the house connections in Msasani and all wards other than mentioned above.

The frequency distribution of per capita consumption values for yard connections obtained from the survey is given in Figure A.2.3. A similar analysis, for the case of yard connections from which a weighted average of 83 lpcd is obtained, is given in Table A.2.2 of this report. This is rounded-off to 85 lpcd for yard connections and adopted for yard connections in DSM. The yard connection consumption of 85 l/d is almost equivalent to the base consumption of 80 l/d.

TABLE A.2.1 PER CAPITA CONSUMPTION -- HOUSE CONNECTION -- (TYPE A READING)

No.	House Number	Street Name	Meter Size inch	No. of people in house hold	April	May	June	July	Aug.	Average	Water-use Equipment*
City Centre											
1	1423	Chose	3/4"	5	----	91	----	145	----	118	(C) F,Sh,Si,-,--,-,-
2	1287/84	Zaramo	3/4"	3	----	101	----	145	----	123	(C) F,Sh,Si,-,--,-,-
3	927/17	Zanaki	3/4"	5	----	123	----	171	----	147	(C) F,Sh,Si,-,--,-,-
4		Market	3/4"	2	----	64	----	81	----	73	(C) F,Sh,Si,-,--,-,-
5	1311/78	Jamhuri	3/4"	4	----	221	----		242	232	(N) F,--,Si,-,--,-,-
6	819/82	Libya	3/4"	2	----	213	----	265	----	239	(C) F,Sh,Si,-,--,-,-
7	727/797	Market/Asia	3/4"	6	----	119	----	154	----	137	(C) F,Sh,Si,-,--,-,-
8		Mansfield	3/4"	3	----	71	----	52	----	62	(C) F,Sh,Si,-,--,-,-
9	724/11	Mkwepu	3/4"	8	----	133	----	129	----	131	(E) F,Sh,Si,B,--,-,W
10	705/24	Mkwepu	3/4"	3	----	169	----	225	----	197	(N) F,--,Si,-,--,-,-
11	149	Indira Gandhi	3/4"	6	----				481	481	(C) F,Sh,Si,-,--,-,-
12	1017	Kitumbini	3/4"	4	----	222	----	370	----	296	(C) F,Sh,Si,-,--,-,-
13	1017(0203)	Kitumbini	3/4"	4	----	388	----	491	456	445	(N) F,--,Si,-,--,-,-
14	1574	Mosque	3/4"	5	----	120	----		----	120	(D) F,Sh,Si,B,--,-,-
15	Karim 3rd fl Mshihiri		3/4"	3	----	----	----		232	232	(C) F,Sh,Si,-,--,-,-
16	Karim 1st fl Mshihiri/Morogoro		3/4"	1	----	273	----	254	278	268	(N) F,--,Si,-,--,-,-
17	2201/148	Libya/Fupi	3/4"	2	----	276	----	264	150	230	(C) F,Sh,Si,-,--,-,-
18	1309/148	Kitumbini	3/4"	4	----	358	----		475	417	(L) -,Sh,Si,-,--,-,-
19	2119	Jamati	3/4"	3	----	556	----		676	616	(D) F,Sh,Si,B,--,-,-
20	1973/10	India	3/4"	3	----	166	----	189	179	178	(C) F,Sh,Si,-,--,-,-
21	9/A	India	3/4"	5	----	63	----	75	83	74	(C) F,Sh,Si,-,--,-,-
22	465-141	Aggrey/Indira Gande	3/4"	4	----		----	686	534	610	(O) F,--,Si,B,--,-,-
23	154	Indira Gande	3/4"	11	----	281	----	403	----	342	(C) F,Sh,Si,-,--,-,-
Ilala											
24	29	Moshi	3/4"	18	----	75	62	72	----	70	(C) F,Sh,Si,-,--,-,-
25	90	Tanga	3/4"	11	----	112	86	56	----	85	(Q) F,Sh,Si,-,Sp,C,-
26	28	Lindi	1/2"	10	----	122	130	----	----	126	(C) F,Sh,Si,-,--,-,-
27	20	Saadani	3/4"	8	----	176	232	220	----	209	(D) F,Sh,Si,B,--,-,-
28	19	Saadani	3/4"	7	----	157	260	212	----	210	(C) F,Sh,Si,-,--,-,-
29	24	Songea	3/4"	7	----	176	245	234	213	217	(D) F,Sh,Si,B,--,-,-
30	10	Nzasa	3/4"	6	----	364	430	----	507	434	(F) F,Sh,Si,B,--,C,-
Kariakoo											
31	42	Swahili	3/4"	10	180	---	----	149	157	162	(C) F,Sh,Si,-,--,-,-
32	A2/81	Matumbi	1/2"	10	205	---	19	635	----	286	(G) F,Sh,Si,B,Sp,-,-
33	NHC F61	Nyati	3/4"	5	----	----	----	----	203	203	(J) F,Sh,--,-,--,-,-

(*) F = Flush toilet   Sh = Shower   B = Bathtub   Sp = Sprinkler

No.	House Number	Street Name	Meter Size inch	No. of people in house hold	April	May	June	July	Aug.	Average	Water-use Equipment*
Kinondoni											
34	145	Ada Estate	3/4"	10	----	----	629	682	622	644	(D) F,Sh,Si,B,--,-,-
35	34	Ada Estate	3/4"	3	----	----	----	1294	1073	1184	(R) F,Sh,Si,B,Sp,C,W
36	33	Ada Estate	3/4"	5	----	----	186	376	297	286	(H) F,Sh,Si,B,Sp,-,W
37	24	K. Shamba	3/4"	14	----	----	191	252	233	225	(H) F,Sh,Si,B,Sp,-,W
38	23	K. Shamba	3/4"	7	----	----	1141	633	816	863	(G) F,Sh,Si,B,Sp,-,-
39	SIDA C	Ada Estate	3/4"	2	----	----	----	274	226	250	(G) F,Sh,Si,B,Sp,-,-
40	64	Ada Estate	3/4"	6	----	----	325	245	----	285	(?) not available
41	63	Ada Estate	3/4"	8	----	----	360	228	----	294	(F) F,Sh,Si,B,--,C,-
42	60	Ada Estate	3/4"	9	----	----	138	142	----	140	(R) F,Sh,Si,B,Sp,C,W
43	58	Ada Estate	3/4"	3	----	----	225	242	----	234	(D) F,Sh,Si,B,--,-,-
Magomeni											
44	B 206	Matombo Street	3/4"	10	----	150	----	193	175	173	(C) F,Sh,Si,-,--,-,-
45	E 8	Matombo Street	3/4"	9	----	67	----	----	115	91	(J) F,Sh,--,-,--,-,-
46	G 27	Matombo Street	3/4"	7	----	----	----	407	246	327	(B) -,Sh,--,-,--,-,-
47	B 300	B (Area)	3/4"	3	----	----	----	----	549	549	(J) F,Sh,--,-,--,-,-
Mikocheni					----	----					
48	Plot 341/34 Block A		1/2"	10	----	----	92	----	39	66	(M) F,--,--,-,Sp,-,-
49	Plot 349	Mikocheni A	3/4"	7	----	----	78	85	82	82	(P) F,Sh,Si,-,Sp,-,-
50	Plot 411/443	Block A	3/4"	12	----	----	97	----	52	75	(?) not available
51	Plot 252	Block A	3/4"	7	----	----	47	----	52	50	(I) F,Sh,Si,B,Sp,C,-
52	Plot 270	Block A	1/2"	6	----	----	115	----	134	125	(J) F,Sh,--,-,--,-,-
53	Plot 321	Block A	3/4"	6	----	----	42	----	65	54	(C) F,Sh,Si,-,--,-,-
54	Plot 286	Block A	3/4"	5	----	128	177	----	101	135	(D) F,Sh,Si,B,--,-,-
55	Plot 273	Block A	3/4"	10	----	----		----	64	64	(C) F,Sh,Si,-,--,-,-
56	Plot 425	Block A	1/2"	3	----	----	73	----	96	85	(E) F,Sh,Si,B,--,-,W
57	Plot 306	Block A	3/4"	6	----	----	582	----	469	526	(D) F,Sh,Si,B,--,-,-
58	Plot 310	Block A	3/4"	8	----	----	109	138	81	109	(D) F,Sh,Si,B,--,-,-
59	Plot 355	Block A	3/4"	6	----	----	138	----	172	155	(P) F,Sh,Si,-,Sp,-,-
60	Plot 351	Block A	3/4"	10	----	----	162	----	191	177	(G) F,Sh,Si,B,Sp,-,-

		Average Kinondoni (High)					405
		City centre (Middle)					254
		Others (Low)					159
		Total					227

(*) F = Flush toilet   Sh = Shower   Si = Sink   B = Bathtub   Sp = Sprinkler   C = Car washing
W = Washing machine

TABLE A.2.2 PER CAPITA CONSUMPTION (YARD CONNECTION) (TYPE A READING)

No.	House Number	Street Name	Meter Size inch	No. of people in house hold	Monthly Average Water Consumption (liter per capita per day)						Water-use Equipment*
					April	May	June	July	Aug.	Average	
Ilala											
1	32	Tabora	1/2"	8	----	72	112	121	----	102	(A) No equipment
2	40	Nzasa	3/4"	17	----	55	68	----	----	62	(A) No equipment
3	69	Bukoba	3/4"	8	----	46	51	51	----	49	(A) No equipment
4	33	Arusha	3/4"	13	----	111	79	120	----	103	(K) -,--,Si,-,--,-,-
5	33	Utete	3/4"	20	----	22	----	41	----	32	(B) -,Sh,--,-,--,-,-
6	28	Nzasa	3/4"	9	----	47	82	75	----	68	(B) -,Sh,--,-,--,-,-
7	63	Moshi	3/4"	15	----	87	157	58	----	101	(B) -,Sh,--,-,--,-,-
8	05	Moshi/	1/2"	10	----	19	45	35	----	33	(B) -,Sh,--,-,--,-,-
9	27	Iringa/Kilwa	1/2"	7	----	145	107	142	----	131	C) F,Sh,Si,-,--,-,-
10	21	Aangani	3/4"	10	----	82	73	85	----	80	(B) -,Sh,--,-,--,-,-
11	17	Arusha	3/4"	10	----	143	123	129	----	132	(B) -,Sh,--,-,--,-,-
Kariakoo											
12	44	Nyamwezi	1/2"	19	----	----	128	253	182	188	(A) No equipment
13	10	Swahili/Nyati	1/2"	20	52	----	----	38	----	45	(A) No equipment
14	16	Faru	3/4"	15	63	----	----	55	----	59	(A) No equipment
15	27	Swahili	1/2"	10	122	----	----	147	142	137	(A) No equipment
16	22	Kongo	3/4"	25	80	----	----	64	----	72	(A) No equipment
17	41	Nyamwezi	1/2"	11	----	----	----	105	----	105	(A) No equipment
18	11	Jangwani	3/4"	9	82	----	----	53	----	68	(?) not available
19	31	Kongo	3/4"	10	152	----	----	131	----	142	(A) No equipment
20	16	Swahili	3/4"	25	123	----	223	89	----	145	(B) -,Sh,--,-,--,-,-
21	37	Nyamwezi	1/2"	4	155	----	----	----	126	141	(B) -,Sh,--,-,--,-,-
22	33	Swahili	1/2"	17	125	----	98	----	----	112	(B) -,Sh,--,-,--,-,-
23	4	Mbuni	1/2"	7	98	----	178	----	123	133	(A) No equipment
24	8	Matumbi	1/2"	20	56	----	89	53	----	66	(J) F,Sh,--,-,--,-,-
25	52	Kongo	3/4"	13	20	----	----	----	22	21	(A) No equipment
26	29	Kongo	3/4"	6	194	----	----	----	170	182	(B) -,Sh,--,-,--,-,-
Magomeni											
27	A 156	Kagera Street	3/4"	13	----	36	88	87	----	70	(A) No equipment
28	D 18	Kapera Street	3/4"	26	----	109	----	251	165	175	(A) No equipment
29	G 16	Chidia Street	3/4"	12	----	36	37	81	----	51	(A) No equipment
30	G 40	Chidia Street	3/4"	18	----	25	62	48	----	45	(A) No equipment
31	G 17	Matombo Street	3/4"	10	----	86	----	180	129	132	(A) No equipment
32	A 168	Kagera Street	3/4"	21	----	46	31	77	----	51	(B) -,Sh,--,-,--,-,-
33	B 204	Matombo Street	3/4"	11	----	87	----	96	91	91	(J) F,Sh,--,-,--,-,-
34	D 34	Kapera Street	3/4"	22	----	20	20	41	----	27	(A) No equipment
35	305	Mkwawa	1/2"	10	----	----	83	----	----	83	(A) No equipment
36	E 14	Chole Street	3/4"	15	----	62	----	----	80	71	(B) -,Sh,--,-,--,-,-
37	F 26	Mengo Street	3/4"	18	----	29	92	----	40	54	(A) No equipment
38	F 20	Mengo Street	3/4"	14	----	40	----	----	60	50	(A) No equipment
39	G 41	Matombo Street	3/4"	16	----	27	135	----	60	74	(B) -,Sh,--,-,--,-,-
40	F 181	Kagera Street	3/4"	20	----	41	----	----	58	50	(K) -,--,Si,-,--,-,-
41	B 44	Matombo Street	3/4"	23	----	56	98	----	55	70	(A) No equipment
42	B 23	Gombero Street	3/4"	12	----	----	----	----	65	65	(B) -,Sh,--,-,--,-,-
Mikocheni											
43	Plot 240	Block A	1/2"	9	----	50	----	----	70	60	(A) No equipment
									Average =	83	

(*) F = Flush toilet Sh = Shower Si = Sink B = Bathtub Sp = Sprinkler C = Car washing
W = Washing machine

TABLE A.2.3 DISTRIBUTION OF WATER-USE EQUIPMENT

water-use equipment	HOUSE CONNECTION (high)	(middle)	(low)	YARD CONNECTION
shower	100.0	78.3	96.2	40.5
flush toilet	100.0	95.7	96.2	7.2
sink	100.0	100.0	76.9	7.2
bathtub	100.0	17.4	38.5	0.0
sprinkler	66.7	0.0	26.9	0.0
car wash	33.3	0.0	11.5	0.0
washing machine	44.4	4.3	3.8	0.0

Note: high...in Kinondoni, middle...in City center, low...in other areas (Ilala, Kariakoo, Magomeni andMikoche

TABLE A.2.4 DOMESTIC CONSUMPTION ACCORDING TO WATER-USE EQUIPMENT

T Y P E*	Average per capita consumption (l/day)	Number of sample	Remarks
(A) No equipment	83	24	
(B) -,Sh,--,-,--,-,-	108	15	
(C) F,Sh,Si,-,--,-,-	169	22	F = Flush toilet
(D) F,Sh,Si,B,--,-,-	312	9	
(E) F,Sh,Si,B,--,-,W	108	2	Sh = Shower
(F) F,Sh,Si,B,--,C,-	364	2	
(G) F,Sh,Si,B,Sp,-,-	394	4	Si = Sink
(H) F,Sh,Si,B,Sp,-,W	256	2	
(I) F,Sh,Si,B,Sp,C,-	75	1	B = Bathtub
(J) F,Sh,--,-,--,-,-	188	6	
(K) -,--,Si,-,--,-,-	77	2	Sp = Sprinkler
(L) -,Sh,Si,-,--,-,-	417	1	
(M) F,--,--,-,Sp,-,-	66	1	C = Car wash
(N) F,--,Si,-,--,-,-	286	4	
(O) F,--,Si,B,--,-,-	610	1	W = Washing machine
(P) F,Sh,Si,-,Sp,-,-	119	2	
(Q) F,Sh,Si,-,Sp,C,-	85	1	
(R) F,Sh,Si,B,Sp,C,W	662	2	
AVERAGE	182	101	
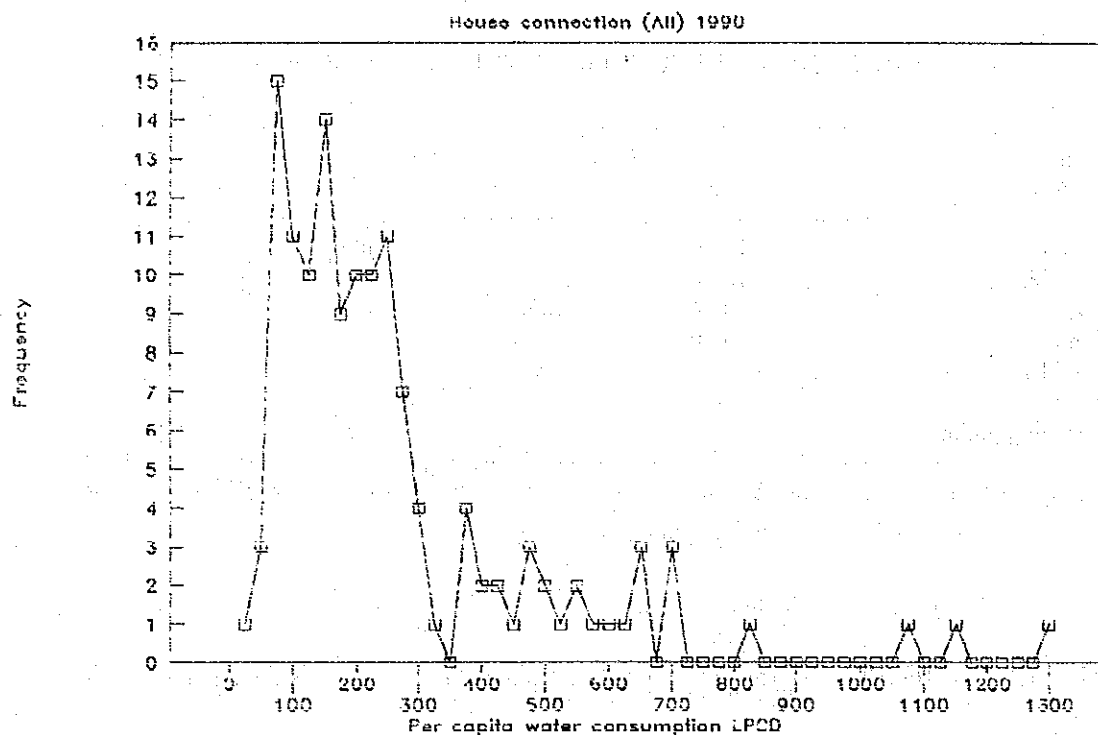
Figure A.2.2 FREQUENCY DISTRIBUTION OF PER CAPITA CONSUMPTION
- HOUSE CONNECTION -
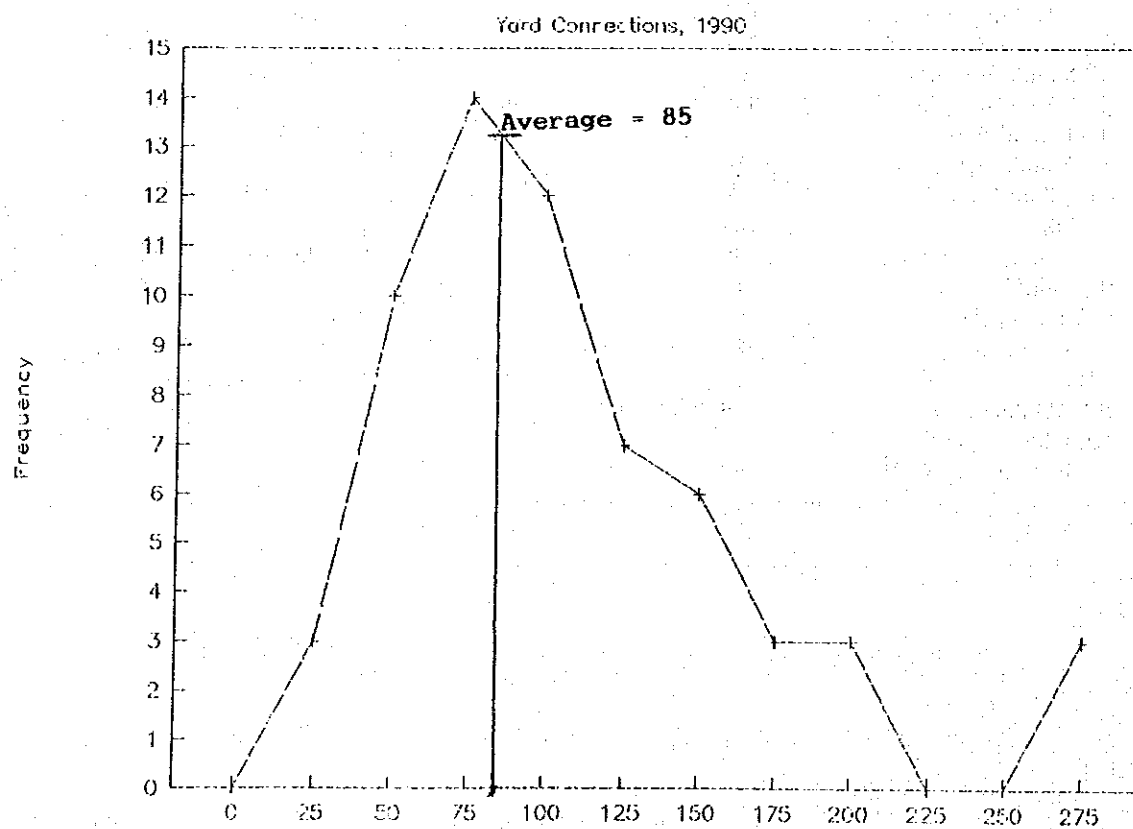
Figure A.2.3 FREQUENCY DISTRIBUTION OF PER CAPITA CONSUMPTION
- YARD CONNECTION

TABLE A.2.5 WATER-USE EQUIPMENT CONSUMPTION

	base consumption (l/d)	House connection (high)	(middle)	(low)	Yard connection
'non-luxury' consumption	80	80	80	80	80
shower	25	25	20	24	10
flush toilet	30	30	29	29	2
sink	30	30	30	23	2
bathtub	140	140	24	54	0
sprinkler	80	53	0	22	0
car wash	50	17	0	6	0
washing machine	40	18	2	2	0
(A) Total	475	393	184	239	94
(B) Measurement	----	405	254	159	83
Difference (A-B)/B	----	-3%	-28%	50%	13%

Note: high.....in Kinondoni
middle...in City center
low......in other areas (Ilala, Kariakoo, Magomeni and Mikocheni)

2.5.2 PER CAPITA WATER CONSUMPTION
- NO CONNECTION (KIOSK/STANDPIPE CONNECTION)

In the case of households not having water connections, and therefore dependent on external source/s of water - from water kiosks, standpipes, or from other people's houses - a study was done to analyze the water consumption patterns of such households. Two model, squatter areas in Magomeni and Kinondoni were selected. About 7 households in the former and about 57 households in the latter were studied. A standpipe was located in each of the two model areas.

One standpipe is in the south-end of the Kinondoni model area (see Figure A.2.4). Houses are located close to each other at an estimated average interval of 10 meters. Fifty-seven households used the standpipe. The following were taken into account 1) 3 to 4 households in one house, 2) 57 households using this standpipe and 3) distance from houses to the standpipes, which is average carrying distance is judged to be 30 to 40 meters.

The other standpipe is located in eastern boundary of Magomeni (see Figure A.2.5). In this part, there were some yard connection users, resulting in only seven standpipe users. The carrying distance here also is judged to be 30 to 40 meters.

These carrying distances are typical for the developed urbanized areas. However, in the newly-developing urbanized areas and developing areas, carrying distance of water is certainly longer due to inadequate secondary pipe network and service pipes. Per capita water consumption in those areas will be

N

SCALE

0   200   400   600   800   1000

Unit : Foot
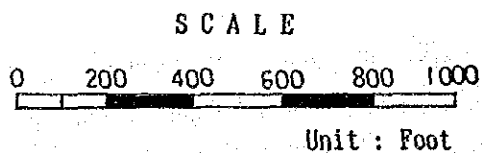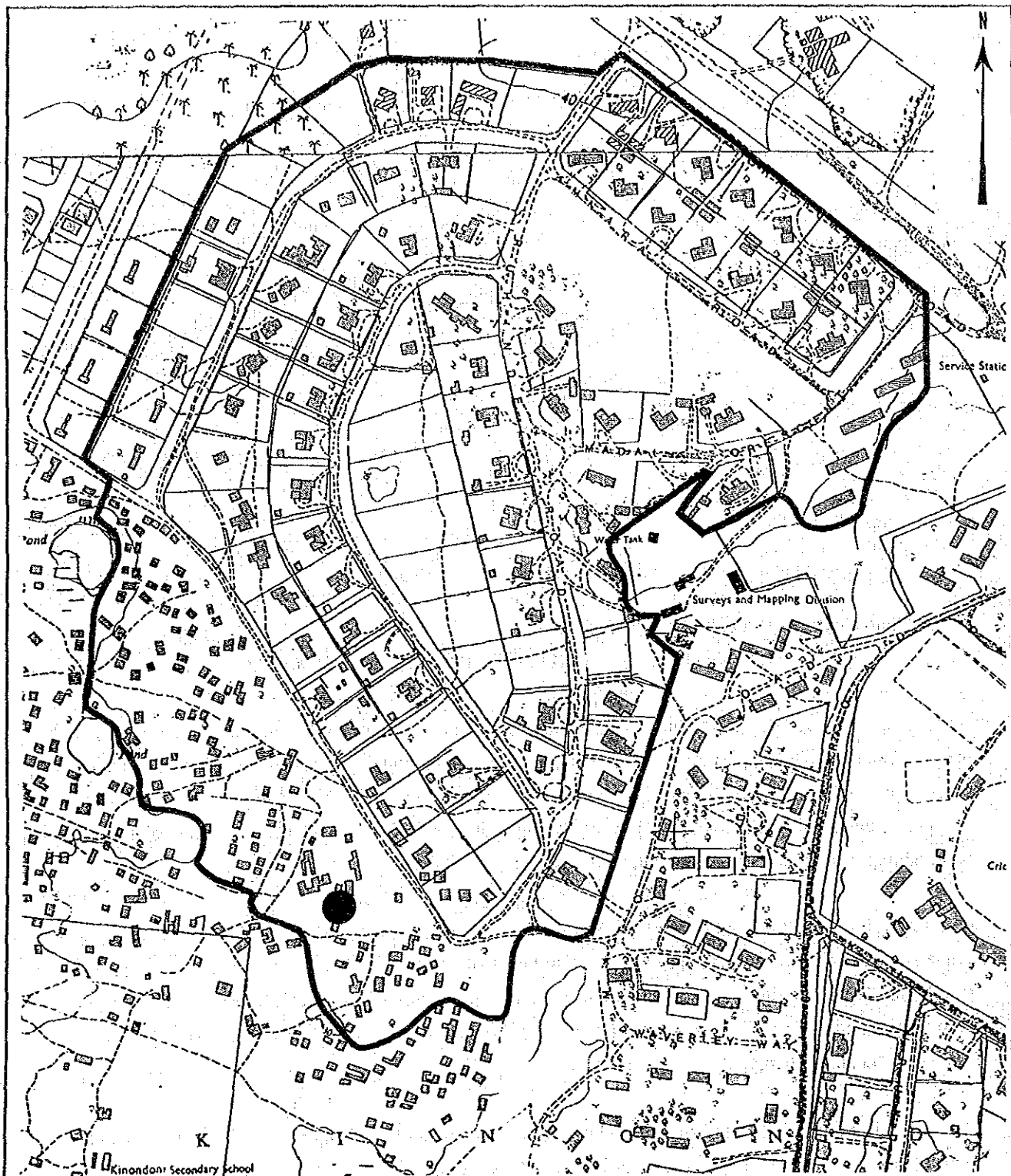
LEGEND

● LOCATION OF STANDPIPE
(MEASURERMENT OF CONSUMPTION)

□ MODEL AREA

FIG. A.2.4	LOCATION OF STANDPIPE IN KINONDONI MODEL AREA
	THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

SCALE

0   50   100   200   300

Unit : Meter

LEGEND

● LOCATION OF STANDPIPE
  (MEASURERMENT OF CONSUMPTION)

□ MODEL AREA

FIG. A.2.5	LOCATION OF STANDPIPE IN MAGOMENI MODEL AREA

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

smaller.

Observation started at 6:00 am and ended 8:30 pm, and was carried on for three days consecutively at each location. On three consecutive days, a record was kept of all people who came to collect water at the standpipe, as well as their address. Records were also kept of the volume of water collected each time. These observations were made in March 1990.

This data was sorted out to group water collection volumes by household. Subsequently, a survey was made by members of the Study team on three separate days to find out the number of people consuming the collected water at the addresses obtained from the people collecting water, during the previous recording days. A summarized list of households identified by a name or number in the Magomeni and Kinondoni model areas, the number of people in the households and the water consumed on each of the three days is given in Tables A.2.6 and A.2.7, respectively.

It can be seen in these tables that in some cases, the number of household members differ on the three survey dates, and therefore a selection was done to obtain the reliable household member count. Such numbers differ due to a variety of reasons. Among them are that the number of people in the household do actually vary on account of migration to and from the rural areas. Another reason was that the residents did have problems in counting large numbers (family sizes were large in many cases), especially older and uneducated members.

The criteria used "to break the tie" was that if two of the values matched, and the third value differed, the majority principle would prevail. If all three values differed, and if any two values were nearer each other, one of the two was selected. One guiding criteria was that the earlier survey value was more correct than a later survey value, due to that date being closer to the dates of water collection measurement.

Another selection had to be made to eliminate unrepresentative or "unreliable" water consumption values since values as low as 1 lpcd was obtained, which is unreasonable. The criteria used here was that lpcd values lower than 10 lpcd would be eliminated, since it was observed in the model areas that quite a few households collected water from more than one standpipe. Such a criteria would rectify this uncertainty, statistically.

The frequency distribution of the 'reliable' values of per capita consumption for population without water connections is given in Figure A.2.6. The overall weighted average per capita value, to account for family size, as in the case of house and yard connection areas, was 19.6 lpcd in the case of Magomeni model area and 21.6 in the Kinondoni model area. For this study, a value adopted for households not having water connections within the premises is 22 lpcd.
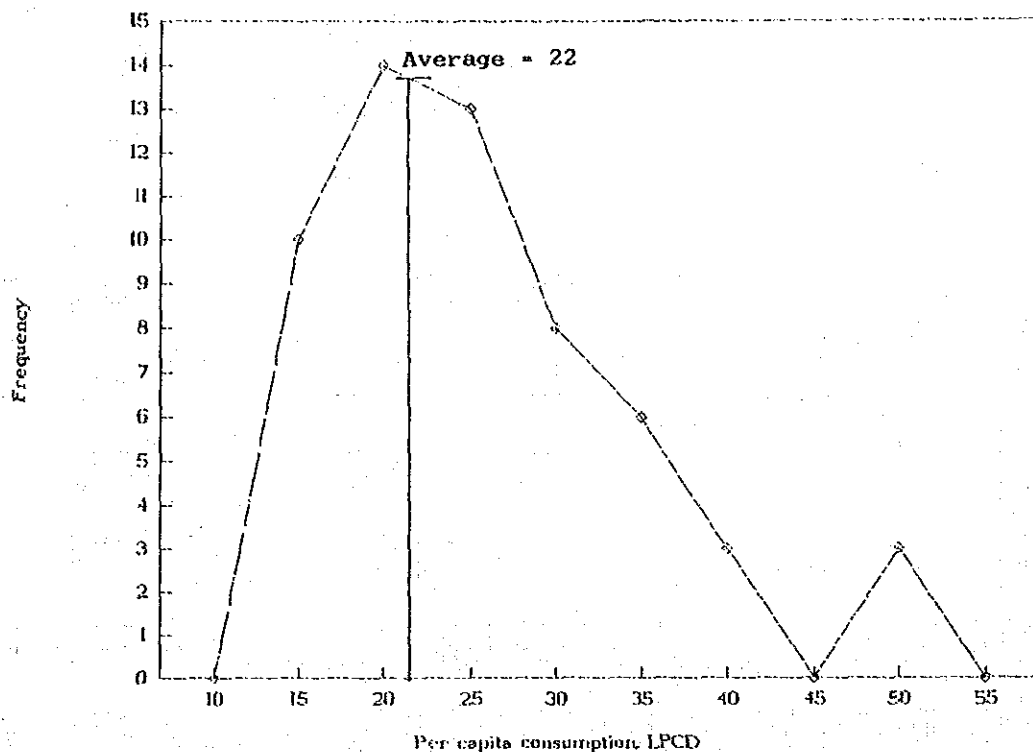
FIGURE A.2.6 FREQUENCY DISTRIBUTION OF PER CAPITA CONSUMPTION - NO CONNECTION (KIOSK/STANDPIPE) -

We have applied the obtained per capita consumption of 22 liters per day in the two model areas to "no-connection" users throughout the city. Hence, estimated total consumption might give rather higher value. Nevertheless, variation of the per capita consumption in no-connection category can have only negligible effect on the estimated domestic consumption and network analysis due to its relative small-ness compared to that of other categories. Accordingly we have concluded that, for the planning pur-pose, the value is effective.

2.6 ANALYSIS

From Type A analysis of house connections (Table A.2.1), it was determined that the per capita consumption varied from 159 lpcd to 405, while Type C (Table A.2.8) analysis resulted in a value of 57 to 151 lpcd. This variation can be explained by the fact that in Type C analysis, a squatter area in Kinondoni was also included, which depressed the lpcd value for house connections. Type A value is representative of all areas.

For the case of yard connections, Type A analysis (Table A.2.2) yielded a lpcd value of 85, while Type C analysis at Magomeni (Table A.2.8) yielded a value of 73 lpcd. Type B analysis at Kariakoo (Table A.2.9) gave a value of 82 lpcd, while another Type B analysis at Magomeni (Table A.2.10) resulted in a value of 91 lpcd. These values appear to be essentially the same.

Type A analysis yielded an lpcd value for households with no water connections of 22 lpcd (Tables A.2.6 and A.2.7).

TABLE A.2.6 PER CAPITA CONSUMPTION (NO WATER CONNECTIONS) (TYPE A READING)
(Survey Location : KINONDONI Model Area)

Sr. No.	House No. or Family Name	HH Survey No. 1	2	3	Selected	Water Collected on 12-Mar Total	LPCD	on 13-Mar Total	LPCD	on 14-Mar Total	LPCD	Reliable LPCD Values (Criteria – LPCD > or = 10) 12-Mar	13-Mar	14-Mar	Average
1	Ally Yusufu		18		18	75.9	4.2	86.4	4.8	59.4	3.3				
2	Elizle	19		21	21	10.6	0.5								
3	Hadija Omari	9			8	21.6	2.7			43.2	5.4				
4	Mari Makeja		8	8	8	16.2	1.0	17.2	2.2						
5	286 Mariam			17	17										
6	37									15.8					
7	38									20					
8	41	1		6	1	35.1	35.1	16.2	16.2	48.6	48.6	35.1	16.2	48.6	33.3
9	42	19			19	32.4	1.7			32.4	1.7				
10	43	9	11		9	129.3	14.4	141.4	15.7	205	22.8	14.4	15.7	22.8	17.6
11	44			9	9	21.6	2.4								
12	66					16.2									
13	72		10		10										
14	74			18	18	16.2	0.9			18.9	1.9				
15	75	5	7	5	5	49.6	9.9	48.6	9.7	16.2	3.2				
16	76	20			20	43.2	2.2	126.9	6.4	86.4	4.3				
17	77	35			35	65.8	1.9	64.8	1.9	36.1	1.0				
18	79	9	9		9	54	6.0	56.7	6.3	89.1	9.9				
19	80	25	10		10			94.5	10.5	116.1	11.6		10.5	11.6	11.6
20	82	9	5		9			307.8	14.7	186.3	20.7		14.7	20.7	15.6
21	84	21	21		21	360.3	17.2	35.1	2.9	391.8	18.7	17.2		18.7	16.8
22	85	12		10	12	399.2	33.3	97.2	8.1	37.8	3.2	33.3			33.3
23	86	12			12	16.2	1.4			32.4	2.7				
24	87		16	14	16	399.6	25.0	278.1	17.4	367.2	23.0	25.0	17.4	23.0	21.8
25	88		8	7	8	306.1	38.3	158.4	19.8	172.8	21.6	38.3	19.8	21.6	26.6
26	89		12	14	12	137	11.4	267.3	22.3	267.3	22.3	11.4	22.3	18.7	18.7
27	90		8	5	8	261.2	32.7	245.7	27.3	232.2	29.0	32.7	27.3	29.0	30.8
28	91	3	9	10	9	237.6	26.4	72.5	9.1	291.6	32.4	26.4		32.4	28.7
29	98			8	8			16.2	2.3						
30	150	7		15	7										
31	154	8	8	8	8	16.2	2.0			16.2	2.0				
32	180	9		7	9	36.1	4.0	57	6.3						
33	190	7			7	18.9	2.7								
34	197	30			30	16.2	0.5								
35	208	3			3	21.6	7.2			38.8	3.9				
36	209	3	10	17	10			81	8.1						
37	210			21	21			64.8	3.1						
38	211	3			3			51.3	17.1	18.9	6.3		17.1		17.1
39	212	10	16	10	10	247.7	24.8	320.6	32.1	334.8	33.5	24.8	32.1	33.5	30.1
40	213	7	12		12	542.5	45.2	297	24.8	361.8	30.2	45.2	24.8	30.2	33.4
41	216			11	11	18.9	1.7								
42	218					43.2									
43	222		13		13	119.4	9.2	217.9	16.8	167.4	12.9		16.8	12.9	14.8
44	223		4	4	4	199.4	49.9	141.4	35.4	116.1	29.0	49.9	35.4	29.0	38.1
45	225					43.2		16.2		16.2					
46															

- A.2.16 -

TABLE A.2.6 (continued)

Sr. No.	House No. or Family Name	HOUSEHOLD SIZE Survey No. 1	2	3	Selected	WATER COLLECTED on 12-Mar Total	12-Mar LPCD	on 13-Mar Total	13-Mar LPCD	on 14-Mar Total	14-Mar LPCD	RELIABLE LPCD VALUES (Criteria – LPCD > or = 10) 12-Mar	13-Mar	14-Mar	Average
47	226					16.2									
48	237	13			13	5	0.4								
49	248					58.7									
50	280			7	7			54	7.7						
51	284	12			12	17.9	1.5								
52	287	15	14	15	15	232.2	15.5	293.6	19.6	316.9	21.1	15.5	19.6	21.1	18.7
53	288	15		10	10	68.9	6.9	110.7	11.1	102.6	10.3		11.1	10.3	10.7
54	289		10	10	10	278.1	27.8	224.1	22.4	241.3	24.1	27.8	22.4	24.1	24.8
55	471	11			11	21.2	1.9	37.8	3.4	67.5	3.1				
56	701			22	22	113.4	5.2	48.6	2.2						
57	707		13		13	213.3	16.4	208.9	16.1	219.7	16.9	16.4	16.1	16.9	16.5

AVERAGE = 21.6

TABLE A.2.7 PER CAPITA CONSUMPTION (NO WATER CONNECTIONS)
(Survey Location : MAGOMENI Model Area)

Sr. No.	House No. or Family Name	Household size 1	2	3	Used	WATER on 07-Mar Total	07-Mar LPCD	on 08-Mar Total	08-Mar LPCD	on 09-Mar Total	09-Mar LPCD	RELIABLE LPCD VALUES (Criteria – LPCD > or = 10) 07-Mar	08-Mar	09-Mar	Average
1	Majid			9	9	182.8	20.3	126.9	14.1	170.1	18.9	20.3	14.1	18.9	17.8
2	153	20			20	172.8	8.6	152.2	7.6	135	6.8				
3	156	15			15			16.2	1.1						
4	212	10			10	261.1	26.1	257.3	25.7	271	27.1	26.1	25.7	27.1	26.3
5	213	12			12	16.2	1.4								
6	214	14			14	118	8.4	71.4	5.1	48.2	3.4				
7	215	9			9	126.2	14.0	86	9.6	27	3.0	14.0			14.0

AVERAGE = 19.6

TABLE A.2.8 PER CAPITA CONSUMPTION IN 3 MODEL AREAS (TYPE C READING)

	Kariakoo	Magomeni	Kinondoni	Remarks
(1) Consumption: m³/day	946	371	344	refer to Table C.4.6, Appendix
(2) Demand: m³/day	1,823	475	547	including leakage
(3) Population	6,272	6,510	4,392	from survey
(4) Connection	358	301	221	from survey
(5) Per Capita Consump.: l/s	151	57	78	(1)/(3)
(6) Per Capita Demand: l/s	291	73	125	(2)/(3)

TABLE A.2.9 PER CAPITA CONSUMPTION IN KARIAKOO AREA (TYPE B READING)

House NO.	Street Name	CONSUMPTION (l/day)				Household Size	Per capita Consumption (l/day)
		First day	Second day	Thiyd day	Average		
42	Congo	907	945	902	918	2	459
8	Mhoro	440	468	727	545	8	68
6	Mhoro	657	554	629	613	10	61
4	Mhoro	1,286	1,206	1,496	1,329	20	66
1	Mhoro	1,270	1,138	1,384	1,264	20	63
15	Jangwani	1,453	1,576	1,545	1,525	15	102
18	Mclcrl	2,461	2,037	2,908	2,469	18	137
58	Jangwani	4,661	3,707	5,372	4,580	Factory	....
18	Jangwani	1,169	1,277	880	1,109	10	111
7	Mhoro	1,637	1,490	1,445	1,524	11	139
44	Congo	1,041	848	1,016	968	21	46
11	Jangwani	437	430	533	466	9	52
5	Mhoro	1,519	1,270	1,422	1,404	30	47
17	Jangwani	1,232	1,150	1,404	1,262	13	97
	TOTAL	20,170	18,095	21,663	19,976	187	*82

Note : * except factory

TABLE A.2.10 PER CAPITA CONSUMPTION IN MAGOMENI AREA (TYPE B reading)

House NO.	Street Name	CONSUMPTION (l/day) First day	Second day	Average	Household Size	Per capita Consumption
12	Gombero	18	27	23	Under construction	
305	Gombero	752	635	694	12	58 l/day
13	Gombero	1,016	990	1 003	16	63
15	Gombero	1,286	1,434	1,360	19	72
17	Gombero	1,326	804	1 065	13	82
333A	Gombero	85	43	64	Under construction	
333	Gombero	945	1,054	1,000	8	125
301	Gombero	981	1,154	1,068	5	214
19	Gombero	630	945	788	20	39
21B	Gombero	3,171	3,205	3,188	8	399
21	Gombero	2,235	240	1,238	13	95
23	Gombero	610	846	728	14	52
25	Gombero	1,239	2,687	1,963	21	93
27	Gombero	1,394	1,746	1,570	20	79
30	Matombo	912	621	767	16	48
1	Gombero	863	903	883	8	110
158A	Gombero	1,955	2,199	2,077	9	231
156	Mkwana	1,526	2,382	1,954	28	70
153	Gombero	1,480	1,338	1,409	10	141
11	Gombero	760	953	857	14	61
7	Gombero	1,145	1,396	1,271	16	79
9	Gombero	530	441	486	11	44
	TOTAL	24,859	26,043	25,451	281	91

TABLE A.2.11 OVERALL ANALYSIS

Model Area	No. of connections	No. of families	No. of people	Per Yard Connection No. of Families	No. of People
Kinondoni	66	183	793	2.8	12.0
Kariakoo	139	433	2,224	3.1	16.0
Magomeni	186	788	3,013	4.2	16.2
Overall	391	1,404	6,030	3.6	15.4

TABLE A.2.12 DETERMINATION OF THE NUMBER OF FAMILIES PER YARD CONNECTION IN KINONDONI, KARIAKOO AND MAGOMENI MODEL AREAS

KINONDONI

N	F	P	N	F	P	N	F	P
1	1	6	23	1	7	45	1	8
2	1	9	24	2	3	46	1	5
3	3	9	25	1	4	47	7	12
4	1	7	26	1	4	48	1	11
5	1	12	27	9	28	49	1	11
6	1	5	28	1	7	50	3	12
7	8	26	29	1	12	51	3	17
8	5	18	30	2	9	52	1	8
9	7	42	31	4	15	53	5	11
10	6	18	32	1	13	54	1	9
11	4	17	33	1	8	55	1	9
12	5	19	34	10	29	56	5	18
13	1	10	35	12	32	57	4	18
14	2	15	36	10	30	58	1	5
15	2	10	37	1	4	59	1	15
16	1	6	38	6	4	60	2	5
17	1	4	39	4	9	61	4	17
18	1	9	40	1	7	62	6	14
19	1	5	41	1	15	63	1	8
20	1	6	42	1	11	64	1	6
21	1	9	43	1	13	65	4	10
22	2	12	44	1	16	66	1	10
						Total	183	793
						Average	2.8	12.0

KARIAKOO

N	F	P	N	F	P	N	F	P
1	4	20	18	2	11	35	1	13
2	1	24	19	2	4	36	1	21
3	1	15	20	7	10	37	7	25
4	4	20	21	6	16	38	1	31
5	6	21	22	6	14	39	1	7
6	1	10	23	1	12	40	3	11
7	1	20	24	4	18	41	4	29
8	1	8	25	7	18	42	1	12
9	1	7	26	1	6	43	4	12
10	8	28	27	1	20	44	2	11
11	1	13	28	1	12	45	6	17
12	2	7	29	5	21	46	1	6
13	4	17	30	3	24	47	1	15
14	2	2	31	1	4	48	4	20
15	8	27	32	3	18	49	1	7
16	3	12	33	6	20	50	2	13
17	1	12	34	2	9	51	1	15

Note : N Sample number, F Number of family, P Number of people

N	F	P	N	F	P	N	F	P
52	3	13	82	1	18	111	3	12
53	5	15	83	6	14	112	6	20
54	5	11	84	5	19	113	5	18
55	5	9	85	2	23	114	1	9
56	1	8	86	3	20	115	1	21
57	6	18	87	5	20	116	1	8
58	6	22	88	1	23	117	1	18
59	1	11	89	2	9	118	10	29
60	6	16	90	1	22	119	1	20
61	7	18	91	1	80	120	1	15
62	4	27	92	1	10	121	5	15
63	4	19	93	1	29	122	3	11
64	1	15	94	1	9	123	5	23
65	1	4	95	3	20	124	3	10
66	8	32	96	1	30	125	2	10
67	2	15	97	1	8	126	7	23
68	1	14	98	1	4	127	3	26
69	1	5	99	1	5	128	1	10
70	1	5	100	6	30	129	1	16
71	1	18	101	3	11	130	5	12
72	3	11	102	2	8	131	5	20
73	1	10	103	1	11	132	6	10
74	6	22	104	1	12	133	4	7
75	1	11	105	9	22	134	2	12
76	2	18	106	6	12	135	7	24
77	3	13	107	9	18	136	1	20
78	6	26	108	1	7	137	2	16
79	4	20	109	1	11	138	7	17
80	4	14	110	4	17	139	4	28
81	3	17				Total	433	2224
						Average	3.1	16.0

MAGOMENI

N	F	P	N	F	P	N	F	P
1	2	8	15	2	6	29	1	5
2	4	15	16	5	16	30	7	23
3	3	17	17	3	10	31	7	18
4	5	10	18	6	28	32	6	21
5	3	18	19	5	23	33	5	18
6	4	13	20	5	17	34	7	24
7	6	14	21	2	10	35	1	24
8	8	18	22	6	19	36	2	10
9	6	21	23	1	4	37	10	19
10	5	14	24	6	18	38	6	19
11	6	28	25	2	10	39	9	28
12	4	7	26	2	5	40	6	7
13	4	16	27	4	5	41	6	20
14	4	8	28	4	8	42	6	11

Note : N Sample number   F Number of family   P Number of people

N	F	P	N	F	P	N	F	P
43	6	7	91	11	24	139	1	18
44	8	19	92	10	27	140	5	10
45	3	18	93	5	32	141	6	12
46	1	13	94	7	22	142	5	17
47	2	10	95	6	19	143	3	6
48	1	12	96	3	15	144	6	10
49	2	20	97	4	16	145	1	9
50	1	11	98	5	29	146	2	10
51	7	15	99	4	15	147	3	21
52	8	22	100	1	4	148	4	19
53	4	17	101	1	10	149	6	19
54	2	12	102	2	7	150	8	27
55	2	8	103	3	16	151	3	9
56	3	20	104	5	31	152	6	17
57	1	12	105	8	22	153	5	17
58	3	19	106	4	23	154	3	14
59	6	23	107	6	21	155	7	24
60	1	8	108	4	18	156	4	8
61	1	5	109	4	22	157	6	19
62	3	10	110	4	15	158	1	7
63	7	12	111	8	33	159	3	9
64	6	20	112	7	29	160	1	9
65	4	13	113	5	21	161	1	6
66	6	22	114	6	13	162	1	11
67	5	11	115	5	20	163	1	8
68	5	26	116	6	19	164	1	10
69	4	19	117	4	30	165	1	10
70	4	19	118	6	15	166	6	24
71	8	14	119	4	21	167	5	5
72	1	20	120	8	24	168	2	6
73	3	25	121	4	15	169	3	21
74	2	6	122	3	12	170	7	21
75	2	25	123	6	24	171	1	8
76	3	27	124	4	18	172	1	18
77	4	18	125	4	16	173	9	26
78	1	5	126	5	14	174	1	8
79	6	16	127	2	7	175	2	12
80	4	24	128	4	17	176	4	19
81	4	12	129	6	12	177	1	7
82	5	25	130	8	20	178	4	20
83	6	21	131	5	17	179	1	20
84	6	15	132	5	23	180	1	12
85	4	25	133	2	12	181	5	20
86	6	25	134	6	20	182	2	16
87	6	19	135	1	15	183	1	7
88	5	19	136	4	14	184	4	9
89	7	25	137	4	14	185	6	22
90	6	25	138	3	6	186	5	20
						Total	788	3013
						Average	4.2	16.2

B.

APPENDIX TO CHAPTER 3

B. APPENDIX TO CHAPTER 3

1. GENERIC JOB DESCRIPTION OF BM, DEPARTMENT HEADS, ENGINEERS IN OPERATION DEPARTMENT, AND SUB-BRANCH MANAGERS OF DSMB *

1.1 BRANCH MANAGER:

a. In charge of the BRANCH both administratively and professionally.

b. Supervise, coordinate and advise on day to day water supply operation in service area of the BRANCH ensuring safe and continuous supplies of water to consumers.

c. Bear responsibility for the technical efficiency of water abstraction, treatment and distribution within the service area and ensuring that adequate maintenance is carried out in all plants and equipments.

d. Bear responsibility of the commercial operation of the BRANCH ensuring that agreed administrative and financial systems are installed and operated.

e. Bear responsibility for the achievement of production and financial targets.

f. Responsible to the Director of Operation.

1.2 HEAD, PERSONNEL AND ADMINISTRATIVE DEPARTMENT:

a. Prepare BRANCH's manpower and training plans for submission to NUWA's HQ.

b. Implement all personnel systems and administrative procedures at the BRANCH.

c. Provide office services and security for the BRANCH.

1.3 HEAD, OPERATION DEPARTMENT:

a. Responsible for the operation of the BRANCH's water supply system according to agreed performance and public health standards.

b. Supervise the preparation and implementation of detailed planned preventive maintenance programmes for plants, equipments, and civil works at the BRANCH.

c. Ensure that regular inspection of plants, equipments and civil works is carried out and monitors all servicing, maintenance and repair.

d. Advise the source & treatment and distribution engineers on major breakdowns and repairs of electrical equipments and civil works.

e. Ensure prompt and efficient investigation of customer complaints concerning quality, taste and health.

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* Refer to section 3.2.2 "staff of the Dar es Salaam branch, NUWA", Main Report.

1.4 HEAD, FINANCE DEPARTMENT = BRANCH ACCOUNTANT:

a. Interprete, implement financial regulations and reviewing their practicability and viability; advising the Director of Finance accordingly.

b. Assist in the reviewing and formulating financial management practices.

c. Deal with accounting problems.

d. Prepare both on the job and formal training programme for accounting personnel.

e. Prepare annual statutory accounts for the BRANCH.

f. Manage working capital and controls cash flow.

g. Produce guidelines for and supervise the co-ordination and critical appraisal of the periodic operational and capital budgets prior to submission to the BRANCH MANAGER.

1.5 DISTRIBUTION ENGINEER, CHIEF OF THE SECTION:

a. Organize, control, supervise and manage;

a) the manpower resources, including contractors, employed on the installation, repair and maintenance of the distribution and a part of transmission networks of the BRANCH through five SUB-BRANCH managers and chief of the emergency unit.

b) the use of materials including setting stock levels, requisitioning, site security, etc.

c) all available vehicles, tools etc. ensuring adequate records of their usage and availability are maintained.

b. Ensure adequate records are maintained of work undertaken, material issued, material returned, manpower employed, cost incurred.

c. Ensure that the standard procedures for operation and maintenance including safety standards are introduced and maintained.

d. Ensure that management and budget control information is disseminated to SUB-BRANCH managers.

1.6 MAINTENANCE ENGINEER, CHIEF OF THE SECTION:

a. Responsible for the maintenance and repair of all the mechanical and electrical plants, building structures, intakes and other civil works of the BRANCH.

b. Responsible for all the workshops, and for buildings maintenance services in the BRANCH.

1.7 SUPPLIES & STORES OFFICER, CHIEF OF THE SECTION:

a. Ensures timely procurement.

b. Ensures proper receipt, storage, and procedures for the acquisition, storage and issue of all materials

and services.

c. Establishes, evaluates and maintains primary and secondary data.

d. Reviews and approves all the purchase orders of the BRANCH before issue.

1.8 SUB-BRANCH MANAGER:

a. In charge of the sub-branch for day to day operations.

b. Makes recommendation to the distribution engineer on the establishment of detailed standard procedures for operation and regular maintenance of the distribution system at the SUB-BRANCH.

c. Investigates customer complaints on tariff rates of water consumed, water disconnexion etc.

d. Responsible for new connexion.

e. Reports over-all matters relating to the operation of the SUB-BRANCH distribution systems to the distribution engineer.

f. Responsible to the distribution engineer.

2. PARASTATAL SALARY SCALE
(refer to section 3.2.2, Main Report)

1) Parastatal Operational Scale (POS)   (Unit: T.Shs.)

	AIR*	1	2	3	4	5	6	7	8
POS 1	60	2,125	2,185	2,245	2,305	2,365	2,425	2,485	–
POS 2	85	2,620	2,705	2,790	2,875	2,960	3,045	3,130	–
POS 3	95	3,265	3,360	3,455	3,550	3,645	3,740	3,835	–
POS 4	110	4,000	4,110	4,220	4,330	4,440	4,550	4,660	–
POS 5	120	4,815	4,935	5,055	5,175	5,295	5,415	5,535	5,655
POS 6	130	5,835	5,965	6,095	6,225	6,355	6,485	6,615	6,745
POS 7	145	6,950	7,095	7,240	7,385	7,530	7,675	7,820	7,965
POS 8	160	8,160	8,320	8,480	8,640	8,800	8,960	–	–
POS 9	170	9,160	9,330	9,500	9,670	9,840	10,010	–	–

2) Parastatal General Scale (PGS)   (Unit: T.Shs.)

	AIR*	1	2	3	4	5	6	7	8
PGS 1	110	3,435	3,545	3,655	3,765	3,875	3,985	4,095	–
PGS 2	120	4,230	4,350	4,470	4,590	4,710	4,830	4,950	–
PGS 3	130	5,100	5,230	5,360	5,490	5,620	5,750	5,880	6,010
PGS 4	145	6,195	6,340	6,485	6,630	6,775	6,920	7,065	7,210
PGS 5	155	7,380	7,535	7,690	7,845	8,000	8,155	8,310	8,465
PGS 6	170	8,665	8,835	9,005	9,175	9,345	9,515	–	–
PGS 7	180	9,710	9,890	10,070	10,250	10,430	10,610	–	–
PGS 8	190	10,825	11,015	11,205	11,395	11,585	–	–	–
PGS 9	200	11,820	12,020	12,220	12,420	–	–	–	–
PGS 10	220	12,675	12,895	13,115	13,335	–	–	–	–
PGS 11	230	13,575	13,805	14,035	14,265	–	–	–	–
PGS 12	240	14,520	14,760	15,000	15,240	–	–	–	–
PGS 13	250	15,520	15,770	16,020	16,270	–	–	–	–

3) Parastatal Rare Scale (PRS)   (Unit: T.Shs.)

	AIR*	1	2	3	4	5	6	7	8
PRS 1	170	7,755	7,925	8,095	8,265	8,435	8,605	8,775	8,945
PRS 2	200	9,145	9,345	9,545	9,745	9,945	10,145	–	–
PRS 3	220	10,345	10,565	10,785	11,005	11,225	11,445	–	–
PRS 4	245	11,690	11,935	12,180	12,425	12,670	–	–	–
PRS 5	265	12,935	13,200	13,465	13,730	13,995	–	–	–
PRS 6	290	14,305	14,595	14,885	15,175	–	–	–	–
PRS 7	310	15,825	16,135	16,445	16,755	–	–	–	–
PRS 8	335	17,165	17,500	17,835	18,170	–	–	–	–
PRS 9	360	18,625	18,985	19,345	19,705	–	–	–	–
PRS 10	385	20,205	20,590	20,975	21,360	–	–	–	–

4) Parastatal Special Scale (PSS)   (Unit: T.Shs.)

	AIR*	1	2	3	4	5	6	7	8
PSS 1	360	16,490	16,850	17,210	17,570	–	–	–	–
PSS 2	480	18,170	18,650	19,130	19,610	–	–	–	–
PSS 3	600	20,330	20,930	21,530	22,130	–	–	–	–
PSS 4	720	22,970	23,690	24,410	25,130	–	–	–	–

* AIR .... Annual Increment Rate,   Effective from July 1, 1990