Table 8-4 Total Cost for Water Supply Project for Small Urban Areas by Province

Province	Total Town ship Number	New Production (m^3/day)	Total Cost (Mil. US$)
Lusaka	1	960	0.66
Copperbelt	3	6,324	3.66
Central	7	13,084	13.32
North-western	2	3,395	4.11
Western	9	16,878	10.16
Southern	18	25,216	22.09
Luapula	2	8,374	6.61
Northern	9	19,373	16.25
Eastern	7	27,956	14.28
Zambia Total	58	121,560	91.14

1) Boreholes are equipped with power pumps.
2) Diameter of borehole is 30cm.

The cost for water supply in small urban areas is summarized as follows:

1) Difference in the cost for drilling one borehole is small by province on the assumption that every province has a drilling centre in its provincial town. The average cost for drilling is US$25,400 per one borehole. Price of the power pump is a large factor in the cost.
2) Difference in the cost for maintenance is small by province. The average cost for maintenance is US$15,600 per one borehole.
3) The average cost of one borehole including both drilling and maintenance is US$41,000 per one borehole.
4) The total cost for each township is different according to the safe yield of the borehole.

The total cost shown in Figure 8-5 and 8-6 includes source development cost (drilling boreholes cost), treatment cost, distribution cost and engineering services

8.3 Cost of Groundwater Development in Lusaka

Cost of completing one borehole is shown in Table 8-6. The borehole cost estimation includes almost the same assumptions as in the case of water supply for small urban areas, however, the length of borehole changes to 100m.

Northern Lusaka Groundwater Supply Project, comprising 50 wells of 20,000m3/day pumpage, is estimated to cost about 16 million US$. The total cost includes cost for Lusaka Groundwater Training Centre Project apart from source development cost (drilling boreholes cost), treatment cost, distribution cost, engineering services.

Table 8-5 Total Cost for Water Supply Project by Township

Province	Township	Water Production Rate (m3/day)	Total Cost (Mil. US$)
Lusaka	Rufunsa	960	0.66
Copperbelt	Masaiti	252	0.30
	Mpongwe	3,040	1.83
	Chambishi	2,530	1.53
Central	Chbombo	2,020	1.21
	Chisamba	510	0.30
	Kapri Mposhi	2,310	2.66
	Mumbwa	3,150	4.03
	Namupundwe	1,270	1.00
	Mukushi	2,440	1.93
	Serenje	1,890	2.19
Northwestern	Mfumbwe	2,100	2.68
	Kasempa	1,120	1.43
Western	Mongu	6,550	3.96
	Limulunga	1,870	1.12
	Namushakande	940	0.57
	Lukulu	1,400	0.85
	Sikongo	470	0.28
	Kaoma	4,210	2.54
	Shangombo	470	0.28
	Mulobezi	470	0.28
	Katima-Mulilo	460	0.28
Southern	Namwala	1,400	0.85
	Itezhi-Tezhi	1,580	2.01
	Mazabuka	6,550	3.96
	Magoye	490	0.63
	Nkambala	1,870	1.12
	Nega-nega	940	0.57
	Kafue-gorge	590	0.58
	Chikankata	880	1.12
	Monze	2,120	1.67
	Chisekesi	380	0.44
	Choma	2,520	2.92
	Batoka	380	0.44
	Pemba	420	0.48
	Mbabala	420	0.33
	Kalomo	2,650	2.10
	Zimba	250	0.30
	Gwembe	550	0.63
	Maamba	1,680	1.94
Luapula	Mansa	7,630	6.03
	Mwansabombwe	740	0.58
Northern	Kaputa	1,070	1.40
	Mbala	1,470	1.87
	Mporokoso	1,580	1.27
	Luwingu	740	0.58
	Chilubi	180	0.23
	Isoka	2,760	2.18
	Nakonde	1,270	1.00
	Chinsali	1,870	1.12
	Mpika	8,370	6.60
Eastern	Chama	1770	2.04
	Lundazi	2,100	2.43
	Chadiza	850	0.66
	Katete	3,150	3.64
	Petauke	3,780	4.37
	Nyimba	710	0.81
	Kacholola	420	0.33

Table 8-6 Borehole Cost for Lusaka Groundwater Development

Item	Specification	Unit Price	Quantity	Cost(K)	Cost(us$)
<Drilling and power pump>					
Mobilization		240,000		240,000	
Kilometer Charge					
Drilling		34,000	100m	3,400,000	
Casing Plain	D=35cm	44,000	80m	3,520,000	
Casing Perforated	D=30cm	48,000	20m	960,000	
Gravel Pack	D=30cm	3,000	90m	270,000	
Grouting		50,000	10m	500,000	
Pumping Test		600,000		600,000	
Power Pump	24 hours	7,320,000	1	7,320,000	
<Sub Total>		8,339,000		16,810,000	
Engineering Cost		x10%		1,681,000	
< Total>				18,491,000	30,313
<Maintenance & Rehabilitation(once/10 years)>					
Mobilization		240,000		240,000	
Cleaning		510,000	1	510,000	
Power Pump		7,320,000	1	7,320,000	
<Sub Total>				8,070,000	
Engineering Cost		x10%		807,000	
< Total>				8,877,000	14,552
<Grand Total>				27,370,000	44,900

8.4 Cost of Constructing Shallow Well

Cost for construction of shallow well is shown in Table 8-7. The cost estimation includes the assumptions listed below:

- Items of cost and unit price are the same as those of DWA.
- Size of shallow well is assumed as 15m in length and 1.2m in diameter.
- Maintenance cost is not included.

Table 8-7 Cost of Standard Shallow Well

Item	Unit Price	Number	
Casual workers	40,000	4	160,000
Windlass	115,000	1	115,000
Well chain	3,000	1	60,000
River sand	9,000 / ton	8	72,000
Crushed stone	12,000 / ton	6	72,000
Pockets cements	4,500 / pocket	23	103,500
Shovels	18,000	2	36,000
Picks	19,500	2	39,000
Blasting	27,000 / rock	3	81,000
Transport & Supervisor	200,000	1	200,000
Sub Total			154,000
Contingency	10%		95,400
Total			1,049,400

In the Table, the item for blasting means breaking up rock at the bottom of wells using dynamite and blasting is assumed as required 3 times for a standard well. However, the amount of blasting depends on geology of the site. The cost of a shallow well is sometimes dominated by the amount of blasting. On the other hand, the number of days needed for completion of a shallow well is as follows:

Table 8-8 The number of days needed for completion of standard shallow well

Digging up to 15m	5 days
Drilling of holes for 3 times blasting	12 days
Removal of debris from well after blasting	3 days
Lining up to 15m from ground surface	16 days
Installation of collar ring , cover, apron and chain	1 day
Total number of days	37 days

The number of days increases rapidly according to the amount of blasting. If the amount of blasting is 6 times, construction period becomes 52 days. The amount of blasting has more weight on the cost than the period of . The cost of a shallow well is less than one fifth as high as that of a borehole. However, the number of days needed for completion of a shallow well (37 days) is more than 7 times as long as that of a borehole(5days). Rapid groundwater development is impossible using shallow wells.

CHAPTER 9 RECOMMENDATIONS

9.1 Continuation of Groundwater Level Observation

Nation wide groundwater level observation is very useful to assess groundwater development potential as carried out in this master plan. The groundwater development potential obtained in the master plan should be examined and, if necessary, should be revised based on new data obtained from continuous groundwater level observation. It is important to observe groundwater level at the same observation points for a long period. From this point of view, 312 observation wells at 169 points established as observation wells in this master plan are useful for continuing observation. Data of groundwater level fluctuation at these observation points was accumulated for one year. Therefore, to continue the observation and obtain new data at these wells will contribute to formulating new groundwater development and management plan in the near future.

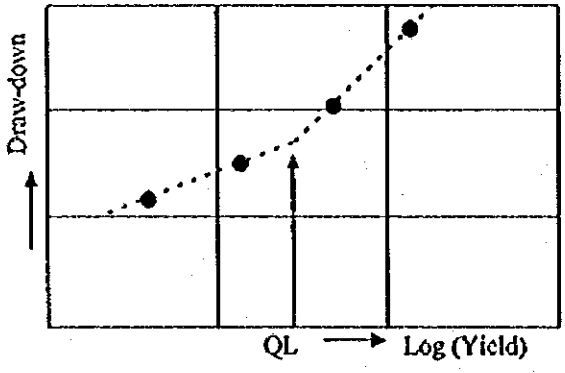
9.2 Continuation of Groundwater Level Monitoring

As explained in the previous section, recently a groundwater table decline in the large cities has been reported. Especially in Lusaka, it is said that the trend of groundwater decline caused by over pumping is remarkable and existing water supply facilities will be damaged in the near feature. From this point of view, continuation of groundwater level monitoring is very important. The groundwater levels were continuously monitored from June 1994 to March 1995 by the JICA Study Team. Trends of groundwater level decline were recognized from the records. However, this data is not sufficient to confirm a relationship between the groundwater decline and over pumping. Monitoring over longer periods is needed for that purpose. Effective counter-measures like regulations against over pumping should be examined based on the long term monitoring results. The monitoring stations were constructed by the Study Team and all the monitoring stations were handed over to the responsible organizations. It is desirable for these organizations to continue the groundwater level monitoring.

9.3 Execution of Adequate Pumping Test

9.3.1 Execution of Step Draw-down Test

Step draw-down test is carried out to determine safe yield of a borehole. Step draw-down test is defined as a pumping test to observe draw-downs of borehole with different yields. Safe yield of a borehole is determined as shown in Figure 9-1.



Safe Yield = QL x (0.7 - 0.8)

QL= An intersecting point of two lines as shown in Figure 9-1.

Figure 9-1 Method to Decide Safe Yield

If pumping rate exceeds safe yield, rock fragments enter into the borehole and are deposited on the bottom. If the worst comes to the worst, the wall of borehole and ground surface may collapse. Other than these phenomena, the efficiency of pumping ratio may be reduced inverse proportion to the pumping rate leading to uneconomical condition. These phenomena mentioned above occur especially in boreholes equipped with power pumps. On the other hand, such the cases occur rarely in boreholes equipped with hand pumps, because yield of hand pump is low. However, proper yields of such boreholes with hand pumps also should be determined in the case of future exchange from hand pump to power pump for rural water supply.

9.3.2 Proper Pumping Test for Aquifer Constants

It is necessary to obtain aquifer hydraulic constants precisely for planning large scale groundwater development. For this purpose, execution of proper pumping test is necessary. As a matter of course, pumping tests are always carried out after completion of boreholes, but those tests are not carried out in an appropriate method in terms of testing the aquifer and obtain the aquifer constants. Important points in execution of a pumping test for that purpose are as follows:

1) To drill observation boreholes and to observe groundwater level fluctuation in the observation boreholes during pumping test.
2) To keep yield of pumping well constant.
3) Before the pumping test, a stepped draw-down test should be carried out to decide the appropriate pumping rate for aquifer constants.

9.4 Effective Use of Borehole Data-Base

The effective use of borehole data-base is desirable for future groundwater development. The advantages of using the data-base are as follows;

1) It is easy to retrieve information about aquifers and existing boreholes near new groundwater development sites. From this, the planning of new boreholes, expected yield, length, casing program, etc., are easily carried out according to information derived from the data-base. Borehole data necessary for users are instantly found and printed out. The computer data-base has greatly reduced the time for searching out borehole data.
2) Statistical information on aquifers hydrogeology and boreholes capacity by district or province are easily obtained from the data-base. These information is useful not only for actual groundwater development planning but also for scientific hydrogeological study aiming at making clear characteristics of aquifers throughout Zambia.

9.5 Effective Survey for Groundwater Resources

Hydrogeological surveys should be carried out to locate drilling points. The better the survey, the more successful the borehole. Usually, aquifers exist at less than 100m from the surface in Zambia. Therefore, resistivity and electro-magnetic methods are the most useful for survey of such shallow aquifers. On the other hand, these surveys are not always carried out at present due to lack of survey instruments and hydrogeologists, and analysis of the

results is not always sufficient. In addition to the survey mentioned above, regional groundwater potential surveys are needed for large groundwater developments such as the Lusaka groundwater development plan. General survey items for such surveys are, pumping tests and analysis of the results, groundwater level observation, climatic survey and water balance analysis. Based on the results of the survey, a new groundwater development plan should be formulated.

9.6 Standardization of Hand Pump

Types of hand pumps should be standardized in terms of maintenance and repair. Indian Mark II type is the best as the standard hand pump. The reasons are as follows:

- The parts supply situation is better than for other types.
- The cost is lowest.
- The Indian Mark II type is the most widespread use in Zambia.

The government has already decided to standardize hand pump to Indian Mark II type. Therefore, donors should also standardize hand pumps to that type in their support for groundwater development. Boreholes are equipped with several types of hand pumps at present. These hand pumps should be changed to Indian Mark II when they have completed their useful life.

9.7 Construction of Provincial Drilling Center

As part of decentralization, groundwater development is scheduled to be transferred to the jurisdiction of local governments. Accordingly, drilling centers with drilling equipment will be needed in each province. On the other hand, these drilling center do not currently exist except in four provinces. This current situation prevents groundwater development from effective implementation. The borehole drilling plan in this master plan has been made under the assumption that there are drilling centers equipped with drilling rigs with high performance, adequate equipment's and experienced staff in each provincial town. Therefore, the drilling centres will first have to be constructed in order to complete the master plan.

9.8 Establishment of Maintenance and Management System for Rural Water Supply

Existing groundwater supply facilities are frequently not in use for the reason that the maintenance of completed water supply facilities is not adequate especially in rural areas. Therefore, a local maintenance and management system for rural water supply facilities should be established to ensure continuous use of completed water supply facilities. For this purpose, organizing community groups for village water supply is the most useful. Other than that, mobile hand pump repair workers are also useful.

9.9 Training of personnel in charge of groundwater development

Under the Master Plan, about twenty-four thousand boreholes should be completed before 2015. Training of engineers and technicians in charge of the borhole site selection, the machine operation, and the maintenance of equipment is essential to achieve these works. In

addition to the above, training of hand pump repair workers, persons in charge of sanitary education for the local residents and organizers of community groups for rural water supply are also needed. In Zambia, technology transfer related to groundwater development has been carried out by usual grant aid cooperation. In the present situation of this grant aid cooperation, technology transfer is restricted to only a few drilling engineers. Therefore, the establishment of a training centre with excellent trainers and adequate equipment's is needed in order to achieve highly effective technology transfer related to groundwater development and use. The organization and training system of the training centre should be established at an early stage in order to satisfactorily fulfill its function.

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF ZAMBIA
MINISTRY OF ENERGY AND WATER DEVELOPMENT

THE STUDY

ON

THE NATIONAL WATER RESOURCES MASTER PLAN

IN

THE REPUBLIC OF ZAMBIA

FINAL REPORT

SUPPORTING REPORT [E]

DOMESTIC WATER SUPPLY

OCTOBER, 1995

YACHIYO ENGINEERING CO., LTD.
(YEC)

THE STUDY ON NATIONAL WATER RESOURCES MASTER PLAN
IN THE REPUBLIC OF ZAMBIA

SUPPORTING REPORT (E)
DOMESTIC WATER SUPPLY

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CHAPTER 1 INTRODUCTION

1.1 Sector Background

This Part E presents results of the study on water supply sector in Zambia. Chapter 2 describes the present situation of the domestic water sector in Zambia based on past studies, publications, information collected through the study and "Current Water Use Survey" done by the JICA study team during the study period. Water demand projection is presented in Chapter 3. The basic socio-economic study such as projections of population, urbanisation, industrialisation and so on are referred to Part A, "Socio-Economy". On the basis of the present conditions and water demand projection, a master plan of water resources development plan for water supply over the whole country is formulated in Part W of Supporting Report.

1.2 Objective of Water Supply Study

The objectives of the study are: (1) to clarify the present conditions of the water supply sector; (2) to project future potential domestic water demand; and (3) to examine possible countermeasures for development constraints on water supplies in the country. This study does not intend to cover specific water supply schemes.

1.3 Acknowledgment

During the study period, the study team's experts visited various offices for collection of information and received kind help from the officers, to which we wish to express many thanks. In particular, the data through "Current Water Use Survey" were answered by the district water engineers and their staff who know the local conditions. However, as shown in various tables presented in this report, there are still lots of blanks, which were not filled by the district engineers and their colleagues, probably due to lack of basic information. Such information gaps will not affect results of this study, but it is considered necessary to fill out them in the future.

CHAPTER 2 PRESENT SITUATION OF DOMESTIC WATER SUPPLY

2.1 Water Supply Situation

2.1.1 Water Supply Coverage

According to the "Social Sector Rehabilitation and Development Programme, 1993-1996" (Ref.E01), only 43% of the urban population of Zambia has access to safe water and to sanitation structures. In rural areas, only about 30% of the population has access to safe water.

According to the 1990 census, 2.75 million people or 37% of the total population (7.38 million) were served by piped water system in the country, as shown in Table 2-1. Of these served population, 0.97 million people or 35% were served by inside water taps within their houses. 1.37 million or 50% was served by communal taps around their houses. The rest of 0.41 million or 15% was also served by communal taps but their service points were located more than 100 metres away from their houses. In urban areas, 2.46 million people or 85% of the urban population were covered by the piped supply system. In rural areas, however, only 0.29 million people or 6.5% of the rural population were covered by the piped system. 2.32 million or 52% of the rural population was served by well or borehole water sources. Thus, 2.61 million or 58% of the total rural population was covered by the safe water sources in rural areas.

Table 2-1 Households and Persons by Main Source of Water Supply: 1990

(Unit: 1000)

Item	Total	Piped Water			Well or Borehole	River/ Stream	Others	Not Stated
		Inside Housing Unit	Outside Housing Unit	Beyond 100m				
1. Zambia								
Households	1,327.0	142.6	242.8	78.9	489.5	322.1	34.7	16.4
Persons	7,367.0	967.7	1,371.8	414.3	2,647.3	1,677.1	189.2	99.6
2. Urban								
Households	491.3	132.2	214.5	62.2	63.8	9.6	1.7	7.4
Persons	2,893.6	904.6	1,228.0	328.6	328.9	47.4	8.6	47.6
3. Rural								
Households	835.7	10.4	28.3	16.7	425.7	312.5	33.1	9.0
Persons	4,473.4	63.1	143.8	85.7	2,318.4	1,629.7	180.7	52.0

Source: Census of Population, Housing and Agriculture, 1990, Volume 10, CSO (Ref. E02)

From the view point of relation between water demand and water supply capacity which were estimated by the JICA study team, a safe water coverage in rural areas was only 24% in the country. The regional disparity was so large as the coverage in Southern province reached to 67% but that in Northern province was still 8% only. With the exception of Lusaka, Livingstone and Kasama, supply capacities exceed the demands in 12 large urban city. The coverage in small urban areas was still 80%. Even in the large urban areas, the

disparity of the coverage was so large as townships in Copperbelt province were blessed with water resources but those of Lusaka, Livingstone and Kasama were tight as their coverage were 57%, 70% and 67%, respectively. In small townships, those in Copperbelt and North-western provinces were in favourable conditions, but the coverage in Eastern province were only 26%, more serious than that of large urban townships.

2.1.2 Managing Bodies

In principal, most urban water supplies are implemented by local authorities and most rural water supplies are managed by DWA. In addition to it, the actual management of water supply and sanitation systems is divided among various managing bodies as follows because of historical background:

(a) Central Government: DWA under MESD, MOH, and Department of Community Development under MCDSS
(b) Local Governments under MLGH: City Councils, Municipal Councils and District Councils
(c) Parastatals: ZESCO, ZCCM, Zambia Railways, etc.
(d) Missionaries and Non-Government Organisations (NGOs)
(e) Private Sectors: Lusaka Water and Sewerage Company Ltd., Chipata Water and Sewerage Company Ltd., Mining Companies, etc.

2.1.3 Target of Water Supply Coverage

In the "Social Sector Rehabilitation and Development Programme" (Ref.E01), the government addresses the water supply goal to fulfill the supply of sustainable safe drinking water to the people. The immediate objective extends the coverage of safe water supplies to 70% of urban people and 35% of rural population by the year 1996. No targets after 1996 have been addressed so far officially.

2.2 Domestic Water Consumers

In urban areas, various supra- and infra-structures as well as residences are settled in accordance with urban agglomeration. These facilities in actual towns are not always composed in conformity with a certain rule systematically, although they should be settled to avert urban and environmental problems and to keep amenity of life. From the point of view of human settlement, Department of Town and Country Planning proposes the Planning Standard for new settlement. This Standard seems to be useful to estimate water demand as a reference for standardisation of water consumers. It was announced for human settlement standard in the "Second National Development Plan, 1972-1976" (Ref. E03). It is summarised in Table 2-2.

Table 2-2 Summary of Planning Standard for Human Settlement

	Facility	Standard	Comment	
1.	Residential		Composition	Density:
	a. High Cost Housing	30x45m (1,350 m²)	2.5%	362.5 persons/ha
	b. Medium Cost Housing	18x30m (540 m²)	15.0%	
	c. Low Cost Housing	12x27m (324 m²)	82.5%	
2.	Educational Facility			
	a. Nursery School	1 school/4,000 pop. (200 pupils/4,000 pop.)	0.5 ha/4,000 pop.	
	b. Primary School	1 stream: 280 pupils/1,500 pop. 4 stream: 1,120 pupils/6,000 pop.	0.8 ha/1,000 pop. 0.5 ha/1,000 pop.	Excludes teachers' housing
	c. Secondary School	4/2 stream for 20,000 pop.	5.0 ha/20,000 pop.	
3	Medical Facility			
	a. Hospital	District Hosp.: 1/50,000 pop. Provincial Hosp.: 1/100,000 pop. General Hosp.: 1/300,000 pop.		
	b. Clinic	600~800 m²/1,000 pop.	15km radius catchment	
4.	Administrative Office			
	a. Council Offices	400 m²/10,000 pop.	Commercial site of 1,500 m², including police post, postal agency & local offices	
	b. Police Post	400 m²/10,000 pop.		
	c. Police Station	1 ha/30,000 pop.	Plus 2ha residential in residential district	
	d. Party Office	400 m²/4,000 pop.		
	e. Central Government Office	4,000 m²/10,000 pop.		
5.	Social Facility			
	a. Community Hall	1,500~2,500 m²/10,000 pop.		
	b. Place of Worship	1,000~1,500 m²/10,000 pop.		
	c. Entertainment	400 m²/10,000 pop.		
	d. Open Air Cinema	500 m²/10,000 pop.		
6.	Commercial Area			
	a. Shopping (Rural Settlement)	160~360 m²/1,000 pop. (260 m² average)	(a) Central area 80~180 m²/1,000 pop. (b) Dispersed 80~180 m²/1,000 pop.	
	b. Retail Market	14 stalls/1,000 pop.	25 m²/1,000 pop.	1km catchment
	c. Offices	400 m²/10,000 pop.		
	d. Licensed Premises	2,000 m²/3,000 pop.	1,000~2,000 m²/plot	
	e. Petrol Filling Station	1,000~1,500 m²/20,000 pop.		
	f. Post Office	300 m²/10,000 pop.		
7.	Open Space Facility			
	a. Children's Playground	0.5 ha/1,000 pop.	200 radius, including informal football areas.	
	b. Playfield	2.0 ha/10,000 pop.	1 km radius, including 1 football pitch/5,000 pop.	
	c. Parks	0.1 ha/1,000 pop.		
	d. Swimming Pools	0.75 ha/30~50,000 pop.		
	e. Golf Course	60 ha (18 holes); 30 ha (9 holes)		
	f. Private Park or Play area	0.05 ha/1,000 pop.	(a) Less specific requests (b) This acts as land reserve within town	
	g. Stadium/Show Ground	5 ha	Demand likely once community exceeds 10,000 pop.	
	h. Cemetery & Crematorium	50 ha/50,000 pop.	1 ha/1,000 pop. Sited away from residential areas	

Source: Planning Standard, MLGH

Yet, this standard seems to be established from an idealistic viewpoint. An actual distribution of infrastructure is somewhat smaller than this standard. For example, a primary school was allotted for every 2,060 population on national average in 1990 and 381 pupils per school in 1992. In the standard, a primary school of one stream has 280 pupils for 1,500 population. The pupil's rate to population is almost the same, but the number of primary school has to be increased more than the actual distribution in order to bring the situation close to the standard. Furthermore, a hospital was allotted for every 950,000 people on national average in 1993. In the standard, however, even general hospital is planned to be established for every 300,000 people. Thus, once the water demand is estimated on the basis of this standard, the estimated figure might be biased to larger side than the actual demand.

Anyhow, it is important to get precise water demand information to establish a water supply system economically. The information of actual distribution of practical water consumers is prerequisite to estimated water demands in the supply areas. Nevertheless, the actual distribution of these facilities is not known even in major townships. In this study, thus, the above planning standard of human settlement is applied instead of the actual distribution of water consumers.

2.3 Water Consumption Rates

2.3.1 Amount of Water Produced and Sold

"Current Water Use Survey" was conducted by the JICA study team in 1994 throughout the country. As a part of the survey, information of water use in urban areas was collected from the 85 schemes, as shown in Table 2-3. The table shows an inventory of water supply projects which are aggregated on the basis of managing body for respective provinces. There are five categories of water supply body in the table.

(1) DWA: Water supply to small townships or rural villages. These schemes are covered usually by various water sources such as surface water and groundwater. Per capita consumption volume supplied varied in accordance with size of schemes but an overall average was calculated at around 150 lit/capita/day.

(2) Councils: Urban water supply schemes throughout the country, operated by the local governments under MLGH. Average per capita consumption volume supplied was calculated at around 210 lit/capita/day.

(3) ZCCM: ZCCM is responsible for water supply covering domestic water and some industrial water for use in production processing in the mine townships. Average per capita consumption volume supplied was calculated at around 450 lit/capita/day. This large per capita volume was probably due to industrial water use combined with increased leakage and wastage.

(4) ZESCO: Small water supply schemes which are located around hydro-electric power plants. Average per capita consumption volume supplied was calculated at around 280 lit/capita/day.

(5) Private Sector: Large water supply schemes, operated by the privatised companies. There are only two cities of which water supply schemes are operated by them, i.e., Lusaka and Chipata. Average per capita consumption volume supplied was calculated at around 210 lit/capita/day, as well.

Table 2-3 Water Supply Projects by Managing Body and by Province

Province		Managing	Number of	Population	Quantity	Per Capita
Code	Name	Body	Schemes	Served	(m^3/day)	(lit/cap./day)
10	Lusaka	LWSC	1	900,000	190,000	211
		Council	2	-	-	-
		DWA	1	1,100	550	500
20	Copperbelt	Council*1	7	1,185,000	240,125	203
		ZCCM	7	507,000	229,800	453
		DWA	6	9,050	4,005	443
30	Central	Council*2	3	121,000	33,120	274
		ZCCM*3	2	50	16	320
		DWA	4	51,150	7,150	140
40	Northwestern	Council	1	-	-	-
		DWA*4	6	14,158	4,695	332
50	Western	Council	1	-	-	-
		DWA	6	43,523	5,623	129
60	Southern	Council*5	7	182,420	43,380	238
		ZESCO*6	2	5,575	800	143
		DWA*7	5	20,980	1,101	52
70	Luapula	Council	1	45,000	6,480	144
		ZESCO	5	18,890	5,966	316
		DWA	1	500	106	212
80	Northern	Council*8	3	62,995	13,500	214
		DWA	7	40,314	5,732	142
90	Eastern	CWSC	1	-	-	-
		DWA	6	35,737	2,832	79
	Zambia	Council*9	25	1,596,415	336,605	211
		Private Company*10	2	900,000	190,000	211
		ZCCM*11	9	507,050	229,816	453
		ZESCO*12	7	24,465	6,766	277
		DWA*13	42	216,512	31,794	147
		Total*14	85	3,244,442	794,981	245

Source: Current Water Use Survey, 1994, JICA

Note:
*1 No data in two schemes
*2 No data in one scheme
*3 No data in one scheme
*4 No data in one scheme
*5 No data in two schemes
*6 No data in one scheme
*7 No data in one scheme
*8 No data in one scheme
*9 No data in six schemes
*10 No data in one scheme
*11 No data in one scheme
*12 No data in one scheme
*13 No data in two schemes
*14 No data in 11 schemes

2.3.2 Unit Rates of Water Consumption

The average unit rates of water consumption are one of the most fundamental information for water demand estimation. In Zambia, the Standardisation Committee was established to provide the standard figures of average water consumption rates in early 80's and to revise them in August 1986. The figures were gazetted in Circulation No.1, "Consumption Figures and Population Projects for Design of Water Supply Systems" (Ref.E04). The major rates were summarised in Table 2-4.

Table 2-4 Summary of Water Consumption Unit Rates

	Facility	Unit	Consumption Rate
1.	Residences		
	- Informal Housing	lit./capita/day	30
	- Low Cost Housing	lit./capita/day	100
	- Medium Cost Housing	lit./capita/day	150
	- High Cost Housing	lit./capita/day	280
2.	Educational Facility		
	- University/College	lit./student/day	120
	- Secondary(non-boarders)	lit./student/day	30
	- Primary (with W/C)	lit./student/day	25
	- Primary (with Pit Latrine)	lit./student/day	15
3.	Medical Facility		
	- Hospital (Urban)	lit./bed/day	365
	- Clinic (without Beds)	lit./patient/day	10
4.	Hotel & Restaurant		
	- Hotel (Medium Class)	lit/bed/day	250
	- Restaurant	lit./seat/day	100
5.	Administrative Office	lit./staff/day	30
6.	Parks & Road Washing	lit./day/pop.	10
7.	Commercial Area	lit./ha/day	30,000
8.	Industrial Area (Light Industries)	lit./ha/day	30,000

Source: Consumption Figures and Population Projections for Design of Water Supply Systems, Circulation No. 1, Revised in August 1986, DWA (Ref. E04)

2.4 Public Investment for Water Supply Schemes

2.4.1 Disbursement of Central Government

In relation to the managing bodies, the various public agencies invest public fund to implement water supply schemes. DWA, the authority regarding water supply schemes in the central government, usually disburses its capital expenditure for water projects. Besides, MLGH also invests public capital in water projects not by itself directly but through local authorities. In other words, MLGH loans local governments its capital fund. Table 2-5 shows the summary of public investment for water supply schemes by the central government for the latest six years. In 1994, 27 projects could be implemented directly by the central government. The total amount will reach to K13.7 billion. Eight projects would be implemented by local governments and financed by MLGH. The total amounts would be K19.7 billion. Besides, the local governments would disburse their capital investment (K14 million) for more water projects through their own finance, but their amounts might be very small. It account for only 12% of that (K115.3 million) of the central government.

Table 2-5 Public Investment for Water Supply Schemes by Central Government

Ministry	1989	1990	1991	1992	1993	1994		
	Actual (K'Mil.)	Actual (K'Mil.)	Actual (K'Mil.)	Actual (K'Mil.)	Estimate (K'Mil.)	No. of Projects	Estimate (K'Mil.)	Donor(Grant) (K' Million)
Direct Investment								
DWA	9.3	14.5	14.3	67.4	1,312.3	24	13,021	9,733
Energy Dept.	-	-	-	*	*	*	*	*
MOH	0.0	0.3	1.0	3.0	583.0	1	559	559
MWS	-	0.4	1.8	7.5	13.0	1	11	0
MAFF	*	*	*	*	*	*	*	*
Total	9.3	15.2	17.1	77.9	1908.3	26	13,591	10,292
Loan								
MLGH	64.2	75.1	127.4	89.8	3,579.2	8	19,651	14,993
Grand Total	73.5	90.3	144.5	167.7	5,487.5	34	33,242	25,285

Source: (1) Estimates of Revenue & Expenditure 1994, Volume I, II & III, MOF (Ref.E22)
(2) Financial Report for the Year Ended 31st December 1992, 1994, MOF (Ref.E18)
(3) Financial Report for the Year Ended 31st December 1991, 1993, MOF (Ref.E19)
(4) Financial Report for the Year Ended 31st December 1990, 1992, MOF (Ref.E20)
(5) Financial Report for the Year Ended 31st December 1989, 1991, MOF (Ref.E21)

Note: "-" means that the agency itself did not exist.
"*" means that the agency has water projects except water supply projects.

2.4.2 Cost Sharing Policy

The cost recovery policy in water resources development and use projects varies in different countries. They range from zero to full cost recovery including the payment of interest cost. In between, partial cost recoveries are widely in practice in accordance with different criteria and socio-political considerations particular to each country.

Water resources development in Zambia will require an accelerated and large amount of investment to keep up with rapid socio-economic development. To meet this requirement, not only effective investment but also efficient recovery of public expenditures should be pursued.

This study envisages two general criteria for formulating the water cost sharing policy.

(1) The first criterion is a leading criterion that the beneficiaries are required to share, according to the benefits they receive, the entire cost of the public facilities including construction, operation and maintenance costs if the beneficiaries are identifiable and are confined to certain sections of the community. In principal this cost should not be covered by tax revenue collected from general tax payers who include non-beneficiaries, but should be recovered from the beneficiaries themselves as a separate charge. This criterion is based on the free market economy principle and the principle of equity, which encourages the economic efficiency and optimum allocation of national resources.

(2) The second criterion is that the government grant should be provided only if it is necessary in order (a) to encourage the beneficiaries' participation in development or (b) to provide social amenities from the standpoint of subsidising low income people. Even in this case, the cost recovery policy would rather be discussed with

beneficiaries. For instance, in construction period some beneficiaries might have an opportunity to share some tasks of construction works as task force. In operation and maintenance stage, some O/M works such as simple periodic inspection could be managed by some beneficiaries. By this participation works, the costs for water supply works could be saved in accordance with beneficiaries' attendance.

2.5 Water Tariff

2.5.1 Financial Status of Water Supply Undertakers

According to financial statement of local governments issued by MLGH in 1990, 33 district councils among 55 districts were managing water supply schemes for the people in the districts. Of the 33 district councils, only nine councils got surplus from water undertaking. Other 24 councils managed the water undertaking in deficit. Mufulira council recorded the largest deficit of K2.35 million in 1990.

Water supply services in Lusaka and Chipata townships are managed by private companies, i.e., "Lusaka Water and Sewerage Company Limited (LWSC)" and "Chipata Water and Sewerage Company Limited (CWSC)". They were originally established as municipal undertakers of the respective councils. They were reorganised as private firms under the privatisation policy of the central government.

LWSC is a leading managing company in the country in terms of water supply and sanitation services. It is responsible for water supply and sewage services covering all over the national capital areas. Thus, it is the largest establishment in the field of water supply and sanitation among Zambia.

Table 2-6 shows a balance between revenue and expenditure of LWSC during four years from 1990 to 1993. For the four years, the overall balance of the company recorded surplus in 1990 and 1992, and deficit in 1991 and 1993. Main sources of the revenue were potable water and sewage services which accounted for K3.87 billion or 99% of the total revenue (K3.92 billion including sundry income and investment income). This main revenue consists of two parts: K2.66 billion (68% of the total revenue) of water supply services; and K1.21 billion (31%) of sewage services. The main revenue of consumer services has continuously increased as shown in the table. However, it looks difficult that the company keeps financially sound conditions without reviewing and revising as necessary because of unsteady economic conditions.

Table 2-6 Profit and Loss Account of Lusaka Water and Sewerage Company: 1990-1993

(Unit: K'Million)

	Item	1990	1991	1992	1993
1.	Revenue	157.0	221.8	1,111.0	3,872.4
	-1 Water Supply	-	-	755.3	2,660.4
	-2 Sewerage Services	-	-	355.7	1,212.0
2.	Operating Expenses	83.5	169.1	428.7	1,765.2
3.	Operating Profit	73.5	52.7	682.2	2,107.2
4.	Sundry Income	0.4	1.2	10.0	3.3
5.	Administrative Expenses	60.2	79.6	647.1	2,373.2
	-1 Employment	10.5	16.2	48.5	107.2
	-2 Premises/Plants	1.0	4.2	11.2	61.6
	-3 Supplies/Transport	1.0	10.3	32.7	108.0
	-4 Establishment/Financial	47.8	49.0	554.7	2,096.5
6.	Profit/Loss before Investment Income	13.8	-25.7	45.1	-262.7
7.	Investment Income	1.3	2.7	5.2	42.4
8.	Profit/Loss for the Year	15.0	-23.0	50.4	-220.4
9	Taxation	7.1	0.0	19.8	7.1
10.	Profit/Loss after Taxation	7.9	-23.0	30.6	-227.5

Source: Financial Statements, December 1993, Lusaka Water Sewerage Company Limited (Ref.E11)
Financial Statements, December 1992, Lusaka Water Sewerage Company Limited (Ref.E12)
Financial Statements, December 1991, Lusaka Water Sewerage Company Limited (Ref.E13)

Assets of LWSC consists of (a) current assets, which include not only general assets such as cash and savings but also account receivable which may include uncollected charges; (b) fixed assets, which include water supply and sewerage facilities and equipment for operation and maintenance; and (c) deferred assets, which include research and studies. The total amount of the assets was reported as K5.25 billion in 1993, as shown in Table 2-7.

The assets of water supply and sewerage facilities owned by the company was evaluated at K2.39 billion in 1993. They comprised (a) K0.21 billion of piping networks for water supply and sewage; (b) K0.54 billion of plant facilities and equipment; (c) K0.09 billion of land and buildings; and (d) K1.54 billion of works in progress. These fixed assets were supported mainly by fixed liability.

The net profits of LWSC during the recent four years were unstable, as seen before. As shown in Table 2-8, a profit ratio of total capital also looks unstable, but the ratio in 1992 was 3.4% which was comparatively large as compared with the Japanese average ratios (1.3% and 1.5%).

A turnover ratio of net worth has rapidly increased, as seen in the table. It was good performance for profitability, but a problem was that the net worth itself shrank and that fixed liabilities rapidly increased. This was not good circumstance for management. A ratio of interest to liabilities were still 4% in 1993, so an interest burden seemed not so heavy for the company. In the future, however, this condition would rather be improved by means of increasing capital and reserves instead of increasing long-term liabilities.

A turnover ratio of fixed assets was higher than that of the Japanese average. This is because the fixed assets was comparatively small. In fact, a component ratio of fixed assets to total assets was 43% in 1992 and 46% in 1993. On the other hand, a rate of depreciation to depreciable fixed assets was large, i.e., 7.3% in 1992 and 9.5% in 1993. It is considered that the depreciable assets were written off at comparatively high rates. This reflected a maintenance level of the equipment and facilities of the plants. It can recover a capital investment within a short period, but it pushes up operating expenses. As a result, it might force to push up a water tariff to meet these increased operating expenses.

A ratio of fixed assets to net worth was 1,189% in 1993 and much worse than those of Japanese entities. On the other hand, a ratio of fixed assets to long-term capital was 60% in 1993 which was not worse. This was because LWSC relied not on its own net worth but on long-term liabilities. Thus, again, this should be improved by means of increasing capital and reserves instead of increasing long-term liabilities.

It is generally said to be desirable that current ratio should be more than 200%. That of LWSC, however, was 155% in 1992 and 91% in 1993. This means that LWSC would be difficult to get short-term loans through creditors.

The company has kept a high level of an operating ratio (around 200%) but has not been able to improve a ratio of current revenue to current expense (around 100%). This was caused by large administrative expenses as seen in Table 2-6. In 1993, the expenses amounted at K2.37 billion, which was 34% larger than the operating expenses of K1.77 billion. It was considered that the expenses included bad debts which was estimated at K1.71 billion in the same year.

Finally, the following recommendations are presented for LWSC, from the point of view of management.

1) Net worth is too small and excessively relies on long-term liabilities for capital investment. At present, an interest burden seems to be relatively low but this condition causes cash flow difficulty in the future when the repayment of loan will begin. Thus, LWSC would rather increase net worth as much as possible, which comprises own capital, internal reserves and contribution in aid of construction from beneficiaries. In addition to that, the company should try to find favourable terms of loans for supplemental funds of construction works.

2) In 1993, the company spent the large amount of K2.37 billion for administrative expenses. This lies heavy on the management. The heaviest component was bad debt losses. Thus, the company has to exert all possible efforts to charge water tariff correctly and to recover uncollected charges.

3) The improvement of operation and maintenance is a key issue to keep the plant machinery and piping network in good condition. This would extend their economic lives and decrease not only O/M costs but also depreciation of the facilities hopefully. It could make water tariff keeping low and steady. As a result, this management policy would get people's dependence on the water supply system and finally recover their reliance on the company.

Table 2-7 Balance Sheet of Lusaka Water and Sewerage Company: 1990-1993

(Unit: K'Million)

Item	1990	1991	1992	1993
Assets				
1. Current Assets	78.6	101.2	373.4	1,162.9
-1 Cash and Savings	8.5	12.9	78.1	174.4
-2 Amount due by Lusaka City Council	0.0	0.0	0.0	110.3
-3 Accounts Receivable	60.1	70.7	230.8	819.1
-4 Stocks	10.0	17.6	64.4	59.1
2. Fixed Assets	378.3	585.2	966.7	2,390.6
-1 Land and Buildings	95.0	90.0	89.0	90.4
-2 Water and Sewerage Network	254.9	241.5	228.1	214.7
-3 Plant, Equipment, Furniture & Vehicles	28.3	37.0	52.2	544.5
-4 Capital Work in Progress	0.0	216.7	597.4	1,541.1
3. Deferred Assets	1.1	0.0	902.7	1,695.8
Total	458.0	686.4	2,242.8	5,249.4
Capital and Liability				
1. Liability	37.0	288.5	1,814.3	5,048.4
-1 Current Liability	24.6	52.9	240.2	1,277.0
- Accounts Payable	13.8	30.3	99.0	979.7
- Amount due to Lusaka City Council	3.7	15.2	3.5	0.0
- Taxation	7.1	7.1	26.7	22.7
- Short-term Loan	0.0	0.3	111.0	274.6
-2 Fixed Liability	12.4	233.8	1,520.9	3,663.2
-3 Grants	0.0	1.7	53.1	108.2
2 Capital	421.0	397.9	428.5	201.0
-1 Share Capital	0.0	0.0	0.0	0.0
-2 Reserves	420.9	397.9	428.4	200.9
Total	458.0	686.4	2,242.8	5,249.4

Source: Financial Statements, December 1993, Lusaka Water Sewerage Company Limited (Ref.E11)
Financial Statements, December 1992, Lusaka Water Sewerage Company Limited (Ref.E12)
Financial Statements, December 1991, Lusaka Water Sewerage Company Limited (Ref.E13)

Table 2-8 Management Indicators of Lusaka Water and Sewerage Company: 1990-1993

Item	Lusaka Water & Sewerage Company				Japanese Companies*1	
	1990	1991	1992	1993	Profiting Entities	All Entities
Profitability						
1. Profit Ratio of Total Capital	-	-4.0%	3.4%	-5.9%	1.3%	1.5%
2. Turnover Ratio of Net Worth	-	0.1	1.7	6.7	0.5	0.4
3. Turnover Ratio of Fixed Assets	-	0.1	0.9	1.3	0.2	0.2
4. Turnover Ratio of Accrued Revenue	-	0.8	4.5	4.0	8.7	8.9
Safety						
1. Ratio of Net Worth to Total Capital	92%	58%	19%	4%	40%	41%
2. Rate of Depreciation *2	-	7.7%	7.3%	9.5%	3.3%	3.3%
3. Current Ratio *3	320%	191%	155%	91%	268%	279%
4. Ratio of Fixed Assets to Net Worth	90%	147%	226%	1189%	222%	218%
5. Ratio of Fixed Assets to Long-Term Capital	87%	92%	48%	60%	93%	93%
6. Component Ratio of Fixed Assets	83%	85%	43%	46%	89%	89%
7. Ratio of Interest to Liabilities	13.7%	3.3%	0.9%	4.1%	6.3%	6.4%
Productivity						
1. Operating Ratio *4	188%	131%	259%	219%	126%	127%
2. Ratio of Current Revenue to Current Expense	110%	90%	104%	94%	106%	108%

Note: *1 Water supply companies in Japan, all of which cover more than 0.3 million people
*2 Ratio of depreciation to total value of depreciable assets
*3 Ratio of current assets to current liability
*4 Ratio of revenue to operating expenses

2.5.2 Present Water Tariff

LWSC presents a tariff of public water services for consumers within the servicing territory of the company. The tariff was revised in October 1994 and again in January 1995. However, 1995's revised tariff was not approved completely by the authority. The present tariff is given in Table 2-9. LWSC will apply the proposed tariff to beneficiaries soon. Figures 2-1 and 2-2 illustrate unit rate of potable water for both the previous tariff in 1994 and the proposed tariff in 1995.

Table 2-9 Water Tariff of Lusaka Water and Sewerage Company Limited

	Item			Effective form October 1994 (Kwacha/month)	Revised in January 1995 (Kwacha/month)
Tariff 1	Commercial and Industrial Consumers				
	Standing Charge			-	5,000.00
	Metered Charge				
	0 - 100,000 Litres		per 1,000 Litres	198.00	238.00
	100,001 - 170,000 Litres		per 1,000 Litres	308.00	370.00
	170,001 - Litres and Over		per 1,000 Litres	461.00	553.00
Tariff 2	High Density Residences with Commercial Taps				
	Upgraded Areas			4,307.00	5,492.00
	Other Areas			-	5,492.00
Tariff 3	Low Density, council residences and Special connections				
	Standing Charge			-	2,000.00
	Metered Charge				
	0 - 20,000 Litres		per 1,000 Litres	88.00	106.00
	20,001 - 40,000 Litres		per 1,000 Litres	143.00	172.00
	40,001 - Litres and Over		per 1,000 Litres	198.00	-
	40,001 - 100,000 Litres		per 1,000 Litres	-	238.00
	100,001 - 170,000 Litres		per 1,000 Litres	-	370.00
	170,001 - Litres and Over		per 1,000 Litres	-	553.00
B.	Water Connections Charges				
	All Connections to be Charged at Cost			-	-
C.	Water Reconnection Fees				
	(i) Commercial and Industrial Consumers			84,500.00	84,500.00
	(ii) All Others			26,000.00	26,000.00
	(iii) Additional penalty where a supply is disconnected due to misuse of water			56,000.00	56,000.00
D.	Water Deposits				
	(i) Industrial, Commercial & Special Connections			-	130,000.00
	(ii) Low & Medium Density Residences			-	26,000.00
	(iii) High Density Residences with Individual Taps			-	8,500.00
	(iv) High Density Residences with Communal Taps			-	5,500.00
E.	Metre Inspection Fee				
	Standard Fee (to be refunded if the metre is found to be faulty)			22,000.00	26,000.00
F.	Illegal Connection Charges				
	(i) Commercial and Industrial Consumers			221,000.00	265,000.00
	(ii) All Others			35,100.00	42,000.00

Source: Tariffs of Lusaka Water and Sewerage Company Limited

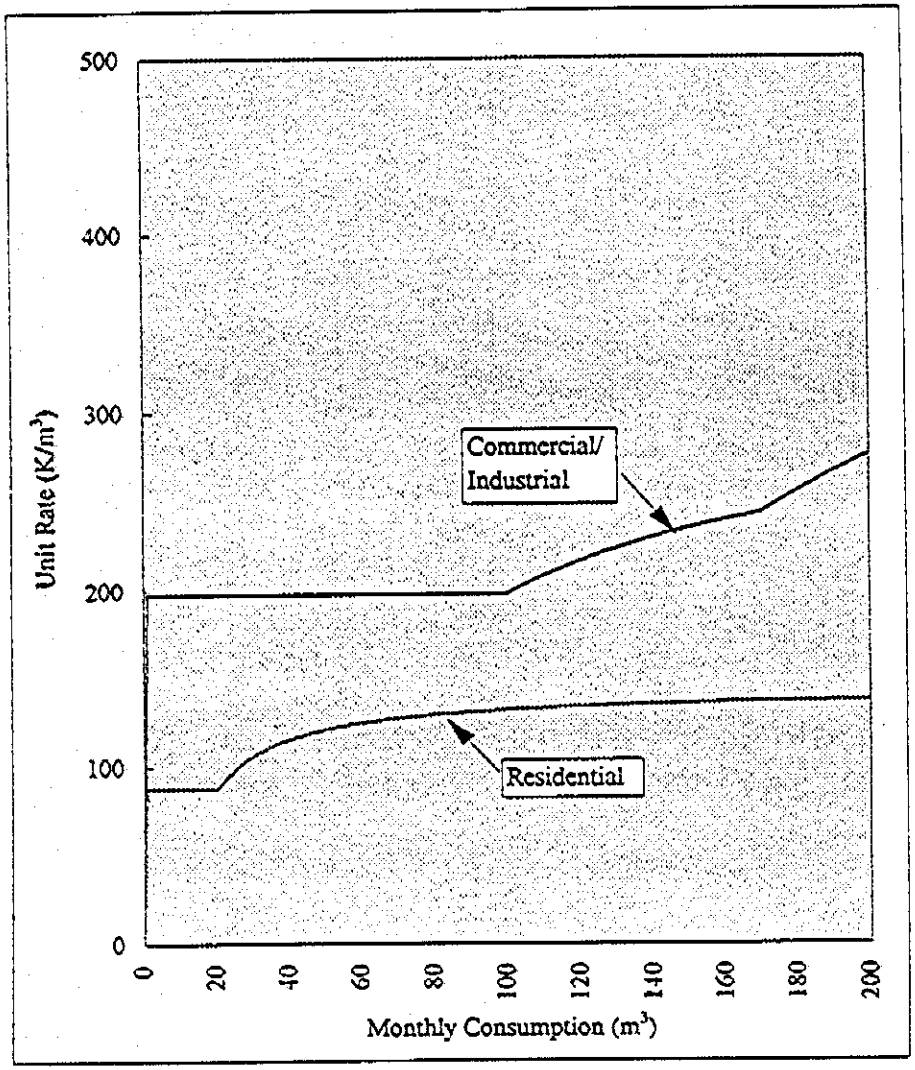

Figure 2-1 Lusaka Water Tariff Effective from October 1994

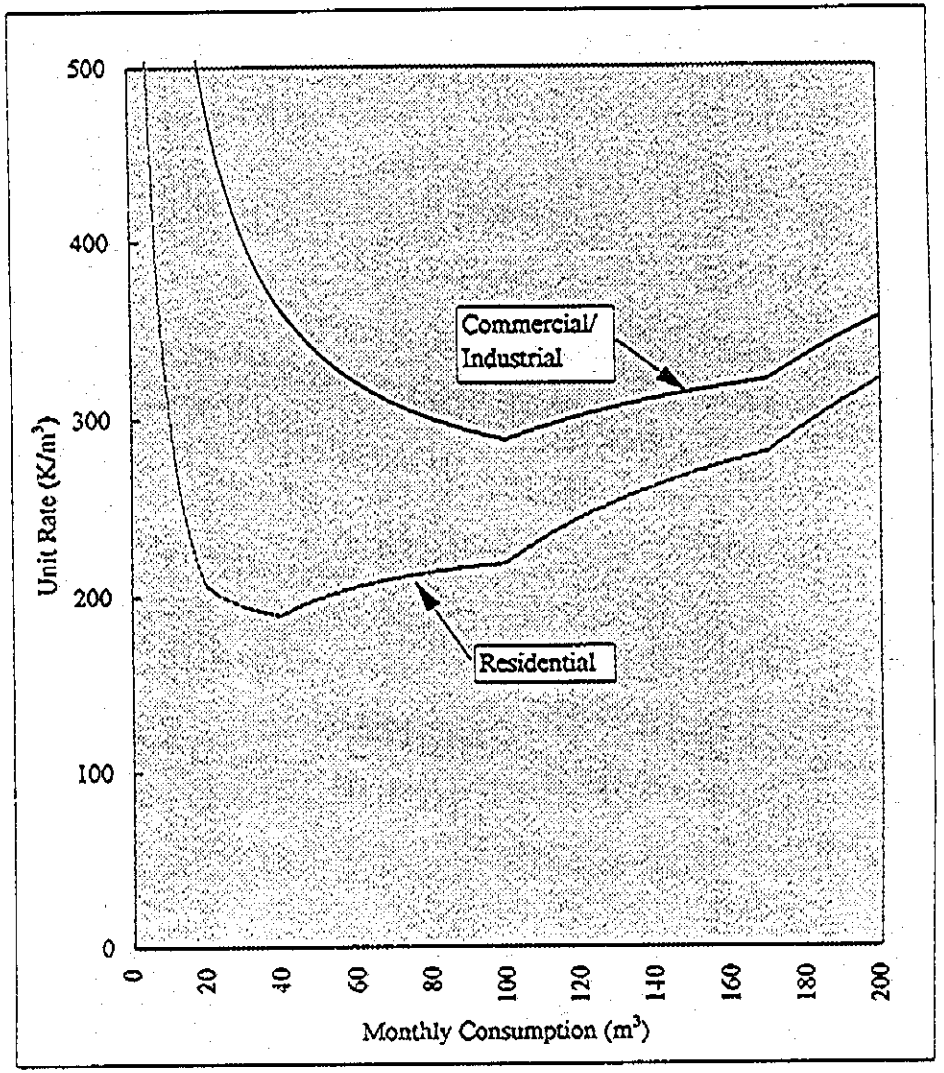

Figure 2-2 Lusaka Water Tariff Revised in January 1995

2.5.3 Household Expenditure for Water

According to the present tariff of LWSC, typical users of the services are charged the following amount per month.

Table 2-10 Household Expenditure for Water under Tariff of LWSC

(Unit: Kwachas/Household)

Water Consumption Volume (m^3/month)	Tariff in 1994		Tariff in 1995		Incremental Charge (%)
	Unit Rate Kwacha/m^3	Charge Kwacha /month	Unit Rate Kwacha/m^3	Charge Kwacha /month	
10	88	880	306	3,060	248
20	88	1,760	206	4,120	134
30	106	3,190	195	5,840	83
40	116	4,620	189	7,560	64
50	121	6,020	199	9,940	64
60	125	7,480	205	12,320	65

As shown in Table 2-10, the new tariff became heavy for small water consumers because of standing charge (K2,000/month). A small water consumer of 10 m^3/month has to pay a monthly water charge of almost 3.5 times of the previous amount. For water users consuming more than 40 m^3/month, however, a charge under the new tariff is around 65% higher than that under the old one.

CHAPTER 3 PROJECTION OF DOMESTIC WATER DEMAND

3.1 Water Supply Target

In this current study, the goal is set to fulfill the safe water supply to urban and rural people as follows: (1) for urban areas, to keep complete coverage in 92 large and small towns and (2) for rural areas, to cover 55% by the year 2005 and 75% in 2015, as discussed in the third steering committee. Thus, the final vision of water resources development schemes will be presented in accordance with this target in the master plan. In action plan, some practical schemes are presented in consideration of various constraints such as environment and financial situation of the county.

3.2 Projection Procedure

3.2.1 Standards and Criteria

The gazette of Circulation No.1 "Consumption Figures and Population Projections for Design of Water Supply Systems" (Ref.E04) stipulates standards and criteria for water demand projection. In this current master plan, the figures of water consumption unit rates in the gazette are applied to estimate water demand as basic information.

The domestic water demand consists of residential and non-residential water demand. The non-residential demand is further broken down to educational, medical, administrative and commercial water demand. It is assumed that these demands are all linearly related to the population concerned. As discussed in Section 2.2, the planning standard for human settlement in Table 2-2 is applied to estimate an inventory of the non-residential facilities. Needless to say, water demand of residential water use is estimated on the basis of future population projected in Part A of Supporting Report.

3.2.2 Water Demand Estimation

Residential water demand is calculated by the following equation.

$$D_{kt} = P_{kt} \sum_{i} \sum_{j} C_{ij} H_{ij} UD_{ijt} / 1000$$

Where, k : target year
1 = 1995
2 = 2005
3 = 2015

t : demand area
1 = urban
2 = rural

i : tap connection
1 = individual connection users
2 = non-individual connection users

j : housing classification
1 = high cost housing
2 = medium cost housing
3 = low cost housing

D_{kt} : projected demand in year k for demand area t (m^3/day)
P_{kt} : number of population
C_{ij} : connection rate
H_j : housing class rate
UD_{ijt} : unit water consumption rate (lit/capita/day)

The non-residential water demand is calculated by the following equation.

$$I_{kt} = P_{kt} \sum_{m} N_m UD_m / 1000$$

where, k : target year
1 = 1995
2 = 2005
3 = 2015

t : demand area
1 = urban
2 = rural

m : institutional user type
1 = education facility
2 = medical facility
3 = administrative office
4 = commercial facility

I_{kt} : projected non-residential demand in year k for demand area t (m^3/day)
N_m : ratio of user to population
UD_m : unit water consumption rate (lit/capita/day)

3.3 Water Consumption Rates

3.3.1 Urban Compound Consumption Rates

Applying "water consumption rates" and "planning standard for human settlement" mentioned in Section 3.2.1, the compound consumption rate in urban area was calculated in Table 3-1. The rate in urban area was classified into (1) large urban area having a population of more than 50,000 and (2) small urban area having a population between 1,000 and 50,000, separately. The compound unit rates of large and small urban areas were estimated at 178.6 lit/capita/day and 142.8 lit/capita/day, respectively. Accordingly, for estimation of water demand, the following compound rates were applied: 180 lit/capita/day for large urban areas and 150 lit/capita/day for small urban area.

Table 3-1 Average Water Consumption Rate in Standardised Urban Area

Facility	Planning Standard	Planned Number		Water Consumption		
		Unit	No.	Unit	Rate	Volume (m^3)
I. Small Urban Area (5,000 Population)						
1 Residence *1						
a. High cost housing	2.5%	house	24	lit/capita/day	280	35.0
b Medium cost housing	15.0%	house	144	lit/capita/day	150	112.5
c. Low cost housing	82.5%	house	793	lit/capita/day	100	412.5
2 Educational Facility						
a. Nursery School	1 school/4,000 pop. (200 pupils/4,000 pop.)	school	1	lit/pupil/day	25	6.3
b Primary School	1 stream/1,500 pop. (280 pupils/stream)	stream	3	lit/pupil/day	25	21.0
c. Secondary School	3 streams/20,000 pop. (700 pupils/stream)	stream	1	lit/pupil/day	30	21.0
3 Medical Facility						
a. Clinic	1 clinic/1,000 pop. (10 patients/day *2)	clinic	5	lit/patient/day	10	0.5
4 Administrative Office						
a. Council Office	1 office/10,000 pop. (50 staffs/office)	office	1	lit/staff/day	30	1.5
b Other Offices	2 offices/10,000 pop. (50 staffs/office)	office	2	lit/staff/day	30	3.0
5 Commercial Area	Land Area / 5,000 pop.*3	ha	1.2	lit/ha/day	30,000	36.0
- Shopping	260 m^2/1,000 pop.					
- Retail Market	25 m^2/1,000 pop.					
- Other Facilities	800 m^2/1,000 pop.					
- Parking Space	1 car/300 m^2 floor space					
6 Other Urban Facilities	(10% of the total of the					64.9
- Parks, Playground,						
7 Total						714.2
Per Capita Consumption Rate (lit/capita/day)						142.8
II. Large Urban Area (50,000 Population)						
1 Residence *1						
a. High cost housing	2.5%	house	240	lit/capita/day	280	350.0
b Medium cost housing	15.0%	house	1,442	lit/capita/day	150	1,125.0
c. Low cost housing	82.5%	house	7,933	lit/capita/day	100	4,125.0
2 Educational Facility						
a. Nursery School	200 pupils/school	school	13	lit/pupil/day	25	65.0
b Primary School	1 stream/1,500 pop.	stream	33	lit/pupil/day	25	231.0
c. Secondary School	3 streams/20,000 pop.	stream	8	lit/pupil/day	30	168.0
d College/University	10% of primary pupils	student	533	lit/student/day	120	64.0
3 Medical Facility						
a. Hospital	1 Hospital/50,000 pop.	bed	100	lit/bed/day	365	36.5
b Clinic*2	1 clinic/1,000 pop.	clinic	50	lit/patient/day	10	5.0
4 Administrative Office						
a. Council Office	1 office/10,000 pop.	office	1	lit/staff/day	30	1.5
b Other Offices	2 offices/10,000 pop.	office	2	lit/staff/day	30	3.0
c. Central Gov. Office	1 office/50,000 pop. (200 staffs/office)	office	1	lit/staff/day	30	6.0
5 Commercial Area	Land Area / 5,000 pop.*3	ha	23	lit/ha/day	30,000	690.0
- Shopping	520 m^2/1,000 pop.					
- Retail Market	50 m^2/1,000 pop.					
- Other Facilities	1,600 m^2/1,000 pop.					
- Parking Space	1 car/200 m^2 floor space					
6 Other Urban Facilities	(30% of the total of the					2,061.0
7 Total						8,931.0
Per Capita Consumption						178.6

Source: (1) Consumption Figures and population projections for Design of Water Supply System, Revised August 1986, DWA (Ref. E04)
(2) Planning Standard, MLGH

Remark: *1 The number of household members was assumed at 5.2 persons on average.
*2 Assumed that people consult a doctor twice a year. (= 2*1,000/200days)
*3 Land area is assumed to need two times of the total floor areas.

3.3.2 Rural Compound Consumption Rates

In the same manner mentioned in the above section, the compound consumption rate in rural area is calculated in Table 3-2. The compound unit rate was estimated at 34.9 lit/capita/day. Accordingly, the compound rates of 35 lit/capita/day was applied for estimation of water demand,. The below Table 3-3 shows the applied unit consumption rates in urban and rural areas.

Table 3-2 Average Water Consumption Rate in Rural Area

Facility	Planning Standard	Planned Number		Water Consumption		
		Unit	Number	Unit	Rate	Volume (m^3)
1. Residence						
a. Served People		person	1,000	lit/capita/day	30	30.0
2. Educational Facility						
a. Primary School	1 stream/1,500 pop. (280 pupils/stream) (with Pit Latrine for Toilet)	stream	1	lit/pupil/day	15	2.8
b. Secondary School	3 streams/20,000 pop. (700 pupils/stream)	stream	-	lit/pupil/day	30	0.0
3. Medical Facility						
a. Clinic	1 clinic/1,000 pop.	clinic	1	lit/patient/day	10	0.1
4. Administrative Office						
a. Community Hall	5 staffs/office	staff	5	lit/staff/day	30	0.2
5. Commercial Area						
a. Retail Market	25 m^2/1,000 pop.	m^2	25	lit/m^2/day	3	0.1
6. Other Facilities	(10% of the total of the above facilities)					1.7
7. Total						34.9
Per Capita Consumption Rate (lit/capita/day)						34.9

Source: (1) Consumption Figures and population projections for Design of Water Supply System, Revised August 1986, DWA (Ref.E04)
(2) Planning Standard, MLGH

Table 3-3 Unit Consumption Rates in Urban/Rural Areas

Category	Unit Consumption Rate
Urban Area	
Large Urban Area	180 lit/capita/day
Small Urban Area	150 lit/capita/day
Rural Area	35 lit/capita/day

The water consumption rate of residential use will increase in proportion to improvement of people's living standard. Besides the household uses, non-residential use will also increase as the economic condition goes up. However, the above consumption rates look large enough to meet future demand as compared to present consumption condition which was appeared in the water consumption survey. The planning standard also seems to have some allowance as compared with the actual distribution. Thus, these rates might be

overestimation for projection of present water demand. In this study, however, that estimate is considered to be allowance for present water demand and to be enough for future water demand.

3.4 Projected Domestic Water Demand

The summary of the projected domestic water demand for the three projections is presented in below Table 3-4 for the years of 1995, 2005 and 2015.

Table 3-4 Summary of Domestic Water Demand

(Unit: 1,000 m^3/day)

Item	1995	2005	2015
Medium Projection			
Urban Area	561	744	961
Rural Area	180	217	255
Total	741	961	1,216
High Projection			
Urban Area	581	855	1,261
Rural Area	178	214	251
Total	759	1,069	1,512
Low Projection			
Urban Area	557	712	876
Rural Area	178	207	228
Total	735	920	1,105

Urban potential water demand is tabulated for respective townships in Appendix 1 for the years 1995, 2005 and 2015. District-wise water demand is enumerated for respective districts classified into urban and rural areas in Appendix 2.

3.5 Financial Constraints of Water Sector Development

3.5.1 Constraints in Financial Aspects

The overall deficit of the central government is still large as mentioned in Part-A of Supporting Report. During the recession period, the central government introduced the expenditure ceilings system and restricts the expenditure for the new projects, unless the projects have extremely high economic efficiency. Although it was not clear how long this investment programme would continue, the ceilings system might be considered to continue for the time being.

The government tried to push its fiscal restraint to improve the fiscal situation and to reduce domestic borrowing. Besides, because of the high debt-service ratio in Zambia, it seems to be sensitive for the GRZ to increase external debt for project implementation. This will put the country in an awkward position to expect more external loans.

Foreign grants are another important financial source for development in Zambia. Since the world economy seems to grow at moderate rate for these years, the international economic situation is not always favourable for increasing more financial grants for Zambia. In this international scene, however, several leading donor countries are expected to remain strong in economic growth and to support the developing countries continuously in the future.

Excluding a few water works, most water supply undertakers can not run their own business on the basis of self-supporting accounts. Although the undertakers are still young and have little experience on management of water business, DWA and MLGH are expected to lead them to support themselves by their own accounting in full cost recovering conditions. In that case, DWA and MLGH could bring about new water projects without any financial difficulty. Moreover, so long as the water business succeeds in management, the undertakers could multiply their supply their supply services to their surrounding areas. This would be desirable for water related undertakings.

3.5.2 Charging Policy for Water Supply

It is apparent that the benefit of public water supply systems is only provided to those who are served by the systems. In principle all cost of water should be collected from that section of population benefited by the systems rather than depending on tax revenue.

Yet, rapid expansion in water supply facilities will have to be undertaken henceforward and will be continued for some time span, during which the self-paying operation may not be practicable in view of increasing burden to water undertakers for repayment of heavy loans and interests. In such a case, it may be necessary to consider providing a grant to partly finance the public water supply projects. However, this should be regarded as an intermediate measure to be abolished over the long term.

With regard to rural water supply schemes, the central government's loans with low interest rates would have to be continued for the time being in view of low level income in the rural areas. The government loans should be distributed on an equitable basis for the whole country area in terms of served population ratio and/or health improvement aspects.

Effort should be made to encourage sound financial management in public water supply projects. Water tariff should be reviewed regularly and revised as necessary. Until the time when self-paying operation is established at each water supply system, it is desirable to apply a common water tariff, probably each for urban and rural schemes, throughout each district with the exceptions of such areas that specifically higher rates should be applied for control of the overall quantity of water consumption, such as Lusaka requiring extensive water transfer.

One of the objectives of public water supply is to provide essential amenities for general social well-being. Water tariff should be so designed to impose a low water charge rate for the minimum consumption to meet basic needs. To encourage water saving, on the other hand, a progressive water charge rate should be introduced

In case of self-help schemes, settlement schemes, and some of rural water supply schemes which aim to meet the basic needs, the beneficiaries may be required only to meet the cost of operation and maintenance of the project.

3.5.3 Prioritisation of Implementation Schemes

It is a fact that the water supply sector has a major constraint in its implementation; that is the limited budgetary resources. However, a great demand is raised from people for early supply of water. This tends in some cases to embark on the implementation of schemes

more than the budgetary capacity. Although this is quite hard to the responsible implementors, a practical approach is to reduce the number of implementation schemes within the constraint of budgetary resources actually available, so that the scheme could be completed at an economical implementation speed.

List of References and Data Collected

Code	Title	Issued on	Issued by
E01	Social Sector Rehabilitation and Development Programme, 1993-1996	Nov. 1993	Office of the President
E02	1980 Census of Population and Housing Vol.I Administration Report, Nov. 1988		CSO
E03	Second National Development Plan, 1972-1976	1972	NCDP
E04	Consumption Figures and Population Projections for Design of Water Supply	Aug. 1986	DWA
E05	Water Policy - The Water Supply and Sanitation Perspective	Oct. 1993	Chiwele, F.C. (MLGH)
E06	Institutional Aspects of Implementing a National Water Policy	Oct. 1993	Chishimba, N.B.
E07	Operation and Maintenance, Township Water Supplies	Oct. 1993	Skarstol, S. (DWA)
E08	Development and Management of Rural Water Supplies	Oct. 1993	Mwanza, D.D. (UNZA)
E09	Update of the Study of the Water Supply and Sanitation Sector	March 1993	Sutton, S. (NORAD)
E10	Drinking Water Supply and Sanitation Sector in Zambia	April 1994	DWA
E11	Financial Statements, Lusaka Water and Sewerage Company Limited, 31 December 1993	1994	LWSC KPMG Peat Marwick
E12	Financial Statements, Lusaka Water and Sewerage Company Limited, 31 December 1992	1993	LWSC KPMG Peat Marwick
E13	Financial Statements, Lusaka Water and Sewerage Company Limited, 31 December 1991	1992	LWSC KPMG Peat Marwick
E14	Human Settlements and the Environment in Zambia	Jan. 1994	Dr.Khonze,G.A.C CTCP, MLGH
E15	Proposed Organisational Structures for City & Municipal Councils Planning Departments	Oct. 1993	DTCP, MLGH
E16	The Local Government Act, No.22 of 1991	1991	Government Printer
E17	Water Supply and Sanitation Programme, January 1994-December 1995	Oct. 1993	NCDP
E18	Financial Report for the Year Ended 31st December, 1989	1991	Government Printer
E19	Financial Report for the Year Ended 31st December, 1990	1992	Government Printer
E20	Financial Report for the Year Ended 31st December, 1991	1993	Government Printer
E21	Financial Report for the Year Ended 31st December, 1992	1994	MOF
E22	Estimates of Revenue and Expenditure for the Year 1st January 1991 to 31st December 1991		Government Printer

APPENDICES

Appendix 1 Domestic Water Demand by Township: 1995-2015..... E-App.-1

Appendix 2 Domestic Water Demand by District: 1995-2015 ..... E-App.-7

Appendix 1 (1) Domestic Water Demand by Township: 1995-2015

I. Medium Projection

Code	Township	1995			2005			2015		
		Population (1,000)	Unit Rate (lit/c./day)	Demand (cu.m./day)	Population (1,000)	Unit Rate (lit/c./day)	Demand (cu.m./day)	Population (1,000)	Unit Rate (lit/c./day)	Demand (cu.m./day)
111	Lusaka	968	180	174,235	1,483	180	266,975	2,181	180	392,533
121	Chongwe	4	150	607	6	150	847	8	150	1,135
122	Kafue	53	180	9,468	73	180	13,215	98	180	17,708
123	Chilanga	11	150	1,644	15	150	2,295	20	150	3,074
124	Rufunsa	3	150	399	4	150	557	5	150	747
131	Luangwa	2	150	278	2	150	360	3	150	446
211	Ndola Township	388	180	69,908	507	180	91,250	635	180	114,323
221	Masaiti	3	150	381	3	150	518	5	150	676
222	Mpongwe	13	150	1,927	17	150	2,621	23	150	3,425
231	Chililabombwe	51	180	9,118	54	180	9,806	56	180	10,124
232	Konkola	2	150	284	2	150	305	2	150	315
241	Chingola	154	180	27,745	175	180	31,461	190	180	34,257
251	Mufulira	131	180	23,518	139	180	24,980	142	180	25,472
261	Kalulushi	37	150	5,494	48	150	7,203	60	180	10,882
262	Chambishi	12	150	1,736	15	150	2,276	19	150	2,865
271	Kitwe	321	180	57,720	383	180	68,992	440	180	79,165
281	Luanshya	126	180	22,719	139	180	25,082	148	180	26,588
311	Kabwe Township	195	180	35,020	273	180	49,208	369	180	66,388
321	Chibombo	5	150	681	5	150	824	6	150	959
322	Chisamba	3	150	499	4	150	604	5	150	702
323	Kapiri Mposhi	15	150	2,272	18	150	2,751	21	150	3,199
331	Mumbwa	13	150	1,926	17	150	2,531	21	150	3,196
332	Nampundwe	5	150	715	6	150	939	8	150	1,186
341	Mkushi	9	150	1,329	11	150	1,657	13	150	1,984
351	Serenje	9	150	1,416	12	150	1,788	14	150	2,166
411	Solwezi	31	150	4,697	43	150	6,479	57	180	10,298
421	Mwinilunga	7	150	1,034	8	150	1,182	9	150	1,297
431	Zambezi	7	150	986	8	150	1,170	9	150	1,332
432	Chavuma	2	150	299	2	150	354	3	150	403
441	Kabompo	6	150	831	7	150	986	7	150	1,122
451	Mfumbwe	5	150	807	6	150	957	7	150	1,089
461	Kasempa	5	150	689	5	150	817	6	150	930
511	Mongu	33	150	4,903	39	150	5,904	45	150	6,825
512	Limulunga	6	150	965	8	150	1,161	9	150	1,343
513	Namushakande	2	150	296	2	150	357	3	150	413
521	Lukulu	3	150	524	4	150	630	5	150	729
531	Kalabo	8	150	1,126	8	150	1,182	8	150	1,197
532	Sikongo	2	150	259	2	150	272	2	150	276
541	Kaoma	11	150	1,576	13	150	2,006	16	150	2,450
551	Senanga	8	150	1,254	9	150	1,421	10	150	1,545
552	Shangombo	2	150	260	2	150	294	2	150	320
561	Sesheke	6	150	842	6	150	884	6	150	895
562	Mulobezi	2	150	314	2	150	329	2	150	334
563	Katima-Mulilo	1	150	159	1	150	167	1	150	169
611	Livingstone	85	180	15,270	100	180	17,994	113	180	20,364
621	Namwala	4	150	670	6	150	908	8	150	1,182
622	Itezhi-Tezhi	6	150	893	8	150	1,210	11	150	1,576

(To be continued)

Appendix 1 (2) Domestic Water Demand by Township: 1995-2015

I. Medium Projection

(Conclusion)

Code	Township	1995			2005			2015		
		Population (1,000)	Unit Rate (lit/c./day)	Demand (cu.m./day)	Population (1,000)	Unit Rate (lit/c./day)	Demand (cu.m./day)	Population (1,000)	Unit Rate (lit/c./day)	Demand (cu.m./day)
631	Mazabuka	27	150	4,113	33	150	4,951	38	150	5,720
632	Magoye	3	150	390	3	150	469	4	150	542
633	Nakambala	8	150	1,255	10	150	1,510	12	150	1,745
634	Nega-nega	2	150	307	2	150	370	3	150	427
635	Kafue-gorge	3	150	470	4	150	566	4	150	654
636	Chikankata	4	150	654	5	150	787	6	150	910
641	Monze	18	150	2,661	21	150	3,202	25	150	3,700
642	Chisekesi	2	150	280	2	150	337	3	150	390
651	Choma	33	150	4,970	39	150	5,814	44	150	6,531
652	Batoka	2	150	238	2	150	279	2	150	313
653	Pemba	2	150	358	3	150	419	3	150	470
654	Mbabala	2	150	291	2	150	340	3	150	382
661	Kalomo	10	150	1,466	13	150	1,927	16	150	2,430
662	Zimba	2	150	236	2	150	310	3	150	392
671	Siavonga	6	150	930	7	150	1,114	9	150	1,283
672	Chirundu	2	150	346	3	150	415	3	150	477
681	Gwembe	2	150	336	3	150	403	3	150	464
691	Sinazongwe	2	150	335	3	150	401	3	150	462
692	Maamba	10	150	1,472	12	150	1,764	14	150	2,030
711	Mansa	44	150	6,537	53	180	9,460	61	180	10,952
721	Nchelenge	17	150	2,490	21	150	3,161	26	150	3,850
722	Chiengi	2	150	326	3	150	414	3	150	505
731	Kawambwa	4	150	626	5	150	700	5	150	751
732	Mwansabombwe	8	150	1,190	9	150	1,330	10	150	1,428
741	Mwense	4	150	596	4	150	668	5	150	717
751	Samfya	13	150	1,934	13	150	1,941	13	150	1,944
811	Kasama	54	180	9,632	64	180	11,559	74	180	13,323
821	Kaputa	3	150	474	4	150	531	4	150	572
831	Mbala	13	150	1,936	14	150	2,102	15	150	2,192
832	Mpulungu	3	150	435	3	150	473	3	150	493
841	Mporokoso	5	150	778	6	150	872	6	150	938
851	Luwingu	5	150	731	5	150	773	5	150	785
861	Chilubi	1	150	214	2	150	227	2	150	230
871	Isoka	9	150	1,398	11	150	1,590	12	150	1,736
872	Nakonde	5	150	731	6	150	831	6	150	908
881	Chinsali	8	150	1,197	9	150	1,308	9	150	1,372
891	Mpika	24	150	3,583	30	150	4,507	36	150	5,446
911	Chipata Township	60	180	10,748	76	180	13,598	92	180	16,527
921	Chama Township	4	150	574	4	150	674	5	150	759
931	Lundazi	6	150	947	8	150	1,168	9	150	1,384
941	Chadiza Township	3	150	520	4	150	659	5	150	800
951	Katete Township	8	150	1,191	9	150	1,416	11	150	1,615
961	Petauke	9	150	1,402	12	150	1,787	15	150	2,186
962	Nyimba	2	150	290	2	150	369	3	150	452
963	Kachokola	2	150	249	2	150	317	3	150	388
	Total	3,227		561,526	4,253		743,514	5,465		961,175

Appendix 1 (3) Domestic Water Demand by Township: 1995-2015

II. High Projection

Code	Township	1995			2005			2015		
		Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)	Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)	Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)
111	Lusaka	976	180	175,735	1,558	180	280,450	2,456	180	442,031
121	Chongwe	5	150	737	10	150	1,535	21	150	3,123
122	Kafue	64	180	11,488	133	180	23,944	271	180	48,709
123	Chilanga	12	150	1,820	21	150	3,173	36	150	5,431
124	Rufunsa	3	150	442	5	150	771	9	150	1,319
131	Luangwa	2	150	326	4	150	584	7	150	1,024
211	Ndola Township	392	180	70,521	532	180	95,838	715	180	128,673
221	Masaiti	3	150	456	6	150	905	12	150	1,754
222	Mpongwe	14	150	2,120	24	150	3,560	39	150	5,871
231	Chililabombwe	51	180	9,200	57	180	10,304	63	180	11,399
232	Konkola	2	150	304	3	150	381	3	150	466
241	Chingola	155	180	27,977	184	180	33,050	214	180	38,545
251	Mufulira	132	180	23,728	146	180	26,250	159	180	28,682
261	Kafulushi	37	150	5,543	50	180	9,082	68	180	12,248
262	Chambishi	14	150	2,046	25	150	3,779	45	150	6,813
271	Kitwe	324	180	58,231	403	180	72,457	495	180	89,063
281	Luanshya	127	180	22,909	146	180	26,352	166	180	29,927
311	Kabwe Township	196	180	35,324	287	180	51,715	415	180	74,765
321	Chibombo	5	150	773	8	150	1,223	13	150	1,888
322	Chisamba	4	150	534	5	150	755	7	150	1,047
323	Kapiri Mposhi	17	150	2,577	27	150	4,080	42	150	6,300
331	Mumbwa	15	150	2,272	28	150	4,221	51	180	9,184
332	Nampundwe	5	150	780	8	150	1,245	13	150	1,953
341	Mkushi	10	150	1,529	17	150	2,562	28	150	4,189
351	Serenje	11	150	1,639	19	150	2,813	31	150	4,714
411	Solwezi	38	150	5,668	77	180	13,863	153	180	27,577
421	Mwinilunga	8	150	1,141	11	150	1,612	15	150	2,224
431	Zambezi	7	150	1,108	11	150	1,684	17	150	2,497
432	Chavuma	2	150	318	3	150	436	4	150	587
441	Kabompo	6	150	934	9	150	1,419	14	150	2,104
451	Mfumbwe	6	150	907	9	150	1,377	14	150	2,043
461	Kasempa	5	150	774	8	150	1,176	12	150	1,745
511	Mongu	37	150	5,551	58	180	10,424	88	180	15,927
512	Limulunga	7	150	1,031	10	150	1,445	13	150	1,990
513	Namushakande	2	150	317	3	150	444	4	150	611
521	Lukulu	4	150	593	6	150	928	9	150	1,417
531	Kalabo	8	150	1,193	9	150	1,423	11	150	1,658
532	Sikongo	2	150	268	2	150	306	2	150	343
541	Kaoma	12	150	1,831	21	150	3,191	36	150	5,429
551	Senanga	9	150	1,378	13	150	1,912	17	150	2,590
552	Shangombo	2	150	273	2	150	350	3	150	439
561	Seshcke	6	150	892	7	150	1,064	8	150	1,239
562	Mulobezi	2	150	324	2	150	370	3	150	416
563	Katima-Mulilo	1	150	164	1	150	188	1	150	210
611	Livingstone	86	180	15,405	105	180	18,908	127	180	22,925
621	Namwala	5	150	802	11	150	1,582	20	150	3,045
622	Itezhi-Tezhi	7	150	982	11	150	1,641	18	150	2,693

(To be continued)

Appendix 1 (4) Domestic Water Demand by Township: 1995-2015

II. High Projection
(Conclusion)

Code	Township	1995			2005			2015		
		Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)	Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)	Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)
631	Mazabuka	31	150	4,655	49	150	7,278	74	180	13,331
632	Magoye	3	150	417	4	150	584	5	150	803
633	Nakambala	9	150	1,341	13	150	1,879	17	150	2,584
634	Nega-nega	2	150	328	3	150	460	4	150	632
635	Kafue-gorge	3	150	503	5	150	704	6	150	969
636	Chikankata	5	150	699	7	150	980	9	150	1,347
641	Monze	20	150	3,011	31	150	4,708	48	150	7,186
642	Chisekesi	2	150	299	3	150	419	4	150	577
651	Choma	37	150	5,549	55	180	9,847	79	180	14,215
652	Batoka	2	150	253	2	150	340	3	150	448
653	Pemba	3	150	380	3	150	510	4	150	673
654	Mbabala	2	150	308	3	150	414	4	150	546
661	Kalomo	12	150	1,728	21	150	3,208	39	150	5,810
662	Zimba	2	150	258	3	150	411	4	150	644
671	Siavonga	7	150	1,050	11	150	1,629	16	150	2,468
672	Chirundu	2	150	369	3	150	514	5	150	703
681	Gwembe	3	150	380	4	150	589	6	150	892
691	Sinazongwe	3	150	378	4	150	587	6	150	889
692	Maamba	10	150	1,571	15	150	2,189	20	150	2,993
711	Mansa	49	150	7,405	77	180	13,946	119	180	21,369
721	Nchelenge	19	150	2,888	33	150	5,009	57	180	10,171
722	Chiengi	2	150	353	4	150	535	5	150	796
731	Kawambwa	5	150	684	6	150	925	8	150	1,221
732	Mwansabombwe	8	150	1,250	10	150	1,569	13	150	1,934
741	Mwense	4	150	651	6	150	883	8	150	1,168
751	Samfya	13	150	1,995	14	150	2,139	15	150	2,240
811	Kasama	60	180	10,881	94	180	16,930	143	180	25,693
821	Kaputa	3	150	518	5	150	704	6	150	934
831	Mbala	14	150	2,084	18	150	2,663	22	150	3,317
832	Mpulungu	3	150	453	4	150	545	4	150	643
841	Mporokoso	6	150	850	8	150	1,156	10	150	1,532
851	Luwingu	5	150	777	6	150	942	7	150	1,113
861	Chilubi	2	150	228	2	150	276	2	150	326
871	Isoka	10	150	1,539	14	150	2,154	20	150	2,940
872	Nakonde	5	150	804	8	150	1,126	10	150	1,537
881	Chinsali	9	150	1,293	11	150	1,671	14	150	2,109
891	Mpika	28	150	4,142	47	150	7,062	78	180	14,096
911	Chipata Township	69	180	12,459	119	180	21,485	201	180	36,179
921	Chama Township	4	150	641	6	150	955	9	150	1,388
931	Lundazi	7	150	1,084	12	150	1,778	19	150	2,848
941	Chadiza Township	4	150	603	7	150	1,040	12	150	1,754
951	Katete Township	9	150	1,339	14	150	2,044	20	150	3,044
961	Petauke	11	150	1,631	19	150	2,850	32	150	4,859
962	Nyimba	2	150	337	4	150	589	7	150	1,004
963	Kacholola	2	150	270	3	150	411	4	150	615
	Total	3,350		581,502	4,886		855,408	7,171		1,261,363

Appendix 1 (5) Domestic Water Demand by Township: 1995-2015

III. Low Projection

Code	Township	1995			2005			2015		
		Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)	Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)	Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)
111	Lusaka	960	180	172,823	1,421	180	255,694	1,985	180	357,210
121	Chongwe	4	150	602	5	150	811	7	150	1,032
122	Kafue	52	180	9,391	70	180	12,652	89	180	16,100
123	Chilanga	11	150	1,631	15	150	2,197	19	150	2,795
124	Rufunsa	3	150	396	4	150	534	5	150	679
131	Luangwa	2	150	276	2	150	345	3	150	406
211	Ndola Township	385	180	69,367	486	180	87,418	578	180	104,028
221	Masaiti	3	150	378	3	150	496	4	150	615
222	Mpongwe	13	150	1,912	17	150	2,512	21	150	3,116
231	Chitilabombwe	50	180	9,046	52	180	9,396	53	180	9,476
232	Kankola	2	150	282	2	150	293	2	150	295
241	Chingola	153	180	27,514	167	180	30,122	173	180	31,162
251	Mufulira	130	180	23,333	133	180	23,934	133	180	24,018
261	Kalulushi	36	150	5,449	46	150	6,901	55	180	9,898
262	Chambishi	11	150	1,722	15	150	2,181	17	150	2,606
271	Kitwe	318	180	57,269	367	180	66,102	400	180	72,012
281	Luanshya	125	180	22,528	133	180	24,012	135	180	24,375
311	Kabwe Township	193	180	34,734	262	180	47,157	336	180	60,452
321	Chibombo	5	150	675	5	150	790	6	150	873
322	Chisamba	3	150	495	4	150	579	4	150	639
323	Kapiri Mposhi	15	150	2,253	18	150	2,636	19	150	2,912
331	Mumbwa	13	150	1,910	16	150	2,425	19	150	2,907
332	Nampundwe	5	150	709	6	150	900	7	150	1,079
341	Mkushi	9	150	1,318	11	150	1,587	12	150	1,804
351	Serenje	9	150	1,405	11	150	1,712	13	150	1,971
411	Solwezi	31	150	4,658	41	150	6,206	52	180	9,366
421	Mwinilunga	7	150	1,025	8	150	1,132	8	150	1,181
431	Zambezi	7	150	979	7	150	1,121	8	150	1,212
432	Chavuma	2	150	296	2	150	339	2	150	367
441	Kabompo	5	150	824	6	150	944	7	150	1,022
451	Mfumbwe	5	150	801	6	150	917	7	150	992
461	Kasempa	5	150	684	5	150	783	6	150	847
511	Mongu	32	150	4,862	38	150	5,654	41	150	6,208
512	Limulunga	6	150	956	7	150	1,112	8	150	1,221
513	Namushakande	2	150	294	2	150	342	3	150	375
521	Lukulu	3	150	519	4	150	604	4	150	663
531	Kalabo	7	150	1,117	8	150	1,142	8	150	1,148
532	Sikongo	2	150	257	2	150	263	2	150	264
541	Kaoma	10	150	1,564	13	150	1,921	15	150	2,230
551	Senanga	8	150	1,244	9	150	1,360	9	150	1,404
552	Shangombo	2	150	257	2	150	282	2	150	291
561	Sesheke	6	150	835	6	150	854	6	150	858
562	Mulobezi	2	150	311	2	150	318	2	150	320
563	Katima-Mulilo	1	150	158	1	150	161	1	150	162
611	Livingstone	84	180	15,151	96	180	17,248	103	180	18,531
621	Namwala	4	150	664	6	150	870	7	150	1,076
622	Itezhi-Tezhi	6	150	885	8	150	1,159	10	150	1,434

(To be continued)

Appendix 1 (6) Domestic Water Demand by Township: 1995-2015

III. Low Projection
(Conclusion)

Code	Township	1995			2005			2015		
		Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)	Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)	Population (1,000)	Unit Rate (lit/c/day)	Demand (cu.m/day)
631	Mazabuka	27	150	4,088	32	150	4,744	35	150	5,204
632	Magoye	3	150	387	3	150	450	3	150	493
633	Nakambala	8	150	1,245	10	150	1,447	11	150	1,587
634	Nega-nega	2	150	305	2	150	354	3	150	389
635	Kafue-gorge	3	150	467	4	150	543	4	150	595
636	Chikankata	4	150	649	5	150	755	6	150	828
641	Monze	18	150	2,640	20	150	3,068	22	150	3,366
642	Chisekesi	2	150	278	2	150	323	2	150	354
651	Choma	33	150	4,931	37	150	5,573	40	150	5,945
652	Batoka	2	150	236	2	150	267	2	150	285
653	Pemba	2	150	355	3	150	401	3	150	428
654	Mbabala	2	150	288	2	150	326	2	150	348
661	Kalomo	10	150	1,454	12	150	1,845	15	150	2,211
662	Zimba	2	150	234	2	150	297	2	150	356
671	Siavonga	6	150	922	7	150	1,068	8	150	1,167
672	Chirundu	2	150	343	3	150	397	3	150	434
681	Gwembe	2	150	333	3	150	386	3	150	422
691	Sinazongwe	2	150	332	3	150	385	3	150	420
692	Maamba	10	150	1,460	11	150	1,691	12	150	1,847
711	Mansa	43	150	6,486	50	180	9,064	55	180	9,963
721	Nchelenge	16	150	2,470	20	150	3,027	23	150	3,503
722	Chiengi	2	150	324	3	150	397	3	150	459
731	Kawambwa	4	150	621	4	150	670	5	150	683
732	Mwansabombwe	8	150	1,180	8	150	1,274	9	150	1,299
741	Mwense	4	150	591	4	150	639	4	150	652
751	Samfya	13	150	1,918	13	150	1,927	13	150	1,929
811	Kasama	53	180	9,553	62	180	11,075	67	180	12,125
821	Kaputa	3	150	470	3	150	509	3	150	520
831	Mbala	13	150	1,920	13	150	2,014	13	150	2,018
832	Mpulungu	3	150	432	3	150	453	3	150	454
841	Mporokoso	5	150	771	6	150	835	6	150	853
851	Luwingu	5	150	726	5	150	741	5	150	743
861	Chilubi	1	150	213	1	150	217	1	150	218
871	Isoka	9	150	1,386	10	150	1,522	11	150	1,579
872	Nakonde	5	150	725	5	150	796	6	150	825
881	Chinsali	8	150	1,187	8	150	1,253	8	150	1,262
891	Mpika	24	150	3,554	29	150	4,317	33	150	4,951
911	Chipata Township	59	180	10,659	72	180	13,032	84	180	15,035
921	Chama Township	4	150	569	4	150	645	5	150	690
931	Lundazi	6	150	939	7	150	1,149	8	150	1,258
941	Chadiza Township	3	150	516	4	150	631	5	150	728
951	Katete Township	8	150	1,181	9	150	1,356	10	150	1,470
961	Petauke	9	150	1,391	11	150	1,742	13	150	1,988
962	Nyimba	2	150	287	2	150	354	3	150	411
963	Kacholola	2	150	247	2	150	303	2	150	353
	Total	3,201		557,018	4,074		712,355	4,982		876,279

Appendix 2(1) Domestic Water Demand by District: 1995-2015

L Medium Projection (Unit: 1000 cu.m.)

District		1995			2005			2015		
Code	Name	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
11	Lusaka-Urban	174.2	174.2	0.0	267.0	267.0	0.0	392.5	392.5	0.0
12	Lusaka-Rural	18.1	12.1	6.0	25.3	16.9	8.4	33.9	22.7	11.2
13	Luangwa	0.9	0.3	0.6	1.1	0.4	0.8	1.4	0.4	0.9
21	Ndola-Urban	69.9	69.9	0.0	91.2	91.2	0.0	114.3	114.3	0.0
22	Ndola-Rural	8.6	2.3	6.3	11.7	3.1	8.6	15.3	4.1	11.2
23	Chililabombwe	9.9	9.4	0.5	10.6	10.1	0.5	11.0	10.4	0.5
24	Chingola	28.5	27.7	0.7	32.3	31.5	0.8	35.1	34.3	0.9
25	Mufulira	24.3	23.5	0.8	25.8	25.0	0.8	26.3	25.5	0.9
26	Kalulushi	8.3	7.2	1.1	10.9	9.5	1.4	15.5	13.7	1.8
27	Kitwe	60.0	57.7	2.3	71.7	69.0	2.7	82.3	79.2	3.2
28	Luanshya	23.6	22.7	0.9	26.1	25.1	1.0	27.6	26.6	1.0
31	Kabwe-Urban	35.0	35.0	0.0	49.2	49.2	0.0	66.4	66.4	0.0
32	Kabwe-Rural	11.2	3.5	7.8	13.6	4.2	9.4	15.8	4.9	11.0
33	Mumbwa	7.2	2.6	4.6	9.5	3.5	6.0	12.0	4.4	7.6
34	Mkushi	5.3	1.3	4.0	6.6	1.7	5.0	8.0	2.0	6.0
35	Serenje	5.2	1.4	3.8	6.6	1.8	4.8	8.0	2.2	5.8
41	Solwezi	8.8	4.7	4.1	12.2	6.5	5.7	17.8	10.3	7.5
42	Mwinilunga	3.9	1.0	2.9	4.4	1.2	3.3	4.9	1.3	3.6
43	Zambezi	3.4	1.3	2.1	3.5	1.5	2.0	3.5	1.7	1.7
44	Kabompo	2.7	0.8	1.9	3.2	1.0	2.2	3.6	1.1	2.5
45	Mfumbwe	1.5	0.8	0.7	1.8	1.0	0.8	2.0	1.1	0.9
46	Kasempa	2.0	0.7	1.3	2.3	0.8	1.5	2.6	0.9	1.7
51	Mongu	10.3	6.2	4.1	12.4	7.4	5.0	14.3	8.6	5.8
52	Lukulu	2.4	0.5	1.9	2.9	0.6	2.3	3.4	0.7	2.7
53	Kalabo	4.3	1.4	2.9	4.0	1.5	2.5	3.6	1.5	2.1
54	Kaoma	5.7	1.6	4.1	7.3	2.0	5.3	8.9	2.4	6.4
55	Senanga	6.4	1.5	4.9	7.2	1.7	5.5	7.9	1.9	6.0
56	Sesheke	3.4	1.3	2.1	3.5	1.4	2.2	3.6	1.4	2.2
61	Livingstone	15.5	15.3	0.2	18.3	18.0	0.3	20.7	20.4	0.3
62	Namwala	4.6	1.6	3.1	6.3	2.1	4.2	8.2	2.8	5.4
63	Mazabuka	11.6	7.2	4.4	13.9	8.7	5.3	16.1	10.0	6.1
64	Monze	7.2	2.9	4.2	8.6	3.5	5.1	10.0	4.1	5.9
65	Choma	10.8	5.9	4.9	12.6	6.9	5.7	14.1	7.7	6.4
66	Kalomo	7.9	1.7	6.2	10.4	2.2	8.2	13.2	2.8	10.3
67	Siavonga	2.3	1.3	1.1	2.8	1.5	1.3	3.2	1.8	1.5
68	Gwembe	1.6	0.3	1.3	2.0	0.4	1.6	2.3	0.5	1.8
69	Sinazongwe	3.9	1.8	2.1	4.6	2.2	2.5	5.3	2.5	2.8
71	Mansa	10.6	6.5	4.0	14.3	9.5	4.9	16.6	11.0	5.6
72	Nchelenge	6.6	2.8	3.8	8.4	3.6	4.9	10.3	4.4	5.9
73	Kawambwa	4.5	1.8	2.7	5.0	2.0	3.0	5.4	2.2	3.2
74	Mwense	3.5	0.6	2.9	3.9	0.7	3.2	4.2	0.7	3.5
75	Samfya	5.3	1.9	3.4	5.3	1.9	3.3	5.1	1.9	3.2
81	Kasama	15.1	9.6	5.5	18.2	11.6	6.6	20.9	13.3	7.6
82	Kaputa	2.2	0.5	1.8	2.5	0.5	2.0	2.7	0.6	2.1
83	Mbala	6.9	2.4	4.5	7.5	2.6	4.9	7.8	2.7	5.1
84	Mporokoso	2.6	0.8	1.8	2.9	0.9	2.0	3.1	0.9	2.2
85	Luwingu	3.0	0.7	2.3	3.2	0.8	2.4	3.2	0.8	2.4
86	Chilubi	1.6	0.2	1.4	1.7	0.2	1.5	1.7	0.2	1.5
87	Isoka	6.3	2.1	4.1	7.1	2.4	4.7	7.8	2.6	5.1
88	Chinsali	4.0	1.2	2.8	4.4	1.3	3.1	4.6	1.4	3.2
89	Mpika	7.3	3.6	3.8	9.2	4.5	4.7	11.2	5.4	5.7
91	Chipata	20.3	10.7	9.6	25.7	13.6	12.1	31.2	16.5	14.7
92	Chama	2.4	0.6	1.9	2.9	0.7	2.2	3.2	0.8	2.5
93	Lundazi	7.5	0.9	6.6	9.3	1.2	8.1	11.0	1.4	9.6
94	Chadiza	2.9	0.5	2.4	3.7	0.7	3.1	4.5	0.8	3.7
95	Katete	6.3	1.2	5.1	7.5	1.4	6.1	8.5	1.6	6.9
96	Petauke	11.5	1.9	9.6	14.7	2.5	12.2	17.9	3.0	14.9
10	Lusaka	193.2	186.6	6.6	293.4	284.2	9.1	427.8	415.6	12.2
20	Copperbelt	233.1	220.5	12.6	280.4	264.5	15.9	327.6	308.1	19.5
30	Central	64.0	43.9	20.2	85.6	60.3	25.3	110.2	79.8	30.4
40	Northwestern	22.2	9.3	12.9	27.4	11.9	15.4	34.5	16.5	18.0
50	Western	32.5	12.5	20.0	37.3	14.6	22.7	41.6	16.5	25.1
60	Southern	65.4	37.9	27.5	79.6	45.5	34.1	93.1	52.4	40.6
70	Luapula	30.5	13.7	16.8	37.0	17.7	19.3	41.6	20.1	21.4
80	Northern	49.1	21.1	28.0	56.7	24.8	31.9	63.0	28.0	35.0
90	Eastern	51.0	15.9	35.1	63.7	20.0	43.7	76.4	24.1	52.3
	Zambia	741.2	561.5	179.6	961.0	743.5	217.4	1,215.7	961.2	254.5

Appendix 2(2) Domestic Water Demand by District: 1995-2015

II. High Projection (Unit: 1000 cu.m.)

Code	District Name	1995 Total	1995 Urban	1995 Rural	2005 Total	2005 Urban	2005 Rural	2015 Total	2015 Urban	2015 Rural
11	Lusaka-Urban	175.7	175.7	0.0	280.4	280.4	0.0	442.0	442.0	0.0
12	Lusaka-Rural	20.1	14.5	5.6	33.9	29.4	6.5	64.6	58.6	6.0
13	Luangwa	0.9	0.3	0.6	1.3	0.6	0.8	2.0	1.0	0.9
21	Ndola-Urban	70.5	70.5	0.0	95.8	95.8	0.0	128.7	128.7	0.0
22	Ndola-Rural	8.9	2.6	6.3	13.2	4.5	8.7	19.5	7.6	11.9
23	Chililabombwe	10.0	9.5	0.5	11.2	10.7	0.5	12.4	11.9	0.6
24	Chingola	28.7	28.0	0.7	33.9	33.1	0.8	39.5	38.5	1.0
25	Mufulira	24.5	23.7	0.8	27.1	26.3	0.9	29.7	28.7	1.0
26	Kalulushi	8.6	7.6	1.0	14.0	12.9	1.2	20.3	19.1	1.2
27	Kitwe	60.6	58.2	2.3	75.3	72.5	2.9	92.6	89.1	3.6
28	Luanshya	23.8	22.9	0.9	27.4	26.4	1.0	31.1	29.9	1.2
31	Kabwe-Urban	35.3	35.3	0.0	51.7	51.7	0.0	74.8	74.8	0.0
32	Kabwe-Rural	11.6	3.9	7.8	15.6	6.1	9.5	20.7	9.2	11.5
33	Mumbwa	7.6	3.1	4.6	11.4	5.5	5.9	18.6	11.1	7.5
34	Mkushi	5.5	1.5	4.0	7.6	2.6	5.0	10.5	4.2	6.3
35	Serenje	5.4	1.6	3.8	7.6	2.8	4.8	10.7	4.7	6.0
41	Solwezi	9.6	5.7	3.9	18.7	13.9	4.9	32.9	27.6	5.3
42	Mwinilunga	4.0	1.1	2.9	5.0	1.6	3.3	6.1	2.2	3.9
43	Zambezi	3.5	1.4	2.1	4.1	2.1	1.9	4.8	3.1	1.7
44	Kabompo	2.8	0.9	1.9	3.7	1.4	2.2	4.7	2.1	2.6
45	Mfumbwe	1.6	0.9	0.7	2.2	1.4	0.8	2.9	2.0	0.9
46	Kasempa	2.0	0.8	1.3	2.7	1.2	1.5	3.5	1.7	1.8
51	Mongu	10.9	6.9	4.0	16.9	12.3	4.6	23.6	18.5	5.0
52	Lukulu	2.5	0.6	1.9	3.3	0.9	2.3	4.3	1.4	2.8
53	Kalabo	4.4	1.5	2.9	4.3	1.7	2.6	4.3	2.0	2.3
54	Kaoma	5.9	1.8	4.1	8.5	3.2	5.3	12.0	5.4	6.6
55	Senanga	6.5	1.7	4.9	7.9	2.3	5.7	9.6	3.0	6.5
56	Sesheke	3.4	1.4	2.1	3.9	1.6	2.2	4.2	1.9	2.4
61	Livingstone	15.6	15.4	0.2	19.2	18.9	0.3	23.3	22.9	0.4
62	Namwala	4.8	1.8	3.1	7.4	3.2	4.2	11.2	5.7	5.5
63	Mazabuka	12.2	7.9	4.3	16.8	11.9	4.9	25.1	19.7	5.4
64	Monze	7.5	3.3	4.2	10.1	5.1	5.0	13.6	7.8	5.9
65	Choma	11.3	6.5	4.8	16.6	11.1	5.5	22.0	15.9	6.1
66	Kalomo	8.2	2.0	6.2	11.9	3.6	8.3	17.3	6.5	10.9
67	Siavonga	2.5	1.4	1.0	3.4	2.1	1.2	4.5	3.2	1.4
68	Gwembe	1.7	0.4	1.3	2.2	0.6	1.6	2.8	0.9	1.9
69	Sinazongwe	4.0	1.9	2.0	5.2	2.8	2.5	6.8	3.9	2.9
71	Mansa	11.3	7.4	3.9	18.3	13.9	4.3	26.0	21.4	4.6
72	Nchelenge	7.0	3.2	3.8	10.2	5.5	4.7	16.6	11.0	5.6
73	Kawambwa	4.6	1.9	2.7	5.6	2.5	3.1	6.6	3.2	3.5
74	Mwense	3.6	0.7	2.9	4.2	0.9	3.4	5.0	1.2	3.8
75	Samfya	5.4	2.0	3.4	5.6	2.1	3.5	5.8	2.2	3.6
81	Kasama	16.2	10.9	5.3	22.9	16.9	6.0	32.2	25.7	6.5
82	Kaputa	2.3	0.5	1.8	2.8	0.7	2.1	3.3	0.9	2.3
83	Mbala	7.0	2.5	4.5	8.2	3.2	5.0	9.5	4.0	5.5
84	Mporokoso	2.6	0.9	1.8	3.2	1.2	2.1	3.9	1.5	2.3
85	Luwingu	3.1	0.8	2.3	3.4	0.9	2.5	3.8	1.1	2.7
86	Chilubi	1.6	0.2	1.4	1.8	0.3	1.6	2.0	0.3	1.7
87	Isoka	6.5	2.3	4.1	8.0	3.3	4.8	9.9	4.5	5.4
88	Chinsali	4.1	1.3	2.8	4.9	1.7	3.2	5.6	2.1	3.5
89	Mpika	7.8	4.1	3.7	11.5	7.1	4.4	19.2	14.1	5.1
91	Chipata	21.8	12.5	9.3	32.8	21.5	11.3	49.3	36.2	13.2
92	Chama	2.5	0.6	1.9	3.2	1.0	2.2	4.0	1.4	2.6
93	Lundazi	7.7	1.1	6.6	10.2	1.8	8.4	13.3	2.8	10.5
94	Chadiza	3.0	0.6	2.4	4.2	1.0	3.1	5.7	1.8	4.0
95	Katete	6.4	1.3	5.1	8.3	2.0	6.2	10.5	3.0	7.5
96	Petauke	11.8	2.2	9.6	16.4	3.8	12.5	22.6	6.5	16.1
10	Lusaka	196.7	190.5	6.2	317.7	310.5	7.2	508.6	501.6	7.0
20	Copperbelt	235.6	223.0	12.5	298.1	282.0	16.1	373.8	353.4	20.4
30	Central	65.5	45.4	20.1	93.9	68.6	25.3	135.3	104.0	31.2
40	Northwestern	23.5	10.9	12.7	36.2	21.6	14.7	55.0	38.8	16.2
50	Western	33.7	13.8	19.9	44.8	22.0	22.7	57.9	32.3	25.6
60	Southern	67.8	40.7	27.2	92.8	59.4	33.5	126.8	86.4	40.4
70	Luapula	31.9	15.2	16.6	44.0	25.0	18.9	60.0	38.9	21.1
80	Northern	51.3	23.6	27.7	66.8	35.2	31.5	89.3	54.2	35.1
90	Eastern	53.3	18.4	34.9	75.0	31.2	43.8	105.5	51.7	53.8
	Zambia	759.3	581.5	177.8	1,069.2	855.4	213.8	1,512.2	1,261.4	250.8

Appendix 2(3) Domestic Water Demand by District: 1995-2015

III. Low Projection (Unit: 1000 cu.m.)

District		1995			2005			2015		
Code	Name	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
11	Lusaka-Urban	172.8	172.8	0.0	255.7	255.7	0.0	357.2	357.2	0.0
12	Lusaka-Rural	17.9	12.0	5.9	23.9	16.2	7.7	30.3	20.6	9.7
13	Luangwa	0.9	0.3	0.6	1.1	0.3	0.7	1.3	0.4	0.9
21	Ndola-Urban	69.4	69.4	0.0	87.4	87.4	0.0	104.0	104.0	0.0
22	Ndola-Rural	8.5	2.3	6.2	11.2	3.0	8.2	13.9	3.7	10.1
23	Chililabombwe	9.8	9.3	0.5	10.2	9.7	0.5	10.2	9.8	0.4
24	Chingola	28.2	27.5	0.7	30.9	30.1	0.8	32.0	31.2	0.8
25	Mufulira	24.1	23.3	0.8	24.7	23.9	0.8	24.6	24.0	0.6
26	Kalulushi	8.2	7.2	1.1	10.4	9.1	1.3	14.1	12.5	1.6
27	Kitwe	59.5	57.3	2.3	68.7	66.1	2.6	74.9	72.0	2.9
28	Luanshya	23.4	22.5	0.9	25.0	24.0	0.9	25.3	24.4	0.9
31	Kabwe-Urban	34.7	34.7	0.0	47.2	47.2	0.0	60.5	60.5	0.0
32	Kabwe-Rural	11.1	3.4	7.7	13.0	4.0	9.0	14.3	4.4	9.9
33	Mumbwa	7.2	2.6	4.5	9.1	3.3	5.7	10.8	4.0	6.9
34	Mkushi	5.3	1.3	4.0	6.3	1.6	4.8	7.2	1.8	5.4
35	Serenje	5.2	1.4	3.8	6.3	1.7	4.6	7.2	2.0	5.3
41	Solwezi	8.7	4.7	4.0	11.5	6.2	5.3	15.9	9.4	6.6
42	Mwinilunga	3.9	1.0	2.8	4.3	1.1	3.1	4.4	1.2	3.3
43	Zambezi	3.3	1.3	2.1	3.3	1.5	1.9	3.1	1.6	1.6
44	Kabompo	2.7	0.8	1.8	3.1	0.9	2.1	3.3	1.0	2.3
45	Mfumbwe	1.5	0.8	0.7	1.7	0.9	0.8	1.8	1.0	0.8
46	Kasempa	1.9	0.7	1.3	2.2	0.8	1.4	2.4	0.8	1.5
51	Mongu	10.2	6.1	4.1	11.8	7.1	4.7	12.9	7.8	5.1
52	Lukulu	2.4	0.5	1.9	2.8	0.6	2.2	3.1	0.7	2.4
53	Kalabo	4.3	1.4	2.9	3.8	1.4	2.4	3.3	1.4	1.9
54	Kaoma	5.6	1.6	4.1	6.9	1.9	5.0	8.0	2.2	5.8
55	Senanga	6.3	1.5	4.8	6.9	1.6	5.3	7.1	1.7	5.4
56	Sesheke	3.3	1.3	2.0	3.4	1.3	2.1	3.3	1.3	2.0
61	Livingstone	15.4	15.2	0.2	17.5	17.2	0.3	18.8	18.5	0.3
62	Namwala	4.6	1.5	3.0	6.0	2.0	4.0	7.4	2.5	4.9
63	Mazabuka	11.5	7.1	4.3	13.3	8.3	5.0	14.5	9.1	5.4
64	Monze	7.1	2.9	4.2	8.2	3.4	4.8	9.0	3.7	5.3
65	Choma	10.7	5.8	4.8	12.0	6.6	5.4	12.8	7.0	5.8
66	Kalomo	7.9	1.7	6.2	10.0	2.1	7.8	11.9	2.6	9.3
67	Siavonga	2.3	1.3	1.0	2.7	1.5	1.2	2.9	1.6	1.3
68	Gwembe	1.6	0.3	1.3	1.9	0.4	1.5	2.1	0.4	1.6
69	Sinazongwe	3.8	1.8	2.0	4.4	2.1	2.3	4.8	2.3	2.6
71	Mansa	10.5	6.5	4.0	13.6	9.1	4.6	15.0	10.0	5.0
72	Nchelenge	6.6	2.8	3.8	8.0	3.4	4.6	9.3	4.0	5.3
73	Kawambwa	4.5	1.8	2.7	4.8	1.9	2.9	4.9	2.0	2.9
74	Mwense	3.5	0.6	2.9	3.7	0.6	3.1	3.8	0.7	3.2
75	Samfya	5.3	1.9	3.3	5.1	1.9	3.2	4.8	1.9	2.8
81	Kasama	15.0	9.6	5.4	17.3	11.1	6.2	18.9	12.1	6.8
82	Kaputa	2.2	0.5	1.8	2.4	0.5	1.9	2.5	0.5	1.9
83	Mbala	6.8	2.4	4.5	7.1	2.5	4.7	7.1	2.5	4.6
84	Mporokoso	2.6	0.8	1.8	2.8	0.8	1.9	2.8	0.9	2.0
85	Luwingu	3.0	0.7	2.3	3.0	0.7	2.3	3.0	0.7	2.2
86	Chilubi	1.6	0.2	1.4	1.6	0.2	1.4	1.6	0.2	1.4
87	Isoka	6.2	2.1	4.1	6.8	2.3	4.5	7.0	2.4	4.6
88	Chinsali	4.0	1.2	2.8	4.2	1.3	3.0	4.2	1.3	2.9
89	Mpika	7.3	3.6	3.7	8.8	4.3	4.5	10.0	5.0	5.1
91	Chipata	20.1	10.7	9.4	24.5	13.0	11.4	28.1	15.0	13.1
92	Chama	2.4	0.6	1.8	2.7	0.6	2.1	2.9	0.7	2.2
93	Lundazi	7.4	0.9	6.5	8.9	1.1	7.7	10.0	1.3	8.7
94	Chadiza	2.9	0.5	2.4	3.5	0.6	2.9	4.1	0.7	3.4
95	Katete	6.2	1.2	5.0	7.1	1.4	5.8	7.7	1.5	6.3
96	Petauke	11.4	1.9	9.5	14.0	2.4	11.6	16.3	2.8	13.5
10	Lusaka	191.6	185.1	6.5	280.7	272.2	8.5	388.7	378.2	10.5
20	Copperbelt	231.2	218.8	12.4	268.5	253.4	15.2	298.9	281.6	17.3
30	Central	63.5	43.5	20.0	81.8	57.8	24.1	100.0	72.6	27.4
40	Northwestern	22.0	9.3	12.7	26.1	11.4	14.6	31.0	15.0	16.1
50	Western	32.2	12.4	19.8	35.6	14.0	21.6	37.7	15.1	22.6
60	Southern	64.8	37.6	27.2	75.9	43.6	32.4	84.2	47.7	36.5
70	Luapula	30.2	13.6	16.6	35.3	17.0	18.3	37.7	18.5	19.2
80	Northern	48.6	20.9	27.7	54.1	23.7	30.3	57.1	25.5	31.5
90	Eastern	50.5	15.8	34.7	60.8	19.2	41.6	69.1	21.9	47.2
	Zambia	734.6	557.0	177.6	918.9	712.3	206.6	1,104.6	876.3	228.3

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF ZAMBIA
MINISTRY OF ENERGY AND WATER DEVELOPMENT

THE STUDY

ON

THE NATIONAL WATER RESOURCES MASTER PLAN

IN

THE REPUBLIC OF ZAMBIA

FINAL REPORT

SUPPORTING REPORT [F]

INDUSTRIAL WATER SUPPLY

OCTOBER, 1995

YACHIYO ENGINEERING CO., LTD.
(YEC)

THE STUDY ON NATIONAL WATER RESOURCES MASTER PLAN
IN THE REPUBLIC OF ZAMBIA

SUPPORTING REPORT (F)
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CHAPTER 1 MANUFACTURING SECTOR SITUATION

1.1 Past Development Trend

Industrial production index over the past 10 years since 1980 is shown in Table 1-1. The table shows that all industrial production (total index) decreased slightly from the level of 1980. The present activity (1992) of the mining sector stands at almost 20% less than that in 1980; in particular, coal production decreased by almost 25%. In spite of this, the manufacturing sector increased by almost 34% from 1980. Within manufacturing, "Food & Beverages" increased sharply by almost 70%, "Chemicals, Rubber & Plastics" also increased by 40% and "Textiles and Clothing" increased by 27% which is almost the same as the rate of increase of the total manufacturing sector. On the contrary, "Basic metal industries" stand at almost 60% of the 1980 level and "Metal products" have remained at almost the same level since 1980.

Table 1-1 Index of Industrial Production (1980=100)

Year	Weigh	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992 (**)
TOTAL INDEX	1000	100	98.3	98.9	100.3	98	99.1	96.7	95.3	96.2	96.1	96.6	92.4	101.4
Coal	13	100	87.6	104.3	73.2	88.2	88.2	96.2	80.1	82.9	68.2	65.3	65.4	74.2
Non-Ferrous Ore (*)	535	100	91.3	94.2	93	89.5	36.8	85.3	83.7	80.6	82.8	79.2	72	80.6
Stone Quarrying	1	100	77.5	83.6	81.4	87.5	80.5	84.3	69.6	78.5	162.4	126.4	142.1	114.7
TOTAL Mining	549	100	91.2	94.4	92.7	89.5	86.8	85.6	83.6	80.6	82.6	79	72	80.5
Food, Beverage and Tobacco	106	100	106.6	104.8	117.3	112	117.9	108.3	109.6	113.2	107.9	124.8	128.1	172.7
Textiles and Clothing	78	100	119.6	117.5	126.7	134.6	166.9	145.7	120.4	147.1	155.5	161.1	145.2	127.7
Wood, Wood Products	19	100	99.3	94.1	77.7	65.3	73.3	66.1	69.8	74.9	83.6	102.2	103.2	102.9
Paper and Paper Products	23	100	118.1	125.2	137.3	133.4	122.7	125.9	197	191.9	146.3	138	134.9	132.2
Chemicals, Rubber, Plastic	66	100	100.9	86.2	102.1	96.6	90.1	100.8	103.3	108	108	110.4	111.1	141.5
Non-Metallic Mineral Products	19	100	101.1	100.2	96.3	79.5	90.9	100.2	126.3	119.7	124.4	119.2	115	110.3
Basic Metal Industries	9	100	90.7	79.8	80.5	81.5	96.6	90.3	91.9	91.9	66.9	49.5	50.3	57.3
Metal Product and Other	72	100	102.4	98.4	94.3	101.3	93.7	98.6	99.2	97.8	108	101.1	101.5	99.3
TOTAL Manufacture	392	100	107.1	102.9	109.8	108.6	115	110.9	112.5	118.9	118.4	123	120.6	133.6
TOTAL Electricity	59	100	106.2	114.7	109.2	106.3	109.1	106.4	91.3	90.7	73.1	84.3	94.2	82.5

Notes:
* Including copper refineries
** Provisional Source: Index of Industrial Production, June 1993

1.2 Manufacturing Characteristics

In order to understand the Zambian manufacturing sector, Table 1-2 shows Value Added by industry type in 1990 and a comparison of the number of establishments and employees by industry type in 1980 and 1990.

Table 1-2 Manufacturing Establishments and Employees by Industry Type

ISIC Code	Description	1980			1990			1990		
		(A) No. of Estab	(B) No. of Employee	(C) Ave. (B/A)	(A) No. of Estab	(B) No. of Employee	(C) Ave. (B/A)	Share of Employee (%)	Value Added (K'million)	Share of Employee (%)
311/2	Food	111	16,599	150	172	25,412	148	36.1	7,629	21.1
313/4	Beverages	25	3,840	154	28	4,465	159	6.3	4,191	11.6
31	Total	136	20,399	150	200	29,877	149	42.5	11,820	32.7
321	Textiles	15	4,299	287	47	9,317	198	13.2	1,237	3.4
322	Wearing apparel	105	5,910	56	68	3,879	57	5.5	835	2.3
323	Leather products	7	983	140	2	141	71	0.2	333	0.9
324	Footwear				8	1,858	232	2.6	100	0.3
32	Total	127	11,192	88	125	15,195	122	21.6	2,505	6.9
331	Wood and Wood Products	14	1,687	121	16	1,511	94	2.1	473	1.3
332	Furniture	15	1,723	115	38	2,073	55	2.9	425	1.2
33	Total	29	3,410	118	54	3,584	66	5.1	898	2.5
341	Paper and Paper Products	11	860	78	9	708	79	1.0	1,453	4.0
342	Printing and Publishing	26	1,820	70	44	2,660	60	3.8	1,574	4.4
34	Total	37	2,680	72	53	3,368	64	4.8	3,027	8.4
351	Basic Chemicals	6	1,499	250	19	2,214	117	3.1	519	1.4
352	Chemical Products	23	3,364	146	34	3,481	102	4.9	1,067	3.0
353/4	Petroleum & Coal Products	3	448	149	5	581	116	0.8	260	0.7
355	Rubber Products	10	1,568	157	11	1,244	113	1.8	333	0.9
356	Plastic Products	9	431	48	10	492	49	0.7	273	0.8
35	Total	51	7,310	143	79	8,012	101	11.4	2,452	6.8
361/2	Glass Products	2	298	149	3	471	157	0.7	497	1.4
369	Other Non-metallic Products	13	3,241	249	25	2,135	85	3.0	3,230	8.9
36	Total	25	3,539	142	28	2,606	93	3.7	3,727	10.3
37	Total (Iron/Steel)	4	1,202	301	17	926	54	1.3	241	0.7
381	Metal Products	68	5,048	74	67	3,750	56	5.3	4,203	11.6
382	Machinery	18	959	53	21	1,263	60	1.8	1,509	4.2
383	Electrical Products	23	1,719	75	9	790	88	1.1	333	0.9
384	Transport Equipment	14	1,293	92	8	713	89	1.0	4,302	11.9
38	Total	123	9,019	73	105	6,516	62	9.3	10,347	28.7
39	Total(Other Manufacturing)	7	158	23	4	273	68	0.4	1,089	3.0
3	TOTAL Manufacturing	539	58,909	109	665	70,357	106	100.0	36,107	100.0

Notes:

1) Data in 1976 and 1980 are based on "Census of Industrial Production, 1974 and 1980".
2) Data in 1990 are based on information given by CSO.

The table shows that, from the viewpoint of Value Added, number of establishments and number of employees, "Food & Beverages" is the leading sector accounting for almost 40% share of total manufacturing sector. "Textiles & Leather" accounts for almost 22% of total employees, and almost 7% of total Value Added, whereas "Metals & Machinery" accounts for almost 30% of total Value Added. This implies that Value Added type of industry should be expanded to achieve national economic development. However, as stated above, the "Metal & Machinery" sector has not been developed over the past 10 years. "Food & Beverages" and "Textiles & Leather" make a large contribution to the national economy by not only creation of employment opportunities but also by supplying to the domestic demands. For these reasons, such industries have expanded noticeably in the past.

1.3 Regional Industrial Characteristics

Regional industrial distribution is illustrated in Table 1-3 by the number of establishments and employees, based on CSO information. The industrial census was made in 1990; however, results and analysis have not yet been published.

Table 1-3 Regional Industrial Accumulation in 1990

Province	31 Food, Beverages	32 Textiles Leather	33 Wood & Furniture	34 Paper & Printing	35 Chemicals	36 Non-Metallic	37 Iron & Steel	38 Metal & Machinery	39 Other Manufg	TOTAL
<LUSAKA>										
- No.of Establishmen	74	37	21	26	31	16	8	31	3	247
- No. of Employees	12,946	5,818	1,514	1,722	3,076	1,278	454	1,805	196	29,012
<COPPERBELT>										
- No.of Establishmen	65	44	23	24	43	7	7	71	1	285
- No. of Employees	6,299	4,592	1,585	1,610	4,486	1,002	425	4,153	77	24,229
<CENTRAL>										
- No.of Establishmen	11	7	1		2	2	1			24
- No. of Employees	454	2,634	14		112	248	27			3,489
<NORTH WESTERN>										
- No.of Establishmen	5		1							6
- No. of Employees	165		38							203
<WESTERN>										
- No.of Establishmen	8	1	2							11
- No. of Employees	250	65	134							723
<SOUTHERN>										
- No.of Establishmen	16	28	4	1	2	2	1	2		56
- No. of Employees	6,176	1,907	254	10	102	40	20	407		8,642
<LUAPULA>										
- No.of Establishmen	3	1	2		1					7
- No. of Employees	1,611	31	45		236					1,923
<NORTHERN>										
- No.of Establishmen	10	4		1		1				16
- No. of Employees	1,587	96		14		38				1,735
<EASTERN>										
- No.of Establishmen	8	3		1				1		13
- No. of Employees	389	52		12				151		604
(National Total)										
- No.of Establishmen	200	125	54	53	79	28	17	105	4	665
- No. of Employees	29,877	15,195	3,584	3,368	8,012	2,606	926	6,516	273	70,560

Note: Prepared on the basis of industrial data in 1990 as given by CSO.

The table shows that almost 40% of the total number of establishments and total employees are located in Lusaka Province and another 42% of total number of establishments and 34% of total employees are located in Copperbelt Province. Of lesser importance are Southern Province, with almost 10% of total establishments and employees, and Central Province with almost 5% of industries.

Generally, Lusaka is the most industrialised province; however, Copperbelt Province is more advanced in "Metal & Machinery" industries than Lusaka. Although most industries are located in Lusaka and Copperbelt Provinces, "Food & Beverages", "Textiles" and "Wood & Furniture" are distributed nation-wide. In other words, light industries exist in all provinces, while more technically advanced industries such as metal and machinery industries are mainly concentrated in Lusaka and Copperbelt Provinces.

1.4 Export and Import Structures

Current trade balance is shown in Table 1-4. Zambia's trade balance is different from other African countries in that many countries have trade balance deficits. However, with the exception of recent years (1992-1994), Zambia earns foreign exchange from the export of copper and cobalt, as well as smaller amounts of lead, zinc and precious metals. Non-ferrous metals account for almost all of Zambia's foreign exchange earnings as shown in Table 1-5.

Table 1-4 Trade Balance of Zambia

Items		1987	1988	1989	1990	1991*	1992*	1993**	1994**
<<<Export>>>									
- Copper	(US$ Million)	736	982	1,231	1,055	895	697	712	710
	(%)	85	85	87	83	83	69	71	69
- Other Metals	(US$ Million)	66	91	106	95	103	177	131	135
	(%)	8	8	8	7	10	18	13	13
- Non-metal	(US$ Million)	66	82	70	113	84	133	158	179
	(%)	8	7	5	9	8	13	16	17
Total	(US$ Million)	868	1,156	1,407	1,267	1,082	1,006	1,000	1,025
	(%)	100	100	100	100	100	100	100	100
<<<Import>>>									
- Machinery	(US$ Million)	233	278	372	346	285	319	335	353
	(%)	30	31	36	32	30	30	31	32
- Fertilizer	(US$ Million)	45	47	73	49	29	40	38	41
	(%)	6	5	7	5	3	4	4	4
- Petroleum	(US$ Million)	67	62	103	119	73	100	96	102
	(%)	9	7	10	11	8	9	9	9
- Maize	(US$ Million)					16	38		
	(%)					2	4		
- Other	(US$ Million)	427	501	473	570	545	581	602	623
	(%)	55	56	46	53	57	54	56	56
Total	(US$ Million)	772	888	1,020	1,084	949	1,078	1,071	1,119
	(%)	100	100	100	100	100	100	100	100
(Trade Balance)		96	267	387	179	133	-72	-70	-95

Notes: * Estimates ** Projections (%) shows share of total exports or imports
Source: New Economic Recovery Programme, March 1992

However this export share has decreased slightly because the unit price of copper and other metals has decreased. Instead, the export of non-metallic products has increased. Additionally, the export of electric energy has increased. Machinery and petroleum account for a large share of imports which is similar to the situation in other African countries.

In addition to industrial products, petroleum products and petroleum account for almost 15% of total imports, ranking first in import items. Specialised machinery for particular industries is ranked second, followed by general industrial machinery, chemicals, cereals and cereal preparations, etc.

Table 1-5 Value of Imports and Exports of Selected Commodities

(Unit:K'million)

Code No.	Description	Exports		Average	Imports		Average
		1991	1992	Share (%)	1991	1992	Share (%)
4	Cereals and cereal preparations	55	222	0.14		384	7.08
6	Sugar, sugar preparations and honey	117	2,221	1.1	62	175	0.12
22	Oil seeds and Oleaginous fruits	576	1,416	1.00	2	195	0.10
26	Textile fibres	1,335	363	0.85	461	745	0.62
33	Petroleum products and petroleum		9	0.00	8,314	22,856	15.91
35	Electric energy	1,790	269	1.03	6	22,856	11.67
51	Inorganic chemicals	2	8	0.01	464	1,193	0.85
52	Organic chemicals	41	40	0.04	711	1,838	1.30
54	Medical and pharmaceutical products	43	14	0.03	1,570	3,708	2.69
56	Fertilizers manufactured		171	0.09	573	4,277	2.48
57	Explosives and pyrotechnic products			0.00	925	3,131	2.07
59	Chemical materials and products	43	152	0.10	1,478	6,238	3.94
62	Rubber manufactured		8	0.00	881	1,851	1.39
64	Paper, paper board and manufactured	44	44	0.04	1,084	2,229	1.69
65	Textile yarn, fabrics and related products	1,889	2,125	2.02	1,198	3,276	2.28
66	Non-metallic minerals manufactures	1,652	2,296	1.98	816	2,354	1.62
67	Iron and steel	5	23	0.01	1,682	5,999	3.92
68	Non-ferrous metals	57,728	117,309	87.92	339	865	0.61
89	Manufacture of metals	14	57	0.04	1,775	4,080	2.99
71	Power generating machinery and equipment	1,947	3	0.98	1,054	2,707	1.92
72	Machinery specialised for particular industry	27	41	0.03	5,051	12,541	8.98
74	General industrial machinery and equipment	15	6	0.01	4,568	11,189	8.04
75	Office machine & automatic data processing	1	4	0.00	562	1,878	1.25
76	Telecomm and sound recording equipment		9	0.00	2,073	2,326	2.25
77	Electrical machinery apparatus & appliances	32	132	0.08	1,797	5,681	3.82
78	Road vehicles	125	243	0.18	6,131	8,383	7.41
79	Other transport equipment	2	78	0.04	1,147	2,851	2.04
85	Footwear		1	0.00	239	1,210	0.74
87	Professional scientific instruments	23	2	0.01	945	2,062	1.54
89	Miscellaneous manufactured articles	59	140	0.10	2,033	2,603	2.37
	Grand Total	69,607	129,475	100.00	51,772	144,108	100.00

Notes: 1) Selected commodities are relatively large amount of imports
2) Average share is calculated as each commodity value in 1991 and 1992 divided by grand total in both years

Source: External Trade Bulletin 1993, CSO

1.5 Manufacturing Activities

Large scale industrial operations in Zambia are undertaken by the state conglomerate, the Industrial Development Corporation Ltd. (INDECO) under the Zambia Industrial Mining Corporation Ltd. (ZIMCO).

1.5.1 Zambia Industrial Mining Corporation Ltd. (ZIMCO)

ZIMCO was established in 1969 to act as the holding company for the emerging state-controlled mining companies. ZIMCO's shares are owned by the State through the Minister of Finance, but are not directly owned by the government. There are reports that ZIMCO controls 80 per cent of the national economy. The ZIMCO group is composed of state-controlled enterprises (with at least a 51 per cent share held by the Zambian government) throughout all economic sectors, and is responsible for the discovery, management, and production of the country's mineral resources. However, in August 1992, ZIMCO's Board adopted a resolution that restructured the corporation into a smaller investment holding company with the disbanding of INDECO and NHDC.

1.5.2 Industrial Development Corporation Ltd. (INDECO)

Until as recently as 1992, the Industrial Development Corporation Ltd., (INDECO) participated directly in business operations and was the government's vehicle for implementing economic reforms because the organisation had acquired the majority shareholdings in designated companies. However, as a result of the Parliament's 1992 approval of the Privatisation Act, and the country's Structural Adjustment Programme (SAP), new economic policies affecting INDECO's business holdings were inaugurated. The policies specifically established the sale of parastatal companies.

Recent economic liberalisation programmes curtailed INDECO's ownership in the production sectors and was designed to promote privatisation of the economy as listed below :

- New investment incentives (June 1992)
- Zambia Investment Centre (June 1992)
- Privatisation Act (July 1992)

CHAPTER 2 MINING SECTOR SITUATION

2.1 Summary Description

Public investments for ZCCM projects are designed to attract funds from international financial institutions such as the African Development Bank and the World Bank. Emphasis is placed on the mining sector because the Government estimates that the copper industry will remain the main economic force in the country for the medium term as a major source of foreign exchange. The government is moving forward with plans to privatise ZCCM. Stanford Research Institute has a contract under a World Bank mining sector loan to carry out a strategic survey of ZCCM, including an examination of the best course to follow in privatising ZCCM.

Also, the Government recognises that there is substantial mineral wealth to be exploited which includes metals, gemstones, industrial, agro, building, and energy minerals. Currently, the most developed sector is the metallic group.

Currently, mined deposits are expected to be exhausted by the end of the century, but there are undeveloped reserves. The Ministry of Mines is actively seeking foreign partners to develop these reserves. In 1992, Phelps Dodge Inc., received prospecting licenses for the Lumwana deposits in the Northwestern Province, and has commenced exploratory work. Priority projects under the investment programme are:

- Acid plant rehabilitation
- Deepening of the Mindola Shaft, and the
- Reopening of Konkola No. 3 Shaft.

2.2 Zambia Consolidated Copper Mines (ZCCM)

In 1982, the mining companies, Nchanga Consolidated Mines Ltd., (NCCM) and Roan Consolidated Mines Ltd. (RCM), were amalgamated as Zambia Consolidated Copper Mines (ZCCM). Of ZCCM's outstanding shares, ZIMCO has about 60.3% equity shareholding.

A summary of the ore reserves and mineral resources of the 11 primary mining operations is given in Table 2-1, and a summary with detailed descriptions of ZCCM's business operations, e.g., divisions, production, ore deposits/reserves, plant capacities, etc., is presented in Table 2-2.

Table 2-1 Ore Reserves and Mineral Resources by Mining Location

Mine Nomenclature	Ore Reserves*	Mineral Resources**
Nchanga	82.582 Million tonnes	388 Million tonnes
Mufulira	43.173 Million tonnes	381 Million tonnes
Nkana	87.569 Million tonnes	144 Million tonnes
Chibuluma	4.060 Million tonnes	11 Million tonnes
Luanshya	29.375 Million tonnes	44 Million tonnes
Baluba	40.310 Million tonnes	28 Million tonnes
Nampundwe	8.073 Million tonnes	18 Million tonnes
Kabwe	1.063 Million tonnes	56 Million tonnes
Chambishi	--	136 Million tonnes
Kansanshi	--	26 Million tonnes

Notes:

* indicates "ore reserves" that are defined as that tonnage which meet the definition of ore and are available for mining from existing or approved planned facilities.

** indicates "mineral resources" that are defined as those mineralised materials which have been examined in sufficient detail to establish mode of occurrence, size, and essential qualities, and include reclamation materials already mined or treated. Before transfer to the "ore reserve" category, investigation into the feasibility of economic exploitation must be accomplished and additional investment incurred.

Source: "1993 Annual Report". The Zambia Consolidated Copper Mines Ltd. September 1993.

Table 2-2 Zambia Consolidated Copper Mines: Summary Description

Divisions	Established Production	Ore Deposits	Existing Reserves	Plant Capacity	Closing Year	Nearest Town	No. of Employees
NCHANGA	- 1927 - 1946 (Underground Mining) - 1957 (Open Pit)	- Copper - Cobalt	- 69 mil-ton (Open pit) - 500,000 ton/yr (Nchanga U/G mine, 1994) - total 82.6 mil-ton	- Nchanga Concentrator east mill west mill cap. 9.7 mil-ton/y - Tailings Leach Plant, Capacity: 43,000 ton/day.	Nchanga open pit: 2001.	- Chingola	10,157
MUFULIRA	- 1933	- Copper	- 43.5 mil-ton actual	- Mufulira Concentrator - Smelter cap.180,000 ton/y - Refinery cap. 165,000 ton/y		- Mufulira	7,978
NKANA	- 1932	- Copper - Cobalt	Ore sources: - Mindola - Central - South ore body - Chibuluma - Chambishi 400 mil-ton Reserves: 87.5 million	- Concentrator - Smelter - Cobalt Plant (2) cap. 4,700 ton/y - Refinery - Sulphuire Acid Plant	Chibuluma : 2004	- Chambishi - Kitwe - Kalulushi	13,400
LUANSHYA	- 1931 - 1973 (Baluba Mine)	- Copper - Cobalt - Gold - Silver - Selenium	- Luanshya 29 mil-ton - Baluba 41 mil-ton	- Concentrators - Smelters - Precious Metals Plant at Ndola Copper Refinery	est. 2010	- Luanshya - Ndola	8,524
KONKOLA	- 1959	- Copper - Cobalt	- 344 mil-ton plus resources in Greater Konkola est. 44 mil-ton	- Konkola Mill 1.6 mil/ton/y	extended	- Chingola - Chilila-bombwe	5,793
KABWE	- 1906 - 1970 (Nampundwe)	- Lead - Zinc - Silicate - Pyrite	1 mil-ton 8 mil-ton (16% sulphur) (Nampundwe)	- Concentrator (2) - Waelz Kiln - Leach Plant	1996-97	- Kabwe	1,997

Notes: Prepared by the Study Team based on the ZCCM "Annual Report, 1993", "Corporate Profile" and "Mining Journal", London, October 9,1992. Volume 319 No.8194.

CHAPTER 3 INDUSTRIAL WATER SUPPLY

3.1 Manufacturing Sector

To understand the unit water consumption rate by industry type in Zambia, the Study Team conducted a questionnaire survey supported by DWA and ZACCI (Zambia Association of Chambers of Commerce and Industry) between February and April 1994. The Team dispatched questionnaires by mail to about 1000 enterprises. The number of questionnaires returned by manufacturers was 139 samples which accounts for about 20% of manufacturers listed in the 1990 statistical data of CSO. A projection of future water consumption was conducted based on the analysis of the replies received. The water consumption rate by industry is estimated as shown in Table 3-1.

Table 3-1 Estimate of Water Consumption Rate by Industry

ISIC Code	Type of Industry	(a) No. of Est.	(b) No. of Employees	(c) (b)/(a)	(d) No. of Sample	(e) No. of Employees	(f) Cons. Rate (m^3/d/Est.)	(g) Cons. Rate (m^3/d/000m^3)	(h) Cons. Rate (m^3/d/Est.)
311/2	Food	172	25,412	148	21	89	602.2	92.1	999.7
313/4	Beverages	28	4,465	159	5	427	971.6	19.9	362.8
31	Total	200	29,877	149	26				910.5
321	Textiles	47	9,317	198	6	642	702.6	57.3	216.9
322	Wearing Apparel	68	3,879	57	2	23	0.2	1.0	0.5
323	Leather Products	2	141	71	1	80	140.0	77.8	123.4
324	Footwear	8	1,858	232	1	100	5.0	10.2	11.6
32	Total	125	15,195	122	10				84.6
331	Wood Products	16	1,511	94	6	107	73.8	29.8	65.1
332	Furniture	38	2,073	55	3	23	3.0	3.8	7.1
33	Total	54	3,584	66	9				24.3
341	Paper Products	9	708	79	1	300	600.0	16.2	157.3
342	Printing/Publishing	44	2,660	60	5	37	1.0	1.0	1.6
34	Total	53	3,368	64	6				28.1
351	Basic Chemical	19	2,214	117	3	530	4,682.3	13.4	1,029.5
352	Chemical Products	34	3,481	102	13	82	10.7	6.6	13.4
353/4	Petroleum/Coal	5	581	116	5	130	428.2	4.5	382.7
355	Rubber Products	11	1,244	113	3	118	133.5	12.0	127.9
356	Plastic Products	10	492	49	5	80	12.3	18.2	7.6
35	Total	79	8,012	101	29				296.3
361/2	Glass Products	3	471	157	1	250	31.0	0.4	19.5
369	Other Non-metallic	25	2,135	85	11	166	119.8	15.7	61.6
36	Total	28	2,606	93	12				57.1
37	Total/ Iron & Steel	17	926	54	3	169	33.7	2.8	10.9
381	Metal Products	67	3,750	56	19	98	20.3	3.5	11.6
382	Machinery	21	1,263	60	14	79	3.0	3.5	2.3
383	Electrical Products	9	790	88	7	85	25.0	20.6	25.8
384	Transport Equip.	8	713	89	2	123	105.0	6.5	76.1
38	Total	105	6,516	62	42				15.9
39	Total/Other Manuf.	4	273	68	2	91	6.8	4.0	5.1
3	Total/Manufact'g.	665	70,357	106	139			18.3	159.2

[Note] 1) (a) and (b): Industrial statistical data (1990) are given by CSO. 2) (d) ~ (h) : Results of questionnaire survey 3) (a): Total number of industrial establishments in Zambia (1990) (b): Total number of employees in industrial sector (1990) (c): Average number of employees per establishment (1990) (d): Total number of samples obtained in questionnaire survey (e): Average number of employees obtained in questionnaire survey (f): Average water consumption rate (m^3/day/establishment) (g): Average water consumption rate (m^3/day/1000m^2) (h): Weighted average water consumption rate (m^3/day/establishment)

3.2 Mining Sector

Large scale mining operations in Zambia are undertaken by ZCCM as explained previously. To understand the water consumption for mining sector (processing plant), the Team visited ZCCM operational sites located in Copperbelt Province and contacted ZCCM head office. The following figures were disclosed by ZCCM.

- Chililabombwe	:	8,000 m^3/day	- Konkola	:	50,000 m^3/day
- Nchanga	:	78,800 m^3/day	- Mufulira	:	53,000 m^3/day
- Nkana	:	25,400 m^3/day	- Chambeshi	:	23,400 m^3/day
- Luanshya	:	52,000 m^3/day	- Baluba	:	15,900 m^3/day
- Kabwe	:	13,700 m^3/day			

According to ZCCM current plans, the estimated end of life of Luanshya mine is year 2005 and Baluba mine is year 2012. An estimate of the Division's total industrial water usage during the years 2005 to 2012 is 32,000 m^3/day. In addition to ZCCM's activities, coal production has been undertaken by Maamba Collieries Ltd.(MCL) at Maamba in Southern Province. According to the questionnaire answered by MCL, water consumption for coal production (coal processing plant: capacity 450,000 tons per year, capacity utilisation 38 %) is 2,800 m^3/day.

CHAPTER 4 INDUSTRIAL WATER DEMAND FORECAST

Industrial water demand for manufacturing sector is assumed at city and district level over the whole country by the following study steps.

1) Industrial development forecast is made on the basis of production amount (VA: Value Added) by industrial type which is projected by macro-economic development as described in Supporting Report [A].
2) Industrial development forecast by district level is also assumed by the present industrial situation such as the existing industrial accumulation and regional population growth.
3) Unit water consumption rates by industrial type are estimated on the basis of analysis of results of questionnaires answered by manufacturing enterprises in Zambia.
4) Industrial water demand in 2005 and 2015 are assumed by growth of industrial type by district and unit water consumption rate.

4.1 Industrial Development Forecast

As discussed in Supporting Report [A], the GDP projection of manufacturing sector in the year 2015 according to Base Case(1) is given as K 766.2 billion. Value added forecast of the manufacturing sector is broken down by the above manufacturing growth rate and past growth rate of each industrial type. According to this analysis, average industrial sub-sector growth rates are obtained as shown in Table 4-1.

Table 4-1 Industrial Sub-sector Growth Rate

Industrial Sub-sector	Share in 1993	1993-2005	2005-2015
Food, Beverages, etc.	41.5%	4.0%	4.0%
Textiles & Leather	5.5%	2.9%	2.8%
Wood & Furniture	2.1%	3.2%	3.1%
Paper & Printing	2.9%	3.2%	3.2%
Chemicals	18.2%	3.6%	3.6%
Non-Metallic Products	11.5%	4.1%	4.0%
Iron & Steel	0.3%	2.4%	2.3%
Metal & Machinery	5.9%	3.5%	3.4%
Other Manufacturing	2.0%	4.8%	4.7%
(Average)	100%	3.6%	3.6%

Note: Growth rate is calculated from Base Case(1) of GDP Projection

Growth rates of "Food/Beverages" and "Non-Metallic Products" are slightly higher than the average rate and other sub-sectors are below the average rate. "Food/Beverages" accounted for about 42% in 1993 and was the largest sub-sector in manufacturing sector. It can be said that the industrial development situation in Zambia is only at the early stages of industrialisation.

According to data of external trade, imports of food/beverages and non-metallic products are relatively high. To reduce foreign exchange, these industries should be developed within Zambia in the future. Value added forecast by industry in 2005 and 2015 based on the above rates is shown in Table 4-2.

Table 4-2 Industrial Structure Forecast in Zambia

Value Added in Basic Value (K'Million)

Code	Description	1974	1980	1990	1993	2005	2015
230	Metal Ore Mining	542	907	9,817	140,334	231,081	318,448
210/290	Other Mining	9	16	400	2,623	4,319	5,952
2	Total Mining	551	923	10,217	142,957	235,400	334,400
311/2	Food	30	71	7,629	93,992	145,654	237,255
313/4	Beverages	25	39	4,191	51,630	80,007	130,323
31	Total Food, Beverages etc.	55	110	11,820	145,622	225,661	322,146
321	Textiles	8	40	1,237	9,489	13,313	17,5631
322	Wearing Apparel	15	27	835	6,405	8,987	11,855
323	Leather Products	4	14	333	2,554	3,584	4,728
324	Footwear	0	0	100	767	1,076	1,419
32	Total Textiles & Leather	27	81	2,505	19,215	26,960	35,566
331	Wood and Wood Products	7	10	473	3,927	5,726	7,795
332	Furniture	5	9	425	3,535	5,153	7,015
33	Total Wood & Furniture	12	19	898	7,462	10,879	14,810
341	Paper and Paper Products	6	12	1,453	4,912	7,185	9,807
342	Printing and Publishing	7	14	1,574	5,322	7,784	10,624
34	Total Paper and Printing	13	25	3,027	10,234	14,969	20,431
351	Basic Chemical	10	18	519	13,494	20,710	29,400
352	Chemical products	18	37	1,067	27,739	42,570	60,433
353/4	Petroleum & Coal Products	7	9	260	6,747	10,355	14,700
355	Rubber Products	11	16	333	8,654	13,281	18,855
356	Plastic Products	2	5	273	7,089	10880	15,445
35	Total Chemicals	48	85	2,452	63,724	97,795	138,833
361/2	Glass Products	1	4	497	5,391	8,685	12,830
369	Other Non-metallic Product	14	26	3,230	35,042	56,454	83,394
36	Total Non-metallic Product	15	30	3,727	40,433	65,139	96,223
37	TOTAL IRON AND STEEL	5	9	241	978	1,296	1,633
381	Metal Products	22	39	4,203	22,704	34,142	47,669
382	Machinery	8	14	1,509	8,150	12,256	17,112
383	Electrical Products	10	21	333	1,799	2,705	3,776
384	Transport Equipment	8	22	4,302	23,234	34,939	48,782
38	Total Metals & Machinery	48	96	10,347	55,887	84,041	117,339
39	Total Other Manufacturing	1	2	1,089	6,948	12,159	19,219
3	TOTAL MANUFACTURING	224	457	36,107	350,503	538,900	766,200

Notes: 1) Figures for 1974, 1980 and 1993 are current prices based on the Industrial Census.
2) Figures for 2005 and 2015 are constant prices at 1993 levels as estimated by the Team.

Manufacturing sector will increase by almost 220% in 2015 from the present level. Thus, this sector is a significantly important sector for Zambia. From this sector, "Food/Beverages" accounts for 42% of total manufacturing.

4.2 Regional Industrial Development

According to industrial statistics in 1990 given by CSO, there are 665 manufacturing enterprises with a total of 70,357 employees in the whole country. Industrial water consumption depends on industrialisation at both national and regional level. It is advantageous to estimate industrial water consumption at the regional and district level; therefore, the present industrial situation and future development frame should be drafted at the district level. The results of the present industrial accumulation and annual growth rate by Province and township are shown in Table 4-3.

Table 4-3 Manufacturing Distribution Ratio by District in 1990

District Name	Population (1990)	31 Food, Bever.	32 Textiles Leather	33 Wood & Furnit.	34 Paper & Printing	35 Chemi-cals	36 Non-Metallic	37 Iron & Steel	38 Metal & Machin.	39 Other Manufg	Total
LUSAKA PROVINCE	829,473	43.9%	38.3%	43.3%	51.1%	38.4%	49.0%	49.0%	27.7%	71.8%	41.2%
Lusaka	769,353	40.7%	35.5%	40.2%	47.4%	35.6%	45.5%	45.5%	25.7%	66.6%	38.2%
Chongwe	5,370	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.3%	0.2%
Kafue	43,801	2.3%	2.0%	2.3%	2.7%	2.0%	2.6%	2.6%	1.5%	3.8%	2.2%
Chilanga	9,126	0.5%	0.4%	0.5%	0.6%	0.4%	0.5%	0.5%	0.3%	0.8%	0.5%
Rufunsa	2,217	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%
Luangwa	1,606	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
COPPER BELT PROVINCE	1,112,637	21.1%	30.2%	44.2%	47.8%	56.0%	38.4%	45.9%	63.7%	28.2%	34.4%
Ndola	334,531	6.3%	9.1%	13.3%	14.4%	16.8%	11.6%	13.8%	19.2%	8.5%	10.4%
Masaiti	2,140	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Mpongwe	10,837	0.2%	0.3%	0.4%	0.5%	0.5%	0.4%	0.4%	0.6%	0.3%	0.3%
Chililabombe	48,055	0.9%	1.3%	1.9%	2.1%	2.4%	1.7%	2.0%	2.8%	1.2%	1.5%
Konkola	1,795	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%
Chingola	142,379	2.7%	3.9%	5.7%	6.1%	7.2%	4.9%	5.9%	8.2%	3.6%	4.4%
Mufulira	124,746	2.4%	3.4%	5.0%	5.4%	6.3%	4.3%	5.1%	7.1%	3.2%	3.9%
Kalulushi	31,474	0.6%	0.9%	1.3%	1.4%	1.6%	1.1%	1.3%	1.8%	0.8%	1.0%
Chambishi	9,945	0.2%	0.3%	0.4%	0.4%	0.5%	0.3%	0.4%	0.6%	0.3%	0.3%
Kitwe	288,592	5.5%	7.8%	11.5%	12.4%	14.5%	10.0%	11.9%	16.5%	7.3%	8.9%
Luanshya	118,143	2.2%	3.2%	4.7%	5.1%	5.9%	4.1%	4.9%	6.8%	3.0%	3.7%
CENTRAL PROVINCE	213,198	1.5%	17.3%	0.4%	0.0%	1.4%	9.5%	2.9%	0.0%	0.0%	5.0%
Kabwe	161,456	1.2%	13.1%	0.3%	0.0%	1.1%	7.2%	2.2%	0.0%	0.0%	3.8%
Chibombo	4,058	0.0%	0.3%	0.0%	0.0%	0.0%	0.2%	0.1%	0.0%	0.0%	0.1%
Chisamba	2,972	0.0%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%
Kapiri Mposhi	13,540	0.1%	1.1%	0.0%	0.0%	0.1%	0.6%	0.2%	0.0%	0.0%	0.3%
Mumbwa	11,015	0.1%	0.9%	0.0%	0.0%	0.1%	0.5%	0.2%	0.0%	0.0%	0.3%
Nampundwe	4,088	0.0%	0.3%	0.0%	0.0%	0.0%	0.2%	0.1%	0.0%	0.0%	0.1%
Mkushi	7,804	0.1%	0.6%	0.0%	0.0%	0.1%	0.3%	0.1%	0.0%	0.0%	0.2%
Serenje	8,265	0.1%	0.7%	0.0%	0.0%	0.1%	0.4%	0.1%	0.0%	0.0%	0.2%
NORTH WESTERN PROVINCE	54,320	0.6%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
Solwezi	26,223	0.3%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Mwinilunga	6,342	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Zambezi	5,941	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chavuma	1,798	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Kabompo	5,005	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mfumbwe	4,860	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
kasempa	4,151	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

District Name	Population (1990)	31 Food, Bever.	32 Textiles Leather	33 Wood & Furnit.	34 Paper & Printing	35 Chemicals	36 Non-Metallic	37 Iron & Steel	38 Metal & Machin.	39 Other Manufg	Total
WESTERN PROVINCE	75,741	0.8%	0.4%	3.7%	0.0%	0.0%	0.0%	0.0%	4.2%	0.0%	1.0%
Mongu	29,302	0.3%	0.2%	1.4%	0.0%	0.0%	0.0%	0.0%	1.6%	0.0%	0.4%
Limulunga	5,764	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.1%
Namushakande	1,771	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Lukulu	3,129	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%
kalabo	7,209	0.1%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.1%
Sikongo	1,659	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Kaoma	9,165	0.1%	0.1%	0.5%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.1%
Senanga	7,727	0.1%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.1%
Shangombo	1,599	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Sesheke	5,390	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.1%
Mulobezi	2,009	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
katima-Mulilo	1,017	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
SOUTHERN PROVINCE	211,984	20.7%	12.6%	7.1%	0.3%	1.3%	1.5%	2.2%	2.0%	0.0%	12.3%
Livingstone	76,875	7.5%	4.6%	2.6%	0.1%	0.5%	0.6%	0.8%	0.7%	0.0%	4.5%
Namwala	3,772	0.4%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Itezhi-Tezhi	5,027	0.5%	0.3%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.3%
Mazabuka	24,596	2.4%	1.5%	0.8%	0.0%	0.1%	0.2%	0.3%	0.2%	0.0%	1.4%
Magoye	2,331	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Nakambala	7,503	0.7%	0.4%	0.3%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.4%
Nega-nega	1,836	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Kafue-gorge	2,813	0.3%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Chikankata	3,912	0.4%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Monze	15,910	1.6%	0.9%	0.5%	0.0%	0.1%	0.1%	0.2%	0.2%	0.0%	0.9%
Chisekesi	1,675	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Choma	30,143	2.9%	1.8%	1.0%	0.0%	0.2%	0.2%	0.3%	0.3%	0.0%	1.7%
Batoka	1,445	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Pemba	2,170	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Mbabala	1,762	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
kalomo	8,386	0.8%	0.5%	0.3%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.5%
Zimba	1,351	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Siavonga	5,569	0.5%	0.3%	0.2%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.3%
Chirundu	2,072	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Gwembe	2,013	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Sinazongwe	2,006	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Maamba	8,817	0.9%	0.5%	0.3%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.5%
LUAPULA PROVINCE	83,126	5.4%	0.2%	1.3%	0.0%	2.9%	0.0%	0.0%	0.0%	0.0%	2.7%
Mansa	39,051	2.5%	0.1%	0.6%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	1.3%
Nchelenga	14,498	0.9%	0.0%	0.2%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.5%
Chiengi	1,900	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Kawambwa	3,882	0.3%	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Mwansabombwe	7,382	0.5%	0.0%	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.2%
Mwense	3,695	0.2%	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Samfya	12,718	0.8%	0.0%	0.2%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.4%

District Name	Population (1990)	31 Food, Bever.	32 Textiles Leather	33 Wood & Furnit.	34 Paper & Printing	35 Chemi-cals	36 Non-Metallic	37 Iron & Steel	38 Metal & Machin.	39 Other Manufg	Total
NORTHERN PROVINCE	118,301	5.3%	0.6%	0.0%	0.4%	0.0%	1.5%	0.0%	0.0%	0.0%	2.5%
Kasama	48,045	2.2%	0.3%	0.0%	0.2%	0.0%	0.6%	0.0%	0.0%	0.0%	1.0%
Kaputa	2,936	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Mbala	12,185	0.5%	0.1%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.3%
Mpulungu	2,739	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Mporokoso	4,818	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%
Luwingu	4,664	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%
Chilubi	1,366	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Isoka	8,596	0.4%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%
Nakonde	4,493	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%
Chinsali	7,509	0.3%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%
Mpika	20,950	0.9%	0.1%	0.0%	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%	0.4%
EASTERN PROVINCE	82,750	1.3%	0.3%	0.0%	0.4%	0.0%	0.0%	0.0%	2.3%	0.0%	0.9%
Chipata	52,213	0.8%	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	1.5%	0.0%	0.5%
Chama	3,474	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Lundazi	5,590	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.1%
Chadiza	3,031	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Katete	7,165	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.1%
Petauke	8,148	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.1%
Nyimba	1,684	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
kacholola	1,445	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
(National Total)	2,781,530	100.6%	100.0%	101.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.3%

Notes:
1) Distribution ratio is based on number of employees by type of industry and by township.
2) Ratio is calculated by the Team.
Source; Number of employees in 1990 is given by CSO.

Manufacturers are mainly located in Lusaka and Copperbelt Provinces which account for 75% of all manufacturing industry. In particular, Lusaka city is the most industrialised region in Zambia accounting for about 40% of total manufacturing industry. Secondly, Ndola city in Copperbelt accounts for about 10% of total manufacturing industry. Although the manufacturing share of Copperbelt is lower than Lusaka province, its share of "metal & machinery" and "chemicals" is larger than Lusaka province. This implies that Copperbelt is a more industrialised region than Lusaka Province. On the other hand, the least industrially developed province is North Western Province which accounts for only 0.3%.

Future regional industrial development is assumed based on the growth rates of industrial sub-sectors and district population combined with the present industrial accumulation by districts. The reason why population growth rate is employed for the assumption of industrial development is based on the fact that employment opportunities should be expanded to match increasing population growth rate.

4.3 Unit Water Consumption Rate

Unit water consumption rates vary widely from industry to industry and from country to country. To grasp unit water consumption rate by industrial type in Zambia, the Study Team conducted a questionnaire survey supported by DWA and ZACCI (Zambia Association of Chambers of Commerce and Industry) between February and April 1994. The number of

questionnaires answered by manufacturers was 139 samples which accounts for about 20% of manufacturers listed in the 1990 statistical data of CSO.

The assumed unit water consumption rates are categorised by sub-sector, as given by the two digit ISIC codes (International Standard Industrial Classification). In order to avoid discrepancies caused by differences in scale between those establishments who responded to the questionnaire survey and the national average in Zambia, the following weighting formula is employed for analysis of unit water consumption rate. The analytical results are shown in Table 4-4.

$$Ur = \sum_{i}^{i} \{AWC \times NAN / ANE\} / NME$$

Where,

- Ur: Unit water consumption rate by sub-sector (2 digit ISIC code)
- AWC: Average water consumption per sample (3 digit ISIC code)
- NAN: National average number of employees (3 digit ISIC code)
- ANE: Average number of employees per sample (3 digit ISIC code)
- *i*: Number of manufacturing establishments by industrial type (3 digit ISIC code)
- NME: Number of manufacturing establishments by sub-sector (2 digit ISIC code)

Table 4-4 Average Water Consumption Rate by Industry

ISIC Code	Industrial sub-sector	Number of Manufacturing Establishments	Number of Samples Collected	Collection Rate (%)	Weighted Average Consumption Rate (m^3/day)
31	Food, Beverage etc.	200	26	13	910.5
32	Textiles & Leather	125	10	8	84.6
33	Wood & Furniture	54	9	17	24.3
34	Paper & Printing	53	6	11	28.1
35	Chemicals	79	29	37	296.3
36	Non-metallic Products	28	12	43	57.1
37	Iron and Steel	17	3	18	10.9
38	Metals & Machinery	105	42	40	15.9
39	Other Manufacturing	4	2	50	5.1
3	Total Manufacturing	665	139	21	159.2

4.4 Industrial Water Demand in 2005 and 2015

4.4.1 Manufacturing Sector

Water demand of the manufacturing sector is estimated by using the following formula. The mining sector is dealt with separately below, because mining sector activity in Zambia is quite significant and solely operated by ZCCM.

$$MWDd = \sum_{1}^{n} (Ur \times NME) \times (1 + GR - WR)^{r}$$

Where,

MWDd : Manufacturing water demand by district
n : Number of manufacturing sub-sectors
Ur : Unit water consumption rate by sub-sector (2 digit ISIC code)
NME : Number of manufacturing establishments by sub-sector
GR : Annual growth rate by sub-sector
WR : Annual growth rate of water recycling
r : Years up to the targeted year

Generally, the water recycling rate in a country normally increases in parallel with industrial advancement. In this study, water recycling growth rate is set at 0.5% per annum in consideration of Japanese past performance which recorded an increase of 6.5% over 13 years (water recycling rate in Japan increased from 68.8% in 1976 to 75.3% in 1988). From the results of the above analysis, assumed water consumption volumes in 2005 and 2015 are shown in Table 4-5.

In 1990, the water consumption volume of Lusaka province was almost the same as that for Copperbelt province. The two provinces accounted for more than three quarters of total water consumption in the manufacturing sector. From the viewpoint of city or district level, Lusaka city is the highest consumer of industrial water (76,500 m^3/day) and accounted for almost one third of total water consumption (222,400 m^3/day) in the manufacturing sector in 1990. In second place, Ndola city at about 23,600 m^3/day accounted for almost 10% of total industrial water consumption. Other major users in Copperbelt province are Kitwe city and Chingola.

By 2015, the industrial water demand of Lusaka city will have increased by about 230% from the 1990 level, and will account for 40% of total manufacturing water demand. Ndola's manufacturing water demand will also increase; however, the rate of increase is slightly lower than for Lusaka city because of differing rates of industrialisation.

4.4.2 Mining Sector

Water consumption rates in the mining sector vary widely depending on type and capacity of processing plant. There are various mineral processing plant, such as concentrators, smelters, refineries and other mineral plants, located at the different ZCCM Divisions or mines. Therefore the present water consumption rates as given by ZCCM are applied for the mining sector and future water consumption is assumed as almost the same volume, because ZCCM expects to maintain annual copper production at the present level of 440,000 tons in future. It is noted that other potential development ores have been identified; however, water consumption rates are not mentioned because detailed development plans are not known at present. Resulting from the above, assumed water consumption volumes for the mining and manufacturing sectors are shown in Table 4-5 and summarised as follows:

		(1990)		(2005)		(2015)	
Mining	(1000m^3/day)	307.1	(58%)	307.1	(46%)	307.1	(41%)
Manufacturing	(1000m^3/day)	222.4	(42%)	366.7	(54%)	446.1	(59%)
Total	(1000m^3/day)	529.5	(100%)	673.8	(100%)	753.2	(100%)

Water consumption in the manufacturing sector will exceed the mining sector by the years 2005 and 2015. Water consumption in manufacturing sector will increase by almost 165% in 2005 and 200% in 2015 from the 1990 level. Water consumption of Copperbelt province, with most of Zambia's mining industry, accounts for almost 70% of the national total at present; this share will decrease to 67% by 2015. On the other hand, Lusaka Province's share will increase to 25% of the total in 2015 from 16% in 1990.

Table 4-5 Water Demand Forecast by Province and Main City

(Unit:1000m^3/day)

District Name	1990			2005			2015		
	Mining	Manufg	Total	Mining	Manufg	Total	Mining	Manufg	Total
LUSAKA PROVINCE		82.4	82.4		136.7	136.7		189.9	189.9
Lusaka		76.5	76.5		126.9	126.9		177.3	177.3
Chongwe		0.3	0.3		0.6	0.6		0.7	0.7
Kafue		4.4	4.4		7.3	7.3		9.3	9.3
Chilanga		0.9	0.9		1.5	1.5		1.9	1.9
Rufunsa		0.2	0.2		0.4	0.4		0.5	0.5
Luanga		0.2	0.2		0.3	0.3		0.3	0.3
COPPER BELT PROVINCE	290.6	78.5	369.1	290.6	127.8	418.4	290.6	140.7	431.3
Ndola		23.6	23.6		39.1	39.1		46.5	46.5
Masaiti		0.2	0.2		0.3	0.3		0.3	0.3
Mpongwe		0.8	0.8		1.3	1.3		1.6	1.6
Chililabombe	8.0	3.4	11.4	8.0	5.6	13.6	8.0	5.5	13.5
Konkola	50.0	0.1	50.1	50.0	0.2	50.2	50.0	0.2	50.2
Chingola	78.8	10.0	88.8	78.8	16.5	95.3	78.8	17.0	95.8
Mufulira	53.0	8.8	61.8	53.0	14.5	67.5	53.0	13.9	66.9
Kalulushi		2.2	2.2		3.7	3.7		4.4	4.4
Chambishi	23.4	0.7	24.1	23.4	1.2	24.6	23.4	1.4	24.8
Kitwe	25.4	20.4	45.8	25.4	33.6	59.0	25.4	36.7	62.1
Luanshya	52.0	8.3	60.3	52.0	13.7	65.7	52.0	13.8	65.8
CENTRAL PROVINCE	13.7	11.3	25.0	13.7	18.8	32.5	13.7	23.5	37.2
Kabwe	13.7	8.6	22.3	13.7	14.5	28.2	13.7	18.6	32.3
Chibombo		0.2	0.2		0.4	0.4		0.4	0.4
Chisamba		0.2	0.2		0.3	0.3		0.3	0.3
Kapiri Mposhi		0.7	0.7		1.2	1.2		1.3	1.3
Mumbwa		0.6	0.6		1.0	1.0		1.2	1.2
Nampundwe		0.2	0.2		0.4	0.4		0.4	0.4
Mkushi		0.4	0.4		0.7	0.7		0.8	0.8
Serenje		0.4	0.4		0.7	0.7		0.8	0.8

District Name	1990			2005			2015		
	Mining	Manuf'g	Total	Mining	Manuf'g	Total	Mining	Manuf'g	Total
NORTH WESTERN PROVINCE		4.6	4.6		7.7	7.7		9.1	9.1
Solwezi		2.2	2.2		3.7	3.7		4.7	4.7
Mwinilunga		0.5	0.5		0.9	0.9		0.9	0.9
Zambezi		0.5	0.5		0.8	0.8		0.9	0.9
Chavuma		0.2	0.2		0.3	0.3		0.3	0.3
Kabompo		0.4	0.4		0.7	0.7		0.8	0.8
Mfumbwe		0.4	0.4		0.7	0.7		0.7	0.7
Kasempa		0.3	0.3		0.6	0.6		0.6	0.6
WESTERN PROVINCE		7.4	7.4		12.4	12.4		13.3	13.3
Mongu		2.9	2.9		4.8	4.8		5.3	5.3
Limulunga		0.6	0.6		0.9	0.9		1.0	1.0
Namushakande		0.2	0.2		0.3	0.3		0.3	0.3
Lukulu		0.3	0.3		0.5	0.5		0.6	0.6
Kalabo		0.7	0.7		1.2	1.2		1.1	1.1
Sikongo		0.2	0.2		0.3	0.3		0.3	0.3
Kaoma		0.9	0.9		1.5	1.5		1.7	1.7
Senanga		0.8	0.8		1.3	1.3		1.3	1.3
Shangombo		0.2	0.2		0.3	0.3		0.3	0.3
Sesheke		0.5	0.5		0.9	0.9		0.8	0.8
Mulobezi		0.2	0.2		0.3	0.3		0.3	0.3
Katima-Mulilo		0.1	0.1		0.2	0.2		0.2	0.2
SOUTHERN PROVINCE	2.8	17.8	20.6	2.8	29.3	32.1	2.8	32.2	35.0
Livingstone		6.5	6.5		10.6	10.6		11.4	11.4
Namwala		0.3	0.3		0.5	0.5		0.6	0.6
Itezhi-Tezhi		0.4	0.4		0.7	0.7		0.9	0.9
Mazabuka		2.1	2.1		3.4	3.4		3.7	3.7
Magoye		0.2	0.2		0.3	0.3		0.4	0.4
Nakambala		0.6	0.6		1.0	1.0		1.1	1.1
Nega-nega		0.2	0.2		0.3	0.3		0.3	0.3
Kafue-gorge		0.2	0.2		0.4	0.4		0.4	0.4
Chikankata		0.3	0.3		0.5	0.5		0.6	0.6
Monze		1.3	1.3		2.2	2.2		2.4	2.4
Chisekesi		0.1	0.1		0.2	0.2		0.3	0.3
Choma		2.5	2.5		4.2	4.2		4.4	4.4
Batoka		0.1	0.1		0.2	0.2		0.2	0.2
Pemba		0.2	0.2		0.3	0.3		0.3	0.3
Mbabala		0.1	0.1		0.2	0.2		0.3	0.3
Kalomo		0.7	0.7		1.2	1.2		1.4	1.4
Zimba		0.1	0.1		0.2	0.2		0.2	0.2
Siavonga		0.5	0.5		0.8	0.8		0.8	0.8
Chirundu		0.2	0.2		0.3	0.3		0.3	0.3
Gwembe		0.2	0.2		0.3	0.3		0.3	0.3
Sinazongwe		0.2	0.2		0.3	0.3		0.3	0.3
Maamba	2.8	0.7	3.5	2.8	1.2	4.0	2.8	1.3	4.1

District Name	1990			2005			2015		
	Mining	Manuf'g	Total	Mining	Manuf'g	Total	Mining	Manuf'g	Total
LUAPULA PROVINCE		3.2	3.2		5.3	5.3		5.7	5.7
Mansa		1.5	1.5		2.5	2.5		2.7	2.7
Nchelenge		0.6	0.6		0.9	0.9		1.1	1.1
Chiengi		0.1	0.1		0.1	0.1		0.1	0.1
Kawambwa		0.1	0.1		0.2	0.2		0.2	0.2
Mwansabombwe		0.3	0.3		0.5	0.5		0.5	0.5
Mwense		0.1	0.1		0.2	0.2		0.2	0.2
Samfya		0.5	0.5		0.8	0.8		0.8	0.8
NORTHERN PROVINCE		9.5	9.5		15.9	15.9		17.1	17.1
Kasama		3.9	3.9		6.5	6.5		7.1	7.1
Kaputa		0.2	0.2		0.4	0.4		0.4	0.4
Mbala		1.0	1.0		1.6	1.6		1.6	1.6
Mpulungu		0.2	0.2		0.4	0.4		0.4	0.4
Mporokoso		0.4	0.4		0.6	0.6		0.7	0.7
Luwingu		0.4	0.4		0.6	0.6		0.6	0.6
Chilubi		0.1	0.1		0.2	0.2		0.2	0.2
Isoka		0.7	0.7		1.2	1.2		1.2	1.2
Nakonde		0.4	0.4		0.6	0.6		0.6	0.6
Chinsali		0.6	0.6		1.0	1.0		1.0	1.0
Mpika		1.7	1.7		2.8	2.8		3.3	3.3
EASTERN PROVINCE		7.6	7.6		12.7	12.7		14.6	14.6
Chipata		4.8	4.8		8.0	8.0		9.3	9.3
Chama		0.3	0.3		0.5	0.5		0.6	0.6
Lundazi		0.5	0.5		0.9	0.9		1.0	1.0
Chadiza		0.3	0.3		0.5	0.5		0.5	0.5
Katete		0.7	0.7		1.1	1.1		1.2	1.2
Petauke		0.7	0.7		1.3	1.3		1.5	1.5
Nyimba		0.2	0.2		0.3	0.3		0.3	0.3
Kacholola		0.1	0.1		0.2	0.2		0.3	0.3
(National Total)	307.1	222.4	529.5	307.1	366.7	673.8	307.1	446.1	753.2

Notes:
1) Figures in mining sector are based on ZCCM's information.
2) Chingola contains ZCCM's Nchanga division.
3) Kalulushi contains ZCCM's Chibuluma mine.
4) Luansha contains ZCCM's Baluba mine.

4.4.3 Case Study

Water consumption stated above is assumed based on Base Growth Case - Agricultural Expansion of projected GDP in the industrial (manufacturing) sector. In addition, the following case study of water consumption for Base Growth Case - Industrialisation and Low Growth Case of GDP projection, is described below. Average annual growth rates are calculated according to GDP projections for both the Industrialisation (maximum) and the Conservative (minimum) assumptions.

Table 4-6 Projected GDP in Max. and Min. Assumption

Projection Case	Projected GDP (K Million)			Ave. Annual Rate of Increase	
	1993	2005	2015	1993-2005	2005-2015
(1) Base Growth Case - Agricultural Expansion (Medium Assumption)	350.5	538.9	766.2	3.6%	3.6%
(2) Base Growth Case - Industrialisation (Maximum Assumption)	350.5	728.6	1,152.8	6.3%	4.7%
(3) Low Growth Case (Minimum Assumption)	350.5	454.8	534.7	2.2%	1.6%

The same formula is employed to estimate industrial water consumption for manufacturing sector. The projection results for the national total and for 3 cities and 9 municipalities are as shown in Table 4-7.

Table 4-7 Industrial Water Demand Forecast in Max. and Min. Cases

(unit:1000m^3/day)

City and Municipality	2005			2015		
	Min.	Medium	Max.	Min.	Medium	Max.
- Lusaka City	100.7	126.9	193.7	140.7	177.3	270.7
- Ndola City	31.1	39.1	59.8	37.0	46.5	71.1
- Chililabombwe	4.4	5.6	8.4	4.4	5.5	8.3
- Chingola	13.1	16.5	25.1	13.6	17.0	25.9
- Mufulira	11.5	14.5	21.9	11.1	13.9	21.1
- Kalulushi	2.9	3.7	5.6	3.5	4.4	6.7
- Kitwe City	26.8	33.6	51.2	29.2	36.7	55.8
- Luansha	10.9	13.7	20.8	11.0	13.8	21.0
- Kabwe	11.4	14.5	22.3	14.7	18.6	28.6
- Livingstone	8.5	10.6	16.1	9.1	11.4.	17.3
- Kasama	5.1	6.5	10.0	5.6	7.1	10.9
- Chipata	6.3	8.0	12.4	7.3	9.3	14.3
[Above Total]	232.7	293.2	447.3	287.2	361.5	551.7
[National Total]	291.8	366.7	557.5	354.8	446.1	678.4

Comparing GDP projection in 2015, the Base Growth Case - Industrialisation (1,152.8 billion Kwacha) stands at almost 50% higher than the Base Growth Case - Agricultural Expansion (766.2 billion Kwacha) and the Low Growth Case (534.7 billion Kwacha) stands at almost 30% less than the Base Growth Case - Agricultural Expansion. In the case of industrial water consumption, however, the Low Growth Case (minimum assumption) gives a figure almost 20% less than the Base Growth Case - Agricultural Expansion (medium assumption). Base Growth Case - Industrialisation (maximum assumption) shows almost the same differential as GDP of 50% higher than the Base Growth Case - Agricultural Expansion.

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF ZAMBIA
MINISTRY OF ENERGY AND WATER DEVELOPMENT

THE STUDY

ON

THE NATIONAL WATER RESOURCES MASTER PLAN

IN

THE REPUBLIC OF ZAMBIA

FINAL REPORT

SUPPORTING REPORT [G]

CURRENT WATER USE SURVEY

OCTOBER, 1995

YACHIYO ENGINEERING CO., LTD.
(YEC)

THE STUDY ON NATIONAL WATER RESOURCES MASTER PLAN
IN THE REPUBLIC OF ZAMBIA

SUPPORTING REPORT (G)
CURRENT WATER USE SURVEY

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CHAPTER 1 INTRODUCTION

This supporting report describes the Current Water Use Survey undertaken as part of the Study on the National Water Resources Master Plan by a local consultant on behalf of the JICA Study Team. The aims and objectives of the survey, the survey methodology and the results and conclusions are described in detail in the following chapters.

The survey has identified the areas of maximum water use in Zambia and has provided data for use in the sections on current and future water balance in the main report. It has assessed the current situation regarding the administration of water rights for the abstraction of surface water from rivers. An understanding of the status and operational problems of the existing water supply projects, based on the replies to a questionnaire survey, has been gained. Overall, the current water use survey has provided valuable information on the level of water consumption in Zambia at the present time and has greatly assisted the prediction of future demands necessary for planning of water resources development.

The valuable assistance of the hard working staff of the Water Development Board, in particular, Mr J. Chilo and Mr A. Mondoka, to both the JICA Study Team and the local consultant is gratefully acknowledged. The efforts of the staff of the local consultant, Rankin Engineering, in the collection of data and the undertaking of the extensive questionnaire surveys are also gratefully acknowledged. Particular thanks to Mr V. Alavian of Rankin Engineering are also due for his valuable advice and professional management of what proved to be an arduous task to collect so much data in such a short time from across the whole of Zambia.

CHAPTER 2 AIMS OF THE CURRENT WATER USE SURVEY

The overall aim of the Current Water Use Survey was to assess the existing situation in the Republic of Zambia with regard to the supply of and demand for water. This information is necessary for the National Water Resources Master Plan to identify areas where there is currently a shortfall in the amount of water supplied, and to predict which areas are likely to experience difficulties in the future.

The current level of water use and the condition of existing water supply facilities was evaluated from several surveys undertaken on behalf of the Study Team by a local consultant. These surveys included the collection of data from the existing Water Rights records, a questionnaire survey of water supply scheme managing bodies and a questionnaire survey of large scale irrigation projects. Collection of socio-economic data related to current water use was also included in the survey. The local consultant was also required to visit water supply and irrigation projects, as well as municipal and district councils and provincial government offices.

CHAPTER 3 OBJECTIVES OF THE SURVEY

There were five main objectives of the Current Water Use Survey undertaken as part of this National Water Resources Master Plan Study. These objectives are outlined briefly below and then the survey methodology for each of the objectives is described in detail in the following chapter.

1. WDB Water Rights Records
   The Water Development Board (WDB) has records of approximately 4000 Water Rights granted over the last thirty years for the abstraction of surface water from Zambia's rivers. The objective of the existing water rights survey was to extract relevant information from each of the record files and input this data to a computer database. The database was then analysed to give an estimate of the volume of water currently used for domestic water supply, agricultural water supply (for both irrigation and stock watering), industrial water and hydropower generation.

2. Domestic Water Supply Projects
   Domestic water supply projects in Zambia are largely managed by either the DWA or local authorities, such as city, municipal or domestic councils, under the Ministry of Local Government and Housing (MLGH). In addition, there are two semi-autonomous water supply companies serving Lusaka and Chipata, and other water supply projects operated by ZCCM and ZESCO. The objective of this section of the survey was to compile a detailed inventory of all existing water supply projects and to identify the current level of supply and condition of the facilities. Questionnaire forms were distributed by the local consultant to all known managing bodies and the information from the replies received was input to computer database.

3. Irrigation Water Supply
   Lists of known large scale irrigation projects and small holder schemes were obtained from the Department of Agriculture of the Ministry of Agriculture, Food and Fisheries. The objective of the irrigation water supply survey was to obtain additional data to be used in the Agriculture and Irrigation sections of the Master Plan Study. Questionnaire survey forms were sent to project managers and the information from the replies received was analysed as part of the Irrigation study.

4. Socio-Economic Survey
   The objective of the socio-economic survey was to collect additional information related to current water use. This information included the performance of the regional economy, inventories of social infrastructure and housing for all urban townships, and details of regional and urban development plans. Questionnaire survey forms were sent to the nine provincial Offices of the President.

5. Field Survey Trips
   To supplement and verify the information obtained from the various questionnaire surveys outlined above, the local consultant and the Study Team made several field survey trips throughout Zambia. The main objective of these field trips was to overcome the communication difficulties, such as faulty telephone / facsimile lines and unreliable postal services, and to encourage and assist the bodies concerned to provide the information required.

CHAPTER 4 SURVEY METHODOLOGY

4.1 Survey of Existing Water Rights Records

The Ministry of Energy and Water Development (MEWD) is responsible, through the Water Development Board (WDB), for the issue and administration of all Water Rights for the abstraction of surface water from Zambia's rivers. It was originally thought that the WDB held records of approximately 4-5000 Water Rights granted over the last thirty years. However, in the course of the survey, it soon became apparent that the actual number of records was considerably less. The objective of the existing water rights survey was to extract relevant information from each of the record files and input this data to a computer database. The database was then analysed to give an estimate of the volume of water currently used for domestic water supply, agricultural water supply (for both irrigation and stock watering), industrial water and hydropower generation.

The local consultant's staff were based in the Water Development Board (WDB) office for a period of about one month. During that time, all the available Water Rights records that could be located in the Water Board Registry, the various Water Board offices and also the Land Registry office were reviewed and the relevant data abstracted to the survey form. A copy of the survey form is included in the Appendix.

Although the records of existing Water Rights held in the WDB Registry are numbered as high as 5200, the actual number of record files found was only about 1830. In addition, a further 500 or so Water Right numbers were listed in the register but the location of the files for these records could not be determined. The procedure for Water Right application and allocation, and possible reasons for the high number of missing records, are discussed in Chapter 5.

The local consultant developed a database programme (dBase IV) to input the required data from the Water Rights records to computer. Analysis of the 1830 records was undertaken by the Study Team and corrections to the data were made where necessary. The results of the analysis are presented in Chapter 5 and a printout of the Water Rights database is included in Data Book 5.

4.2 Survey of Water Supply Projects

The main objectives of the survey of water supply projects were to compile a detailed inventory of all existing domestic water supply schemes, and to identify the current level of supply and condition of the facilities.

Domestic water supply projects in Zambia are currently managed by either DWA or local authorities, such as city, municipal or domestic councils, under the Ministry of Local Government and Housing (MLGH). In addition, there are two semi-autonomous water supply companies serving Lusaka and Chipata, and other water supply projects operated by ZCCM and ZESCO. Lists of known schemes were obtained from DWA and MLGH and a total of 85 water supply projects were identified. The number of projects operated by each of the managing bodies is summarised Table 4-1 and the location of the projects is shown in Figure 4-1.

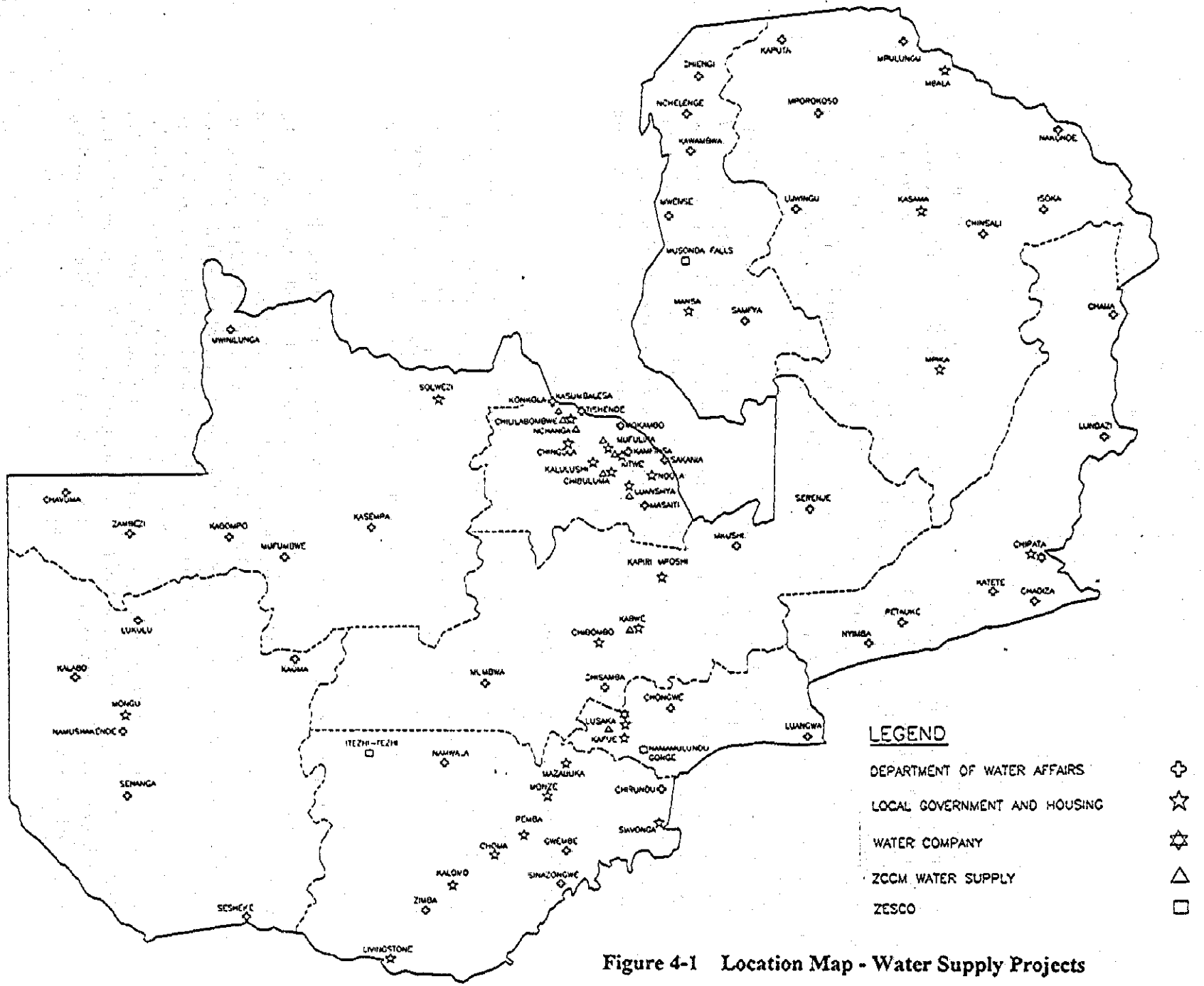

Figure 4-1 Location Map - Water Supply Projects

Table 4-1 Number of Water Supply Projects

Managing Body	No. of Projects
DWA	46
Council	25
ZCCM	9
ZESCO	3
Water Co.	2
TOTAL	85

The local consultant was responsible for the distribution and collection of the survey questionnaire forms to all known managing bodies. A copy of the questionnaire form is included in the Appendix. In order to ensure the best possible response to the survey, the Study Team worked closely with the local consultant and letters of support from both DWA and MLGH were obtained to accompany the survey forms. The Study Team also forwarded the questionnaire to ZCCM management prior to the field survey trip to the Copperbelt, and distributed the forms to ZESCO managed schemes via the SADDC Project Office.

As with the Water Rights records survey, the local consultant developed a database programme (dBase IV) to input the data from the completed questionnaire forms to computer. A total of 72 replies to the questionnaire survey were received from the 85 water supply projects identified - this represents a response rate of almost 85%. A list of the projects and analysis of the data from the questionnaire forms is included in Chapter 5. Summaries of the completed questionnaire forms received by the local consultant are included in Data Book 5.

4.3 Survey of Irrigation Projects

The survey of large scale governmental irrigation projects was included in the current water use survey to supplement a separate survey of Zambian farmers undertaken as part of the agriculture and irrigation sections of the Master Plan Study. A list of large scale irrigation projects was obtained from the Department of Agriculture (DOA) and questionnaire survey forms were sent to each of the schemes. A copy of the questionnaire is included in the Appendix.

From the list of ten large scale projects, replies to the questionnaire were received from six and the local consultant visited four of the schemes during the field survey trips. The irrigation projects visited were Mpongwe Developments in Central Province, Zambia Coffee at Kasama in Northern Province, and Kawambwa Tea and Mununshi Banana Estates in Luapula Province. In addition, the Study Team also visited some of these projects and also Nakambala Sugar Estates and Masstock Farm. The completed questionnaire forms were copied to the agriculture and irrigation experts for inclusion in those sections of the Study. The list of large scale irrigation projects and some key information from the replies are presented in Table 4-2. The location of the irrigation projects is shown in Figure 4-2. For the projects which did not reply to the questionnaire, estimates made by the local consultant have been included.

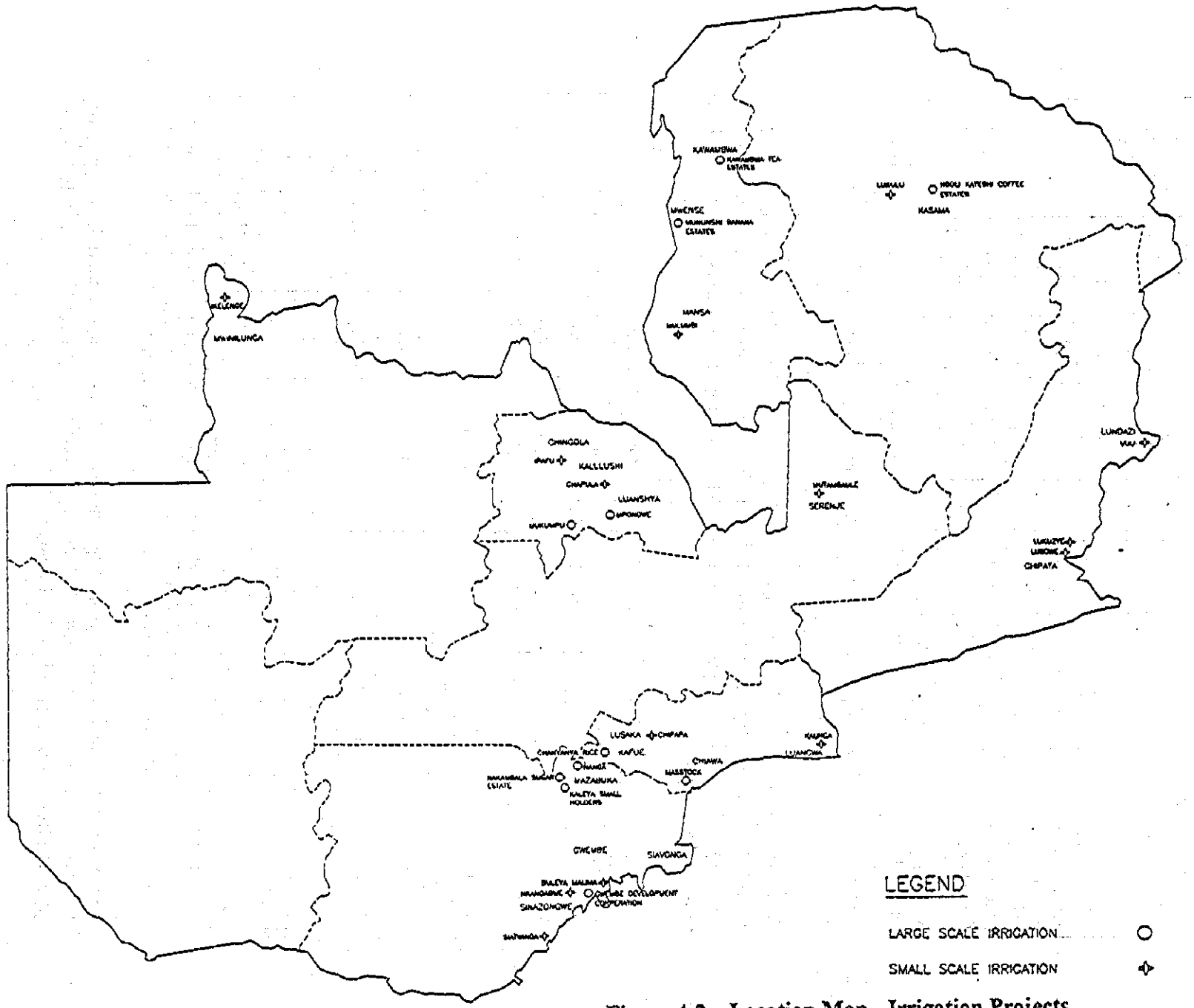

Figure 4-2 Location Map - Irrigation Projects

Table 4-2 Large Scale Irrigation Projects

Name of Project	Province	Water Use (m^3/sec)	Source	Area (ha)	Crops
Nanga	Southern	1.75	Kafue River	600	1,2,3
Mpongwe	Central	0.97	Groundwater	1,300	3,4,2
Zambia Coffee	Northern	0.21	Lukupa River	174	2
Kawambwa Tea	Luapula	0.66	Luano River	453	5
Kaleya	Southern	0.25	Kafue River	250	6
Nakambala	Southern	12.74**	Kafue River	10,400	6
Masstock	Lusaka	1.25*	Kafue River	1,200	3,1
Gwembe	Southern	2.20*	Lake Kariba	2,200	- - -
Mununshi	Luapula	0.05*	Mununshi River	50	7
Mukompu	Copperbelt	- - -	- - -	- - -	- - -

Notes : Crops : 1 = cotton 2 = coffee 3 = wheat 4 = soybean 5 = tea 6 = sugarcane 7 = banana
* estimated by local consultant
** Nakambala Sugar Estates provides water to Kaleya Smallholders and Mazabuka council

The local consultant also obtained a list of small scale irrigation projects from the DOA and information on these projects was extracted from the ASIP report on the agricultural sector dated July 1994. Table 4-3 shows the list of small scale irrigation projects and the key data from the ASIP report.

Table 4-3 Small Scale Irrigation Projects

Name of Project	Province	Water Use (l/sec*)	Source	Area (ha)	Crops
Ikalenge	N/Western	210	Stream	300	Pineapples, coffee
Lukulu	Northern	2,100	River	3,000	Wheat, coffee, veg., citrus
Kaninga	Lusaka	20	Stream	20	Veg., maize
Mulumbi	Luapula	7	River	10	Vegetables
Mutambaule	Central	7	Stream	10	Veg., maize
Buleya Mulima	Southern	65.5	Lake Kariba	65.5	Veg., maize
Chapula	Copperbelt	14	Stream	20	Veg. citrus
Chipapa	Lusaka	10	Dam, River	10	Vegetables
Ipafu	Copperbelt	56	Stream	80	Veg., maize
Nkandawe	Southern	15	Dam	15	Veg., maize
Lukuzye	Eastern	3	Dam	3	Veg., maize
Siatwinda	Southern	18	Lake Kariba	18	Veg., maize
Vuu	Eastern	20	Dam	20	Veg. citrus
Lusowe	Eastern	5	Dam	5	Veg., maize

Note : Water use estimated by the local consultant based on average requirements of 1.0 l/sec/ha for Southern, Central, Western and Eastern Provinces; 0.7 l/sec/ha was used for other provinces. Water use shown represents the maximum usage if all areas are under irrigation.

Detailed analysis of the irrigation project questionnaires has not been undertaken as part of the current water use survey. For further information on agricultural water use, refer to the Supporting Reports on Agriculture and Irrigation.