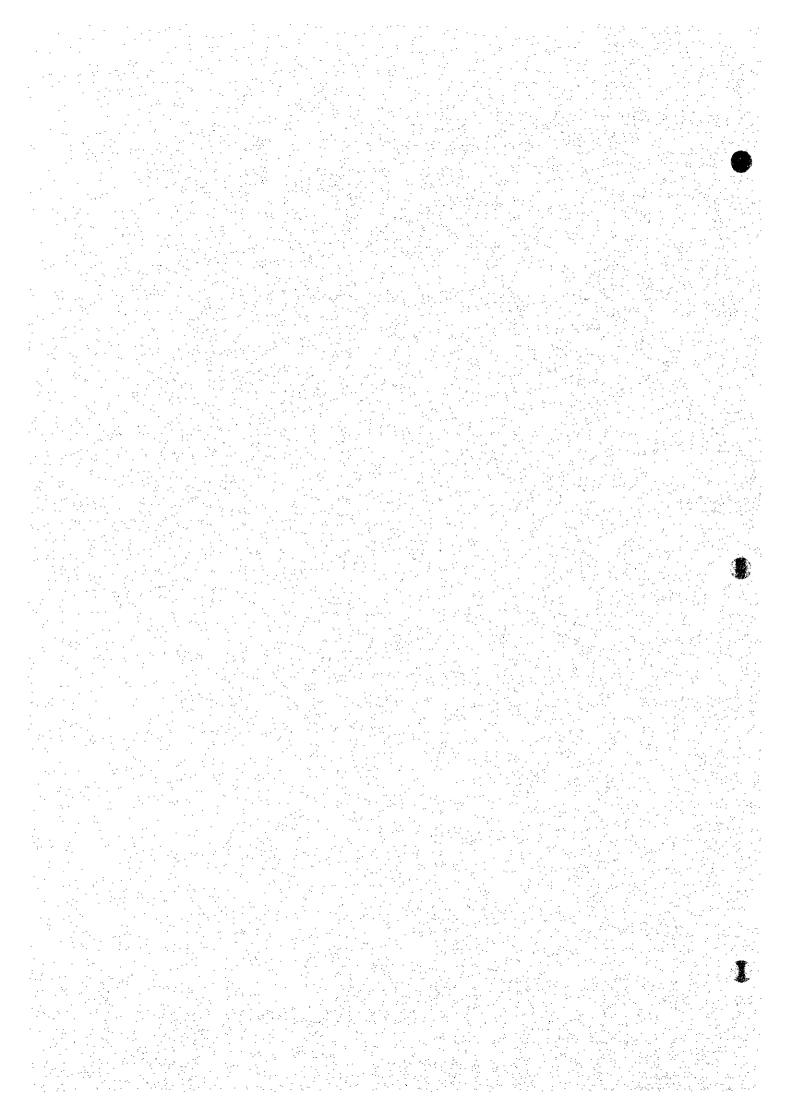
### THE STUDY ON WATER SUPPLY FOR SEVEN TOWNS IN EASTER PROVINCE IN THE REPUBLIC OF KENYA

APPENDIX K

POPULATION AND WATER DEMAND PROJECTIONS





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### 1. POPULATION

### 1.1 Baseline Situation and Census Results

National population censuses have been held in Kenya every ten years since 1969. Each census has covered the whole country in detail and the results have been the primary basis for national projections and planning.

The national census figures were therefore assessed for every sub-location within each of the water supply projects. Information from the 1969, 1979 and 1989 censuses were used in the analysis.

Due to widespread changes in sub-location boundaries, each sub-location growth rate was adjusted appropriately to allow for changes in area.

It was found, especially in the smaller areas, that the growth rates between the 1969 and 1979 census, and the 1979 and 1989 census indicated considerable changes in short term trends, but that the longer term growth rates indicated from the 1969 and 1989 census provided a more uniform trend that was in fairly close agreement with District and National trends and predictions. This is consistent with the assumption that reliability and accuracy of data increases with the length and quantity of data, and suggests that the growth rates obtained from assessment of the 1969 and 1989 population figures would be more reliable than using the shorter term between the 1979 and 1989 censuses.

The National and District Growth rates between 1969 and 1989 are indicated below,

Table K.1.1 National and District Population Growth Rates

	1969 to 1989 Annual Growth Rate
National Growth Rate	3.43 %
Meru District Growth Rate	3.12 %
Isiolo District Growth Rate	4.31 %

(Note: rates adjusted where appropriate to suit changes in administrative boundaries).

These figures indicate that population growth rates in Kenya, during the twenty years between 1969 and 1989, have been among the highest in the world. Since the 1989 census, there has been no similar widescale and detailed population survey, although a number of local population estimates have been made. These however do not give sufficient justification for adopting alternative growth characteristics. Therefore, the current (1997) population levels have been estimated using the average 1969-1989 annual growth rates.

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The exception being Maua where, due to raw water source constraints, the supply area is limited to the urban areas of Amwathi sub-location only. Since the growth characteristics of urban areas is different from rural areas, the growth rate for the whole sub-location can not be applied in this instance. A higher growth rate has therefore been assumed to allow for the higher level of urbanisation in the supply area and also due to the location of the new District Offices close to the supply area.

Details by sub-location of the 1969, 1979 and 1989 populations and growth rates, adjusted for changes in sub-location boundaries, have been integrated to provide appropriate figures for the individual scheme areas as given in *Table K.1.2*.

Table K.1.2 1989 Scheme Populations and Current Population Estimates.

Project	Кепуа	Eastern Province	Meru	Nkubu	Isiolo	Chuka (1)	Chogoria	Maua (2)	Tigania
1989 population	21,443,636	3,768,677	125,191	6,881	18,658	62,784	25,148	3,223	51,826
1969-1989 annual									
growth rate	3.4%	3.65%	3.6%	3.5%	4.2%	2.7%	3.4%	3.4%	2.4%
1997 population	28,000,000	5,020,000	165,980	9,471	25,679	81,034	32.134	5,537	63,891

Notes (1) Chuka population includes for additional area outside supply area, for which water will be delivered from the proposed treatment plant.

### 1.2 Future Projections

Future population projections were estimated after consideration of the above baseline figures together with a review of a number of past studies and reports and have also taken a number of additional factors into account, including:

- 1) Analysis of past census results and trends
- 2) District Development Plans
- 3) National Master Water Plan
- 4) Water Resources Assessment Project for Meru and Isiolo Districts
- 5) Local development
- 6) Population pressures and migration
- 7) Land potential
- 8) Government population policies







<sup>(2)</sup> The growth given rate for Maua is the inter-censal growth rate for the whole of Amwathi sub-location. Maua supply area however is limited to the urban areas within the sub-location. A higher growth rate has therefore been applied to arrive at the current population.

### (1) Census Results

As discussed above, an analysis of the census results has been used to estimate the current population levels for each of the schemes. They have also been used, together with levels of urbanisation given by the WRAP project, to estimate the growth rate of different categories of water supply consumers, as discussed below.

The population distribution for each supply area was calculated by integrating the housing and land classification, (as defined in the 1986 Design Manual), for each sub-location contained within each scheme. The results are indicated below.

Table K.1.3 Distribution of Land and Housing Classification for Projects

Land Classification		Meru	Nkubu	Isiolo	Chuka	Chogoria	Maua	Tigania
Rural	High	72%	48%	0%	74%	94%	34%	54%
	Medium	0%	0%	0%	21%	0%	51%	16%
	Low	0%	0%	33%	0%	0%	0%	30%
Urban	High	3%	8%	3%	0%	0%	0%	0%
	Medium	8%	26%	13%	2%	3%	6%	0%
	Low	17%	18%	50%	3%	3%	9%	0%

Source: WRAP District Water Assessment Reports for Meru and Isiolo Districts.

Comparing the above results with *Table K.1.2*, it can be seen that a correlation exists between growth rate and degree of urbanisation, confirming that urban areas are growing at a higher rate than rural areas and, that the adoption of different growth rates for urban and rural areas is a valid approach. A statistical analysis of the figures indicates that the historic trend, averaged over the supply areas can be represented by:

Annual growth rate = 2.2% x % urbanization + 2.8%

This formula implies the following average growth rates for totally rural and totally urban areas within the scheme supply areas:

1) Rural population growth rate: 2.8% per annum

2) Urban population growth rate: 5.0% per annum

This average urban growth rate is below those adopted by both the National Master Water Plan and the WRAP project as indicated in the following sections.

The rural growth rate found from the analysis of census figures for the 7 schemes is significantly higher than that used by the NWMP but, considering most of the rural area is high potential land, the growth rate is lower than that adopted by the WRAP project.

### (2) District Development Plans

In preparing the District Development Plans for future development, other factors such as land potential, population densities, agricultural, commercial and industrial trends are taken into account. The respective projected growth trends adopted by the different Districts covered by this project are given below:

Table K.1.4 District Development Plan Growth Rates

Development Plan		Growth rates adopted						
	1979-1993	1993-1994	1994-1996					
Tharaka-Nithi	3.96 %	3.54 %	3.50 %					
Meru	3.34 %	3.28 %	3.37 %					
Isiolo	4.87 %	4.87 %	4.87 %					

In each case, it would appear that these growth rates adopted for the District Development Plans are slightly higher than the historic growth rates found from the 1989 census results.

### (3) National Water Master Plan (1992)

The National Water Master Plan projected population growth rates per Location for the whole of Kenya. These projections differentiated between urban and rural growth. The growth rates adopted for the Master Plan appropriate to the different water supply projects under this study are indicated below:









Table K.1.5 NWMP Growth Rates

Project	1990-2000	1990-2000	2000-2010	2000-2010
	Rural growth	Urban growth	Rural growth	Urban growth
Meru	2.26%	9.35%	1.9%	5.2%
Nkubu	2.26%	9.35%	1.9%	5.2%
Isiolo	0.71 %	12.9 %	4.0%	6.0%
Chuka	2.26%	7.5%	1.9%	4.15%
Chogoria	2.26%	N/A	1.9%	3.1%
Maua	2.26%	7.5%	1.9%	4.15%
Tigania	2.26%	N/A	1.9%	N/A

These rates are generally lower for rural areas and higher for urban areas than those found from the census results. After allowing for the relative degree of urbanization, the overall growth rate is slightly lower than historic growth rates. However, the principal of adopting different growth rates for urban and rural populations is an improvement in projection technique over the use of an average growth rate applied to the whole District. This is particularly true when, as in the present study, it is required to predict the future spatial distribution of population in areas with different degrees of urbanisation. The projections also indicate a declining growth rate for the future, which reflects Government policy to slow down the present very high level of population increase.

### (4) Water Resources Assessment Study (1991)

In 1991 The Water Resources Assessment and Planning Project (WRAP) submitted comprehensive water resources assessment studies for both Isiolo and Meru Districts. These studies projected population and water demand estimates per Sub-Location using a number of different categories of urban and rural population. These projections are therefore more detailed than either the District Development Plan or the National Master Water Plan. For projection purposes, standardised growth rates were used for different housing and land categories, as indicated below:

Table K.1.6 WRAP Growth Rates

	Meru District (Scenario 1)	Isiolo District
Meru Municipality	4.2%	
Isiolo Town		5%
Other Urban centers	7.2%	
Rural centers		5%
High potential rural areas	4.0%	4.0%
Medium potential rural areas	3.5%	4.0%
Low potential rural areas	2.5%	4.0%

The 1989 census figures, which indicate slightly lower growth rates than the above, were published after the study had been completed. For this reason, the WRAP Meru Scenario 2, which indicated even higher growth rates has not been included in the table.

The advantage of this method of using different growth rates for different areas of land potential and urban development is that the resultant overall growth rate adjusts automatically to suit the characteristics of different areas. In addition, the different classifications were chosen to correspond with water service levels defined in the 1986 MOWD Design Manual which are still valid. They can therefore be used directly to assist water demand, revenue and tariff calculations.

Disadvantages of the WRAP method include the need for prior knowledge of the distribution of land and housing classifications in each sub-location, and that it applied a constant growth rate over the design period.

However, it is relatively easy to incorporate changes in growth rate over the design period. Also, the WRAP study itself investigated the whole area and defined the distribution of land and urban development for each sub-location, using a base year of 1988. Therefore, if the WRAP population distribution characteristics are used as 1988 baseline conditions, future projections can be readily made by application of selected appropriate growth rates for each population category.

### (5) Local Development

The impact of localised development plans need to be superimposed on the background historical growth characteristics of areas. There are two important







developments currently taking place in the supply areas, due to the newly formed Districts of Tharaka-Nithi and Nyambeni.

The location of the new District offices for Tharaka Nithi at Chuka Town, and for Nyambeni close to Maua Town, will have a significant impact on the development of these towns. Rapid growth is already evident in Chuka by the intense construction activity taking place in, and around, the municipality. The District Planning Officer for Tharaka Nithi District is projecting an annual growth rate of 12% for Chuka Town which, judging by the existing construction activity, would appear to be justified. The new District Offices for Nyambeni District have been proposed to be located about 4 km north of the centre of Maua Town. It is outside the area that can be served by this project. Nevertheless, considerable growth of the town is expected to result, and an annual growth rate of 7% per annum has been adopted.

### (6) Population Pressures and Migration

The high population growth rates in the country are leading to high rural population densities placing an increased pressure on the limited agricultural land available. The socio-economic survey indicated that currently 60% of households in the supply areas live on plots of less than 2 acres, with an average family size of 7.4.

Current annual growth rates of around 3.5% will result in roughly doubling the population over 20 years or, halving the land available per household.

To avoid the increased poverty that would result from this pressure on land, a number of changes are expected to take place: agricultural production will become more efficient, there will be a tendency towards industrialisation encouraging migration to towns, and the rural population growth will slow.

The impact of this process is already evident by the relatively high urban population growth rates compared to rural areas.

However, this migration itself creates pressures on land around the urban areas resulting in high urban land and rental costs and will result in growth of satellite areas around the urban centres, where people can live in cheaper housing but still in commutable distance. The current growth of Nkubu, located 12 km south of Mcru, would appear to be as a result of this process.

### (7) Land Potential

The population density that agricultural land can sustain depends upon its agricultural potential. *Table K.1.3* shows that, apart from Isiolo, the land in the supply areas are generally high agricultural potential, and can therefore support relatively high population densities.

However, past attempts to calculate the land carrying capacity for different categories of land have not been successful. This study has therefore adopted a similar approach to the WRAP project which logically suggested that growth will be distributed over the rural areas, with more constraint on growth in the lower agricultural potential areas.

### (8) Government Policy

The Government is concerned over the high population growth rate in the country, and the impact it will have, if not restrained, on the environment and on household income. It therefore wishes to see the present high population growth rates lowered, and has introduced a number of measures, such as using advertisements and educational means to try and reduce the growth rate.

However, in an environment where life expectancy has been historically low, large family units have been needed to ensure adequate future household labour. There are therefore very fundamental reasons behind the large family culture which exists in Kenya and many other developing countries, and to ask a Kenyan farmer to limit his family size is similar to asking someone in the developed world to work without a insurance and a pension arrangement.

Without more direct incentives therefore, the existing culture will not change rapidly.

### (9) Projections

Generally, based on the analysis of historic data, growth rates were found to be influenced by the degree of urbanization within the individual supply area. It was also assumed that the current high population growth rates will slow down over the design horizon in response to Government population policy. However, due to population pressure on rural land, the reduction in growth would be felt mostly in the rural areas, and that the urban areas would continue to grow at similar rates to present.







SUPPORTING REPORT

The final projections have been based on consideration of the above factors. The format is similar to that developed for projections by the WRAP project. Growth rates were assumed to vary gradually over the plan horizon using the figures given below:

The growth rates adopted for future projections varied with the particular circumstances.

Table K.1.7 Annual Population Growth Rates for Household Categories

Scheme	Year		Rural			Urban	A
		High	Medium	Low	High	Medium	Low
		Potential	Potential	Potential	Class	Class	Class
General	1997	3.0%	2.5%	2.0%	5.0%	5.0%	5.0%
Contrac	2000	2.5%	2.0%	1.0%	5.0%	5.0%	5.0%
	2010	2.0%	1.0%	1.0%	5.0%	5.0%	5.0%
Chuka	1997	3.0%	2.5%	2.0%	11.5%	11.5.0%	11.5%
Onana	2000	2.5%	2.0%	1.0%	12.0%	12.0%	12.0%
	2010	2.0%	1.0%	1.0%	7.0%	7.0%	7.0%
Maua	1997	3.0%	2.5%	2.0%	7.0%	7.0%	7.0%
Mada	2000	2.5%	2.0%	1.0%	7.0%	7.0%	7.0%
	2010	2.0%	1.0%	1.0%	7.0%	7.0%	7.0%

The resultant detailed annual projections for each land and housing category for each scheme are given in the tables at the end of this chapter, and are summarised below:

Table K.1.8 Population Projections

Year	1989	1997	2000	2010
Project				
Meru	125,191	165,980	183,527	251,668
Nkubu	6,882	9,471	10,648	15,611
Isiolo	18,658	25,679	29,029	43,648
Chuka (I)	31,265	41,502	46,238	64,433
Total	62,784	81,034	88,861	116,577
Chogoria	25,148	32,134	34,920	44,376
Maua	3,223	5,537	6,763	13,344
Tigania (2)	51,826	63,891	68,891	83,121

Notes (1) Chuka intake and treatment plant to be sized for a larger area than required to serve the Municipal area alone.

(2) Figures for new Tigania scheme only

### 1.3 Livestock Projections



Numbers of existing livestock within the supply areas have been taken from a number of sources:

- 1) The livestock census conducted by WRAP in Meru Districts in 1988 in collaboration with the district local administration for each sub-location,
- 2) The socio-economic survey results,
- 3) Discussions with local District Officers.

The results of these exercises are shown below, using the following conversion factors in assessing the number of Livestock Units:

1 Livestock unit = 1 Grade Cow = 3 indigenous cows = 15 sheep or goats. Poultry were not included, but camels have been accounted for assuming 1 camel = 3 livestock units.

Table K.1.9 Estimates of Existing Livestock Numbers as Livestock Units per 1000 Population

Project	WRAP	District Water Office	Socio- economic survey
Meru	202		250
Nkubu	191		226
Isiolo	4-	1206	235
Chuka	267		231
Chogoria	209		319
Maua	80		210
Tigania	194		226

In most cases, there is a fairly close agreement between the figures given by WRAP and by the socio-economic survey, although the survey findings generally indicate a slightly higher level of livestock ownership.

WRAP did not produce a Livestock figure for Isiolo. The DWO's estimate looks high in comparison to the other figures but is due to the fact that it reflects the nomadic nature of the surrounding environment, and has therefore been adopted rather than the survey figure, which reflects the permanent livestock levels.

The WRAP study findings were based on a much larger census population than this study's survey and should therefore be more accurate. They have been adopted as baseline levels for future projections.

The WRAP studies, after consultation with the various District Livestock Officers used two growth scenarios. Scenario 1 adopted a uniform growth rate for livestock of 2.0% per







annum. Scenario 2 used higher initial growth rates of up to 6% depending upon land potential, but declining in the future. The sensitivity of the different growth rates to overall water demand were investigated, but as the livestock water demand represented only a small percentage of the total, the sensitivity of the overall water demand projections to different livestock growth rate assumptions was found to be virtually nil. A uniform growth rate of 2.0%, was therefore adopted for present purposes, using the 1988 WRAP figures per sub-location for livestock numbers, except for Isiolo, where the figures obtained from the District Offices were used.

### 1.4 Industry

Service Control

The supply areas are generally predominantly rural in character, except for the relatively small urban centers where economic activity is concentrated on commercial trading, shops, bars etc. There are some isolated industries in the rural areas which are mainly coffee and tea factories or timber mills.

The coffee factories are a major water user and obtain large quantities of water from surface water sources, but return most of this water to the rivers, although often in a polluted state. They do not wish to connect to piped water supply schemes, since they do not require good quality treated water, the cost of which would be prohibitive. Their activities however do require monitoring and control.

Meru Town is the exception. It has a significant industrial base which is likely to grow. Current industries include Milling (4), Cotton, Fruit processing, Milk Processing, Animal feed industry, Timber manufacturers (5), Coffee (5), Tannery, Tea Factories. The most significant water users are the coffee and milk processing factories but these do not currently obtain water from the Ministry supply. However other industries do, and during interviews with management staff, the lack of sufficient water was given as a significant constraint to their operations.

Assuming that water will not be a constraint in the future, it is reasonable to assume that industry will grow at least at the same rate as population growth, but will tend to concentrate around the urban areas.

### 1.5 Institutions

### (1) Schools

The number of pupils attending schools in each sub-location, and the distribution between day schools with and without WCs and boarding schools have been taken from the WRAP estimates. The total number of pupils in each sub-location averages at 32% of the total population. This percentage is close to the level of 30% suggested in the MLRRWD Design Manual, and is also close to the percentage of people within the school attending age groups indicated by the 1989 census. It is therefore likely to represent a maximum level of attendance. This high levels of pupils will however reduce with a declining growth rate, and a figure of 30% has been used for projection purposes.

The proportion of pupils in schools with WC, without WCs and at boarding schools in each sub-location has been assumed to remain constant for future projections.

### (2) Administrative Staff

The numbers of administrative staff in District, Divisional offices etc. were also estimated on a sub-location basis. The number of staff varied widely from a maximum of 27 per 1,000 population in Isiolo to below 1 per 1,000 in Chogoria and Nkubu. With some adjustment to allow for local circumstances, the numbers of administrative staff have been assumed to grow at the same rate as the population.

### 1.6 Health Facilities

The existing numbers of health centers, hospital beds etc were established initially from the WRAP estimates. These were verified and discussed at District level and adjusted accordingly, with an average of 5 beds per 1,000 outpatients. The numbers of hospital beds, number of outpatients and dispensaries has been assumed to grow in parallel to population growth.

### 1.7 Commercial

Commercial activity in each supply area was assessed by the numbers of hotel beds, shops and bars in each sub-location which, for future projections, was also assumed to grow pro-rata with population.

### 1.8 Irrigation

It is evident that many people with individual connections currently use water to a greater or lesser degree for irrigation. The present situation, with virtually no effectively metered connections, encourages this practice, as water costs are not related to consumption.

It is considered however that the introduction of full metering together with a full cost recovery tariff system will effectively stop this practice except for a few wealthy



households. In these cases the high per capita unit consumption rate adopted for high class housing allows for some limited watering of gardens etc.

Due to the high cost of metered piped water, it would be uneconomical for any large irrigation consumer to obtain water from the piped system. It has been assumed therefore that such consumers will make their own arrangements for irrigation water.

It is therefore not proposed to make any separate allowance for irrigation from the piped water supply system. Water source assessment will however make appropriate allowances for existing water users.

### 2. WATER DEMAND

### **Water Consumption Rates** 2.1

The per capita consumption rates recommended in the 1986 MOWD Design Manual were found by the consumer survey to be reasonable for metered connections. It was also found however that consumption of up to 5 times higher is to be expected if meters are not connected. This is an important finding since it supports the MLRRWD's current policy to introduce full metering to its supplies and, assuming full metering is affected, it supports the use of design manual consumption rates, as given below, for design.

**Table K.2.1 Unit Consumption Rates** 

Category	unit	Demand		
Individual connections	Rural High potential land		l/c/d	60
		Medium potential land	1/c/d	50
		Low potential land	1/c/d	40
	Urban	High class housing	l/c/d	250
		Medium class housing	1/c/d	150
		Low class housing	1/c/d	75
Water Kiosks/communal water points	Rural		l/c/d	10
	Urban		1/e/d	20
Schools		Boarding	1/c/d	50
		Day school with WC	l/c/d	25
		Day school without WC	1/c/d	5
Hospitals		Regional	l/bed/d	400
•		District	l/bed/d	200
	1	Other	I/bed/d	100
		Out patients	l/patient/d	20
Dispensary/Health centre		1	m3/day	5
Hotels		High class	l/bed/d	600
		Medium class	l/bed/d	300
· · · · · · · · · · · · · · · · · · ·		Low class	l/bed/d	50
Offices			1/c/d	25
Bars			l/day	500
Shops			l/day	100
Unspecified industry	T		m3/ha/d	20



- (1) All individual connections will be metered.
- (2) Billing will take place on a monthly basis using a stepped tariff designed to constrain high water usage.
- (3) All water kiosks will be metered, and water paid for.
- (4) The consumption rates include an allowance for 20% losses.

These consumption rates are comparable with consumption rates used elsewhere internationally, both in developing and developed countries. They are also within the range of consumption rates that the public awareness survey suggests should be affordable. However, the per capita consumption rates for the existing schemes tended to be significantly higher than those given in the design manual. There are a number of reasons for this, including:

1) Higher levels of water losses







- Very few meters have been installed, and few of these are working. Hence, in practice, flat rates are being used for billing, which are not related to the amount of water consumed.
- 3) Illegal connections
- 4) Poor and inadequate data
- 5) Tariff levels are low compared to income levels

Following discussions with the MLRRWD it was decided that, for design purposes and, for assessing the adequacy of existing facilities, the Design Manual guidelines should be adopted. This assumes that a programme will be initiated to investigate the reasons for the apparent current high consumption rates, and appropriate action taken to rectify the situation. This will include water loss surveys, tariffs index linked to costs, the effective metering of all connections, regular meter reading, preventative maintenance and effective revenue billing and collection.

### 2.2 Service Levels

Guidance for the distribution between individual connection and other water users is also given in the 1986 MOWD Design Manual. This suggests connection levels for the different household categories as indicated below:

Table K.2.2 Service Levels as Percent of Individual Connections within Service Areas

Categor		Initial	Intermediate	Design Horizon
Rural	High	20%	40%	80%
	Medium	10%	20%	40%
	Low	5%	10%	20%
Urban	High	100%	100%	100%
	Medium	100%	100%	100%
	Low	10%	30%	50%

Results of the consumer survey also indicated that, assuming good reliability of water supplies, higher affordability and connection levels than suggested above could be expected at the current tariff level. However, in order to achieve greater cost recovery, it will be necessary to increase the current tariff levels in the future. This will have the effect of reducing this high level of affordability.

Without a detailed study specifically targeting the price elasticity of water, it is not possible to accurately predict future trends, other than by using internationally accepted levels of affordability in terms of percentage of income available for water.

However, it is possible to "engineer" connection and consumption levels by making appropriate adjustments for connection charges, the water tariff structure, and the degree of cost recovery. Assuming this approach will be adopted, the MOWD design guidelines for levels of individual connections, as given above, can be used.

It has been assumed that all hospitals, administrative offices and commercial premises will be connected to the water supply schemes.

However, most livestock will be watered "free" at traditional water sources. After discussion at District level, it has been assumed that only 15% of livestock will obtain water from the piped system for which owners will have to pay.

The industrial water consumption rate assumes fairly high water using industries. Nevertheless, due to the low industrial level in the rural areas, the estimated industrial consumption, even assuming 100% connection rates, results in only a very small industrial consumption in nearly all supply areas. These demand levels have therefore been adopted. For Meru however, the level of industrial activity is higher but, most of these industries do not require treated water and do not therefore use the Ministry's supply. For projection purposes therefore, only 20% of the industries in the Meru supply area have been assumed to connect to the piped water system.

### 2.3 Water Demand Projections

Water demand was projected according to the criteria and assumption outlined in previous sections. The sensitivity of assumptions for different consumer category is shown in *Table K. 2.3*.







Consumer Category	Assumptions	Comments on Sensitivity to Overall Demand
a) Number of pupils	30% of total population	The total water demand is not sensitive to alternative assumptions of numbers of pupils
b) Proportion of schools with and without WCs	Will remain constant	Not sensitive to alternative assumptions
c) Institutional and commercial growth	Will be the same as population growth	Not sensitive to alternative assumptions
d) Industrial growth	As population growth	The resultant industrial demand represents 18% of total demand and is therefore, subject to the type of industry involved, sensitive to alternative assumptions. Lower growth rates were not considered realistic and, higher growth rates, due to their speculative nature, and their resultant impact on investment were not considered justified at this stage. In this respect the resultant projections could be viewed as conservative.
e) Institutional and commercial connections	All will receive water connections	There is little sensitivity to this assumption, which, provided the establishments are within reasonable distance of a supply main, is realistic.
f) Industrial connection rate	All urban industries, but no rural industries for processing water	Sensitivity is as d) above. However it is considered reasonable for rural industries such as coffee factories to continue to use untreated water from local streams for processing requirements

Source: JICA Study Team

Water demand projections based on the design criteria and population projections given in the previous Sections are detailed for each category of consumer and for each year over the design horizon on the attached *Tables K.2.6 to K.2.12*.

These tables contain a considerable amount of information. However, it is deemed advantageous to contain all the information for one scheme on a single page to gain a good overview of the project and, to assist sensitivity studies, to gain a better overall understanding of how changes in assumptions will impact on the ultimate water demand forecast. The tables are divided into 5 sections:

### (1) Baseline Data:

Baseline population, livestock, industrial, institutional and commercial data are provided for each sub-location within the supply area. The population is as given in the 1989 census, other sub-location details have been based on the data and assumptions given in Section 2.2 above. If only a part of a sub-location is located within the supply area, appropriate adjustments have been made to the overall population, and to the distribution between rural and urban populations. For example it is only possible to serve the urban population in Maua, and the population distribution for Maua therefore indicates 100% urban, although the urban population currently only represents 15% of Amwathi's total population. The right hand column of this section totals the baseline information for the whole supply area.

### (2) Projection Assumptions:

This section provides all the projection assumptions made in developing the projections for growth of population, livestock, institutional, industrial and commercial facilities. It provides population and livestock growth rates and the distribution of the types of schools, health and commercial facilities.

### (3) Service Levels:

This provides the assumed level of connections for the different consumer categories for the planning years of 1997, 2000 and 2010, together with per capita consumption rates, and expected peak factor per consumer category.

### (4) Annual Projections:

This section indicates the annual projections for each category of consumer based on the data given in the first two sections: baseline data and projection assumptions.

### (5) Water Demand Projections:

The final section applies the service levels to the projected numbers of each category of consumers to provide the annual water demand projections.

The results of these projections are summarised below:

Table K.2.4 Total Water Demand Projections for 2000 and 2010

Project Year	Meru m3/d	Nkubu m3/d	Isiolo m3/d	Chuka (1) m3/d	Chogoria m3/d	Maua m3/d	Tigania (2) m3/d
2000	13,188	1,142	3,970	2,192	1,578	719	2,125
2010	22,725	1,915	6,372	4403	2,886	1,493	3,778

Note

(1) Chuka supply area only

(2) New Tigania supply area only

Table K.2.5 Breakdown of 2010 Water Demand by Consumer Category

Project	Meru	Nkubu	Isiolo	Chuka (1)	Chogoria	Maua	Tigania (2)
110,000	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d
Domestic	17,311	1,577	2,859	3,659	2,371	1,181	3,193
Livestock	306	25	258	100	61	16	127
Industry	3,627	91	234	206	106	83	64
Institution	779	87	2,760	160	239	54	184
Health	217	73	120	55	71	46	51
Commerce	485	63	140	223	36	114	159



**TABLES** 

## Table K.2.6 Water Demand Projections for Meru Water Supply

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# Table K.2.7 Water Demand Projections for Nkubu Water Supply

NKIIRII WATER SUPPLY	Baseline Data										_			Service	Service Levels	la.		ĮŽ.	Table K.2.7		
								Total P	Protection assumptions	1883 Umc	Sugar								199	1997/10/3	
	Sub Locations						_		Assume varying growth	rying are	Mh				Service	Service Levels	Δ.	$\overline{}$	Comments		•
Sub-Location	Katheral* Note 60 % of sub-location only included in supply area, hence	% of sub-loc	ation only is	ncluded in	supply are	a, hence	-	****	ates as for	.				Percen		rections	Rate Factor	actor			_
1989 Census figures	16 urban/rur	16 urban/rural population adusted accordingly	adusted at	scordingly		-			1997   2000	ı	2010			1997	2000	2010	l/c/d				1
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Table K.2.8 Water Demand Projections for Isiolo Water Supply

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	1,236		32,37	25,950		<u> </u>					549	2004	46		241	2,016 2			3	0	4,794	2.03
	1,296	5,191 19,408		31.155	01 5.6	<u></u>						2005	8		245			2,251	8 5	4 0	5,026 020 020	9 6
2005	168			31 778		Ψ.				20		2006	4 6	71 1892	20 0		243		90	124	5.526	2.02
2002	1,502			32,414		9 !		2 5	n.			2008	g &		256	2.547				129	5,794	2.02
	1,578			33,062			243	2 22	786 561		674		9		258	_	253 225	2,650	13	135	6.076	2.02
	1,656		41,903	427.55	7 1	13 094 18	715	477	619 584.8				71	71 2457	261		258 234	2,760	_į	140	5,372	5,02
2010 - 8.862	1,739	6,857 20,069		12221																		

Table K.2.9 Water Demand Projections for Chuka Water Supply

CHINKS WATER SUPPLY	4	Pasoline	data fo	Basaline data for area to be fed from combined intake	be fed fi	om comt	ined int	63	nd treatment works	works			-				Serv	Service Levels	S		Ta	Tablo K.2.9		П
Beceline Opto	Baseline data	cato										Total	<b>†</b>	Projection assumptions	mptions				·			(0)	1997/10/3	П
anditano			Y	Karingani				Wuthambi	igm !	Mwonge	nge	Baso	***	Assume varying growth	prowth				2		Service Levels	Covels	Peak	 **
000/jtd00   41.00	Advisor Maria	Miner	Marian	Notecoani	Chuka T	Kanang	Z.	Kittangani		<u> </u>  -	_	<u>*</u>	_	s follows:					1	Percent	E١	Potion	Rate Factor	 je
1980 Constra figures	2		25%			apuc O		15%					*	1997 2000	2010					182	3000	2010	0/0	7
	8073	5239	1292	556	3848	4680		499	_			31,285	ທູ			-		-						
ರಿಟ್ ion ಜಿ g	WRAP 198	38 estima	ates)	ř	ò	è		 è				ŝ	) (1	2 2 2 3 2 3	36	Domestic C. C.	Domestic Demand ICs Bural (Land cotential	ootential	Ę.	50%	-% 04	80%	8	ÇV
	2000	300	3 3	5 8	8 8	3 8		ီ နိ				0,4,4,0							Ned	8	30%	%54	S	
Land potential: Med	8 8	* 8	860	Š Š	8 6	88	: 							2.0%					, Mo,	2%		20%	8	
	8 8	ŝè	2 8	3 8	8	1 36		- Je				%00°					Urban Housing class	ng class	5 T	100%		96	33	Ćν
Urben area	Š è	ŝè	8 8	5 8	8 8			3 8			_		,					,	Şed Ş	3001		%001	ž,	
nousing classis	8 8 6 6	8 % 5 6	8 %	8	29%	8		8				3.6%		12.0%	7.0%				Low	10%	J	20%	75	
Liverstock numbers:	1847	1720	617	1526	179	1333	_	507				7,729	ـــــ	L	L	WKs	Rural unconnected supplies	ected sup	olies				5	(T)
	452				<b>Q</b>	Ö		127				88	α				Urban unconnected supplies	nected sup	plies		$\dagger$	+	ล	e
Shoats		3200	839	1685	248	1638	_	1446				10,171				Liveato	Ų.							ú
Total Livestock Units	٠.	1933	6/9	1638	212	1442	_	646				8,520		2.0%	5.0%		Total Livestock Units	S Chils		15,%	32%	200	ह	T
Note: The following are assumed to increase in	in ease in	ā	n with the	population,	within the	mits specified	ij	_					Proje	Projection constraints	traints									
Industry	<u></u>	<del>-</del>		-		0		_	_	_				_		Industry			E		8	+	20003	10
303		-	-				_					X	29% Pupil/	Pupil/pop ratio	Š	Instituti	82							CV.
Day with WC				•	••••	ō		0				•	ž,	w th WC	Š		Day pupils with WC	± ⊗C	_		<u>%</u>	_	52	
Day Priority Without WC	2101	1858	280	2083		1890		136				8,351	1 achools:	No WC	83%		Day pupils without WC	thout WC					'n	
Roarding of Inglis	277			• ••		323						8	g	Boarding	7%		Boarding pupils	NIS.			8		ন্ত্র	
thete edition rimby	i				8	Ĝ						۲ –	8			٠.	Admin office staff	झवर्ष			8	-	52	٦
Hith Health Ontrol Solv	-	2				Ö			_				4			чин	Health Centre/Dispenca Nr	a/Dispence	ž				8	CI
Google Hospitals						ō		0					ō ×°	Regional			Regional Hospitals	spitals	Seds		<u>1</u>		\$	
				60		ō		0					31 Hospital	_			District Hospitals	slet	Beds		8	_	8	
			_	4		0		0		•			4 8	00.0	11%		Other Hospitals	als	Beds		8		8	
Outpatients per day Nr	æ	Ü		240		О		6	_			269	Ω				Outpatients per day	er day	ż		3001		8	1
						0	-	0		<u>-</u>		•	ō ×	6. I		Commercial		High class hotels	Speds .		8 8		8 8	ωį
				-		o o		<del>5 6</del>					ē O I	Medum	·		Dary .	Med class notels beds Lour class botals Bade	s deds		3 8		3 6	
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3000	3	3		3	}	<del>,</del>		<del>,</del>														-		_
				7	Annual projection	jections										Water Demand		Projections				ı	1	
Vear Bural Population	Urban Population	noulation		Total	Livestock	-bu	Т	Admin He	Health Facilities	1	Sie		Year	Flural Demand	Priend	0	mano Total		-hdu	_~	Health Comm	<del>-</del> -	_	Overall
_	Housing	Housing classification		Population	Pop'n	ustry	Pop'n st	staff Critis	dsoH	Out- Total	al Bars	Shops	·····	<u>ග</u>	Kosks								Avg .	ر مورد ا مورد
High Medium Low	High W	Medium [L	Low.		3	_	_		Beds	petents beds	_			٥	p/Eu	m3/d		E	٤			-+	~	actor
L		1,747	2,666	41,502	10,301	6.6	12,451	<u></u>		357			944 1997		8	282				<u> </u>	9 8			
		1,950	2,977	43,045	10,507		12,914	••		370							50 1,232		3 5	<u>}</u> ;	٠- ۶		- 0	† ;
34,475	<u> </u>	2,18	9,329	4.622	10,718	_				384				25.728						- u	3 8	·		- g
2000 35,337 4,730 .	-	2.43 E	3.729	46,238	<u>3</u>	1	000	ļ	Ì	0.5		i	2002	ŀ	1	2 0	20.	1	_[_	2 0	3 -	1	<u> </u>	8
36.203	'	2.724	157.4	400.00	11,15	0 0				4 4 - 70 - 70		2 -			2 6		1989		3 13	2 8	 - 2	<u> </u>	2,568	2.07
37,072	·	3 6	0 0	19,010	5 8					1 2			2003					_		128	. 63			5.06
		+ 10 10 11 11	200	200	5 6					\$ 15 15									99	8	10			2.05
2000		3 6	0.00	3 5	15.070					074		129	1241 2005				74 2,562			137	φ -	189		2.05
000000		, 4 4 85 4 84	1 00	5 68 65	15.31					485							78 2.7			14:	48			85.0
		4.759	7.264	58.743	12.557	000	7,623			88										146	S			8.8
40 SO	•	5.15	7.845	80,838	12,808					519										15	<u></u>	808		8
		5,525	8,433	62,538	13,085			83	9 70	536	6	14.8			137		88 3,429	65	199	155	8		35.	202
44,035		5,912	9,00	85.43	13,326	10.3	19,330			<del>8</del> 8	J		465 2010					_	_	<u>8</u>	55	223	_	202
	-																	ļ						

**\*\*** 

# Table K.2.10 Water Demand Projections for Chogoria Water Supply

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							Service Levels	evols			Tabl	Table K.2.10	
CHOGORIA WATER SUPPLY Baseline data		Total (P	Projection assumptions	sumption	8	,					ſ	1997/10/3	8/2
-			Assume varying growth	g growth!			•	Service Levels	eve!s	ا چ			
<u>~</u> 21.			rates as tollows:	3:			Percenta	Percentage connections	ctions	Rate Factor	<u></u>		
Sub-Location Criodona			1997 2000	2010			199	38	2002	0/2	+	-	
1989 Census figures 2390 3390		060.6 6	<u> </u>		% urban14.0%		-						
n & growth (WRAP 1988 e		8 075		%0%	IC* Rural IC* Land potential		20%	%04	80%	8	61		
Rurai area land potential: High 65%		) ;					%0	%	% 3	ន			
Nied Co.							8 8	80 8	% % \$ \$	¥ 5			
					Urben IC Mousing class	Light See	3 5	3 8	8,0	3 2	,		
Med		8 5	5.0%	0 0 0 0 0 0		wo.)	10%	30%	20%	75			
Low		1,260	1_	1_	WKs Rurel unconnected supplies	sejiddho			<u>.</u>	0 6	ო ი		
Livestock numbers: Grade					Urban unconnected supplies	Saiddns		1	1		20 10		
Shoats		802			Livestock		4 D 9.	, pg.	1. %	G	<u>-</u> -		
1313	0 0 0	~	2.0% 2.0%	2.0%	I ORBI LIVESTOCK UTILIS	2	2			-	_		
med to increase in pro		α	Projection constraints	instraints ,	1.40.00	a .C		20%		3000	:0		
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Statisticus		2 3 7	ă		30% prestruitores	,		100		32			
upils with WC .					Day public with WC	, S		8		'n			
		- 450	achodia: na vy.c	_,	Boarding publis			100%		ß			
182			200	L	Admin office staff			100%	_	Ś	-		
Admin office staff	-	-	 		Hith Health Centre/Dispendant Nr	encarie Nr		8		8	C)		
 Ž í	-		A of Regions	_	Regional Hospitals			8		3 5			
Regional Hospitals Beds of		_I	3		District Hospitals	Beds		8		3 5			
		Towns 1	Beds Other	8	Other Hospitals			8 8		3 8	-		
		250	-		틝	ts per day Nr		% 50.5		2,02	1.8		
ss hotels Beds					Commercial High cless	righ class notes beds		300		8			
Med class hotels				Ė	Med class	Vied class notels beds		38		S			
Beds		_	Beck.		S S S S S S S S S S S S S S S S S S S			88		8			
Bars		n G			Sports			80,		8			
Shops		, ,		_						1			
Annual Projections					- [		Water De	mono Pr	Ş١.		X	7	Г
	Admini Health Facilities	-	Hotels		emand	Φ.	1019 1019	ģ	_		Teen Comm		2000
Population Population	start	50	Yola Bars	s Shops		ICs Klosks	7,0	Stock	Stry Stry	E POUGE		5.84 A 444	
dium ow High Medium Low	Be	patients	peds		1007 m3/0	-	-	12	╁╾	-	╄		-
10,230 - 15,000 - 10,000 - 10,000 - 10,000 - 10,000		328	<i>5</i> <b>6</b>	2 2	86 86	146		ţ,	56	8	8		
10,520 1,165 1,165 1,255 1,550		8	o	_	1999 216			5 5	27	2 5	<del>.</del> 5	5 t	525 2.12
964 1,285 13,318 1,656 1,4	၀	8,	0	72	2000 266	-	ĺ	N C	9 8	74	3 4	<u> </u>	i, cv
11,341	,	998	<del>a c</del>		2002	1 00	8	<u>0</u>	8	92	4		
11,613		\$ C	o 'c	78 78	2003			9	8	78	<del>Ω</del>		
11,886		385	ō		2004 409		702	4 ;	F 8	င္တ	<b>4</b> :		887 2.06
1,520		391	0		2005 448			4 :	5 8	N 4			
12,707	0	<b>Ş</b>	<del>o</del> 6		2006 488			1 4	8 8	3 %	 }		
12,980 - 1,913 1,608 15,144 1,913 1.6			<b>&gt;</b> C		2008			ťΩ	8	9	ક્ષ		
13,253	7.55	4 2	φ	16 90		296 21	996	ξ,	8	83	25 (	<u></u>	1,175 2,03
8.5		144	0		2010 662		1	Ç.	8	\$	S		-

### Table K.2.11 Water Demand Projections for Maua Water Supply

									ou contract	940	-				Service	Service Levels	5		_	Table K.2.11		
Maua Water Supply	Baseline data							r		2	- 1									657	19.97/10/3	Γ
	-							g 6	Projection assumptions	n assum	and The same				_	Servi	Service Levals		Peak			
Sub-Location	Amwathi		-	-	-				Assume varying grown.	atylig yr.	-				Perce	niage co	nnections	Rate	Factor			
% of population within supply area									1997	٠l	2010	ļ			1997	2000	1997 2000 2010	1/c/d				
1989 Census figures	3 223		-	-		-		3,223														
Population distribution & growth (WRAP 1998 estimates)	958 estimates)							(	Š	 8	000	Domestic Demand	ם. מעק מעק		, 				(V			
Rural area land potential: High	88							00	5 C			5		Med	¥01	30,	40%	20	-			
Delvi -	3 8		-					,	2.0%	2.0%	1.0%				cio —							
Hold costs coloured costs contri-				_					7.0%		%0.	Urban (C Housing class	lousing ci		8	8			N			
Pew								1,289	8 6	7.0%	7.0%			Med	<u> </u>							
Low				-	+	-	1	1,934	80	.1.	+-	MV Complete	pologod	nonline.	2	L	╀		က			ļ
Livestock numbers: Grade								20.00			e de co	The Tuesday of the State of the	onnected	salladus				8	69			
6ipui								3349			٤	Livestock				-			1.5			
Shoats	2000	-	-	O	0	0	0	.38	2.0%	2.0%	2.0%	Total Livestock Units	tock Unit		15%	15%	5.6	95				Ţ
9	to locease in proportion with the population, within the limits specified:	opulation, with	in the limits	specified	-				Projection	Projection constraints	almts								,			
Note: The tollowing aire assumed to make	*			_								ndustry		å		100%	و	20000	1.8			T
				 		-		182%	Pupil/pop ratio.	rațio.	30% ms	Institutions						- ;	N			
CW the signer set	- o								X of	with WC.	%	Day pupils with WC	with WO	•		100%	. م	52				
Day supply without WO	5445								TChools:	D VC	8 :	Day pupils without w.C.	without	2)		600	2 3	n 6				
Sparding publis	429							429		Boardmg	P.	Soarding pupils	Sildno			8 80	P >	3 %				
Admin office staff	200	_		-		-		200		+		Admin onice stair	Ce stair	voneir NV		3 5	ر. اه	5000	٥			
Hith Health Centre/Dispendance Nr	0							•	1	+	Ž		ine) Craptor	Dodin (A)		3 6		009	ī			_
Regional Hospitals		_								Heologia	8 8	District Hospitals	enitals splitals	Roda		2 2	2 29	8 8				
ព									a Live		36	Other Hospitals	ortals	Beds		100	مد	8	-			
	100							. K	1	-	3	Outpatients per day	s per day	ž		100	30	. 50				7
atents	-		-		-	-			8	į.		Commercial	ligh class	High class hole! Beds		1000	24.	009	1.8			
Commercial High class notes peds	. ·									Ę	٥ پو	_	ried class	Med class notel: Beds		1008	3º :	000				
	×								Bods	, , ,	8	- •	ow class	Low class hotels Beds		0 3		3 8				
						_		÷.			-	(	و و س			5 6	e >	3 5	_			_
Shops	100			~~~	_			9				•	sdous			3	e	3				
			Profections	1							-		Υ.	Water Demand Projections	d Project	euo			! [	ļ	Ì	٦
	0 111	Total	Also Indiana	Sister	1	Admin	Health Facilities	seiti	Hotels	-	<del>ب</del> ر ا	Year   Flurai Demand		Urban demand	Total	-	- Inde	-	Health	ė		Overall
	Orban replication Housing classification	Population	Pop'n		Popin	ত	ra Hosp'	ģ	Total	Bars S	Shops	<u>~</u>	S						;		Α. 6.3	sak 1
High Medium Low High	Medium Lay	****	3	ā		-	စျိ	patients	peds	-		m3/c	_	Ë	É	m3/0	É	Ē	5/2 E	. .	0	2 6
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0	2,536	0,040	7 7 7 2 2 2 2	, .		3 6 7			421	35			c						ន	88		2.8 8
0 0	1		1 787	23	L	450		L		8	<u>:</u>		0		65 256				ĸ	8	774	2.0
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	_	8,310	1,859	(Q)		516	0 284			90		2003	0	633	769		14 52		8 8	- 1	969	9.0
· ·			1,396	89		252				4	276 20		6						8	e ;	200	3 8
			1,934	3.0		290				44			6						8 8		1,035	3 8
) C			1,973	3.2		632				47	316 20	2006 0	0				_		3 5	ò 6	2	3 6
- C			2,012	9,4		929				ξ,			0 (				15		÷ 5	3. 6	200	3 8
0			2,052	ဗ		723				4 (	362 20	2008	5 6						₹	5	9 6	6 6
. 0 0 5005	4,988 7,483	12.471	2,094	ص د	3,741	774	426	50.	4 / 4	0 () 0 n			0 0	101	1.151				46	7.	1.493	2.02
		1	2, 3	,	-		۱															



Table K.2.12 Water Demand Projections for Tigania Water Supply

															-				Ser	Service Levols	is			Table K.2.12	. 12	
New Tigania Water Supply	Supply	۱	Baseline data	o data										Total	1	exion as	Projection assumptions	38			'				8/01/268	
Locations			3		A share share	d House	Action Milhon							Base		me varyii	Assume varying growth				L		Servic	Service Levels		yea A
Sub-locations		NKOMC	anauev	2000	NKOMC Marrierie Agueria Amaria		200						_	. <u></u>	_	rates as follows:		_1			1	Percen	Percentage connection	Dection	23	ractor
% of sub-tocation within supply wear	y wea	100%	100 k	%pg.	2001		200	000								1997 20	Q	2010				1997	200	2010	0/0/	
1989 Census figures		3 6		200	288	36	86						_	51,826	56	-	<del>-</del>									
Population distribution & growth (WRAP 1988	n & growth (W	RAP 1988	8 estimates)	fee)					_									_	Domestic Demand ICs Dural Land potential	notential	Ë	%0%	20%	%08	8	N
Rural areas	, rejr	30%	읟	%	%OE		%0 %0	%					. —	n	10.3%	0 0 0 0 0 0	20.0%	80.7			Med	10%	50%	8	ß	
Land potential:	Med	808	8	કુ	<u>6</u>									<u>-</u>				, je			Wo.	%	10%	20%	4	
	No.	క	Š	%	8	<u>~</u>		<del>%</del> .					_	; č —				%0.0%	Urban Housing class	ing class	Ę	%00	300%	100%	250	W
Urban area	High	8	8	%				3° ×						. d		_	5.0%	×6		,	Wed	100%	100%	100%	ğ	
housing class	;	<del>8</del> 8	88	8 8	% 6		88	% ×						i o			_	5.0%	- 1		wol	10%	%%	8	75	1
	A COM	86	1079	25.5	38			9			-	_		4,114	14			¥¥		nected sur	Salles				2 8	
Uvestock numbers.	india	1752	7912	1445				Ş						15.689 89.61	8				Urban unconnected supplies	nnected St	ppiies			$\dagger$	3	2 -
n <del>n-Y</del>	Shoars	94.	13556	780				¥ (			<del></del>		ć	24,146		20%	2.0%	2.0%	Total Livestock Units	ock Units		15%	15%	15%	50	•
Total Livestock Units.	Juits	1327	5519	895	8	5	1129	(3)			-	1	,	L	-	ection c	ĕ									
Note: The following are assumed to increase in proportion	assumed to inc	rease in t	Proportion -	- 	With the population,	. with 1	5 CHILL O				•						_	_	Industry		ä		8			1.8
Industry	ng	1	†				-	<del> </del> <del> </del> -			-	_		.,	34% Pupi	Pupil/pop ratio	:1		Institutions			-	ì		,	
Ow dim slice and	Ç	_		_		_												8	Day pupirs with WC	with wC	,	•	3 8		Q V	
Day pupils without WC	E WC	2873	2567	2729	2145		3720 2758	<del>2</del> 2	_	_	~			9	16,792 schools:		-	82%	Day pupits without we a	william www			800	_	. <u>.</u>	
			\$	_											20.00	BOARONG	-I:-	ę	Admin office staff	staff			90		32	
		\$	इ			2	"  -  ,	8	-			-	+		1 (2)	-	-	표		're/Dispenk			100%		2000	_
되		-			_		_								i v	Regional	+	%	Regional Hospitals	ospitals	Beds		8		\$	
Segional Hospitals	als Beds	_		_												3	-	8	District Hospitals	pitals	Beds		100%		8	
Other Hospitals			 					8							170 Becs	og ge	· 	%001	Other Hospitals Outpatients ner day	oilais ner dav	ກ ອີ ຂ້		38		3 8	
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Note: The following are assumed to increase in proportion with the population, within the limits specified:	to increase	w hothodora m	th the populatio	o, within the li	mits specifie	 							Project	Projection constraints				-	ě	-	 
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Day pupils without WC			2221			_			_ <del>-</del> -			2,22	schools		2 2	day pur	is without vy	_	8 60 60		. <u>.</u>
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_	Housin	Housing classification	Population	on Pop'n	ustry		staff Cutrs	Hosp,	4	Bars	Shops	ភ	-					ELOID ELOID		Cial Avg	
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·	355	1.243				4,352										36 15	•	42		<i>₹</i> ~	
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Checations   Continue Data   Checations								'	Service Levels			ľ	2000
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Charles areas					•••	80.08	790	36		2000	80	828	ç
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Total Livestock Units.   Total Livestock Units.     Total Livestock Units.   Total Livestock Units.     Total Livestock Units.	_						200		2			36	
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Total Livestock Units   Total Livestock Units     Total Livestock Units   Total Livestock Units     Total Livestock Units   Total Livestock Units     Total Livestock Units   Total Livestock Units     Total Livestock Units   Total Livestock Units     Total Livestock Units   Total Livestock Units     Total Livestock Units   Total Livestock Units     Health CharDispiral						9 6	800		ngin ngao	8 8 8	2 6	2 66	2 4
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Total Livestock Units.   Shoats   Total Livestock Units.			-			820		_	WKs Rural unconnected	d supplies			2
Total Livestock Units									Urban unconnected supplies	ed supplies		-	20
Total Livestock Units	_					946		_	Livestock				_
The following are assumed to increase in proportion with the states   Proportion with the states						913	2.0% 2.0%	20%	Total Livestock Un	15%	15%	15%	S
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Day pupils with WC   Day pupils with WC   Day pupils with without WC   Day pupils with without WC   Day pupils with without WC   Day pupils without WC   Day pupils with without WC   Day pupils   Day Day Day Day Day Day Day Day Day Day						33%	Pupil/pop ratio	30%	Sus		-	-	_
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Admin office staff						1 335	chrole	α.	Dov priorie alicinate	10,0	7000		ď
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Health Christophery   Nicolate   Health Christophery   Health Ch		+			-	-					200	-	9
Regional hospitals         Beds         Reds         Acceptable         Beds         B					_		T	į	Centre Nr		8 8		3 8
Obstrict Hospitals         Beds         Beds         Cuther Hospitals         Beds         Accordance         Accordance<									Xegion Beds		Š		5 6
Other Hospitals         Beds         Beds         50           Hotelating Low         Beds         50         50           Hotelating Low         Beds         50         50           Rural Population         Urban Population         Total Housing classification         Total Housing classification         Total Housing classification         Fight Attack         6.229           4,953         -         -         148         443         886         6,436           5,072         -         -         148         443         886         6,436           5,073         -         -         177         513         1,026         7,056           5,074         -         -         177         513         1,026         7,056           5,073         -         -         177         513         1,026         7,056           5,074         -         -         177         513         7,772           5,672         -         -         198         565         1137         7,712           5,674         -         -         198         564         1,167         7,772           5,674         -         -         -         1,247 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>8</td> <td>District Beds</td> <td></td> <td>Š</td> <td></td> <td>200</td>								8	District Beds		Š		200
Cultipation			_				Beds Other	_	Other F Beds		, 00 %		8
High Beds   High Beds   Solidass   Solidass   Shops							Ţ	Outpati		100%	_	8	
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Shops   Shop						ક્ર 		=			800	_	8
Rural Population         U-ban Population         Total Low High Medium Low High Gassitication         Population High Medium Low High Gassitication         Population High Gassitication         <							Secs. Low	8	Low Beds		300,		8
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1 0	Baseline Data	1	Baseine data	data												۲,		Projection assumptions	sumption	s		Ĺ			28/06/07		T
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‡	Thealth Chiroft	Ż									-	_		_					- 1	퇀	Centre		5 :	100%	· ·	<del>2</del> 2	v
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VIGGIS GETAN HERN	A.zeelina da	Baseline data for area to be fed from combined intake and	Se fed from	combine	d intake	and trea	d treatment works	SYYS							Servi	Service Levels					
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94		-		_		-	-					23%	Pupil/pop ratio	61	% Institutions						7
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Day publis without vo		_		•			298					298		Boarding, 10%	96	Boarding pupils	slidnd 8		100%		<u>o</u>
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ľ	MERU WATER SUPPLY		Locations	Sub	tation .	ibution	ý	of to		a	housing class		2		Total Livestock Units	wing are		:	Day pupils with WC	Day pupits without wo	Soaroing pupils	Admin Office State	Regional Hospitals	Spitais	spitals	Outpatients per day	High:	Med.	7 0 C	Shops			putation partial:	Wedum		o.	<u>-</u> -	0 10	a c	(0	50 f	- C	· (n	(1)	
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Note: The following are assumed to increase in proportion with the population, within the limits specified	d to increase	in proportion	with the pu	pulation, w	ethin the lim	its specific	ję.						_		Projec	Projection constraints	straints				_		
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Control No.   Control No.	Day pubi	s with WC			_										655	schools:		100%	Day	pupils withor	ut WC	100%		ഗ	
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MERU WATER SUPPLY	-	Baseline data for area to be fed from combined intake and treatment works	for area to	be fed fr	om comt	uned inta	ke and û	eatment	works							200	Service Levels	S				
Baseline Data	Baseline data	data											Total	Projectio	Projection assumptions	tions		·			- 1	78/06/97
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.5									_				0.0%	2.5%		1.0%		Med	15%	30%	40%	8
									_				%0.0			1.0%		Low	2%		20%	4
TOTAL SERVICE CONTRACTOR	_					_		••	_	_	_		0.0%	% 0.0 %	5.0% 5.0	5.0%	Urban		100%	_	ž	250
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:										_				l			i	Low	10%	30%	20%	75
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																	- 1	Urban unconnected supplies	supplies		_	
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e following are assu	o increase in	proportion with t	, notation,	vithin the ii	mits specd	ied,								Projection	Projection constraints	ints Indicate			_	ò		
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Day publis without WC				-				•	_			000				17%	Boardin	Boarding punits 1	?	200	•	9 5
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ıs.									_				,	Ē		8	District Beds	Beds		%001	<b>-</b> -	5
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		-		Annual projections	syections										Yater Dan	Water Demand Projections	TC EVOTA					
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	Housing	lassification	ő	Pop'n	ustry	u doc	Ō	Cntrs Hosp'	ź	Total Bars	s Shops	 s	<u>5</u>	Kiosks		- 18 -	_	stry	utional			
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l and potential: Med		%0											% 0.0			- R		Ned	e 2		£ 56	2 5	
		%0											900			e 5		2 1			8 8	Ş	,
Urban area High		40%		_									2 5			2 %	5	50			3 6	15.0	4
SS:	-	30%											8 6	2 2	200 m	8 8		3	10%	3 8	300	75	
	-	%0%			+	-	1		+		<b>†</b>		718	٠.		WKs	1	Rural unconnected supplies	1	┞-		ο̈́	63
Livestock numbers: Grade		716	-										2 '					Urban unconnected supplies	sellddns			20	(L)
inaig inaig		200											704			Livestock	Š		_				1.5
Shoats		1 20									-		763	2 0%	2.0% 2.0%	%	Total	Total Livestock Un	15%	15%	15%	25	
Note: The following are are unant to increase to condition with the bookulation within the limits specified:	in creases of	popular with the	e population, w	vithin the limit	ts specifie	ŭ		 	_				<u>a</u>	Projection constraints	constrain							-	
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Sus	-	-					-						15% T	ä		30% Institutions	Bons	- 3					7
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Boarding pupils	_	 											5	80	Soarding	<u>e</u>	Admin	Admin office staff		2 6		3 %	
		0				-	1		1	1		1	-	+	-	1	Cantro Mr	Nr.		1008	-	2005	1
		7											7	97 79	Bacterial D		Region Beds	Section		100%		8	1
s	<b></b> .	00											· T	e		%	District Beds	Beds		100%		200	
Order Hospitals Beds Other Hospitals Beds		) C													_	%	Other F Beds	Beds		100%		8	
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High		۵											38 5	% of 145	Hgr			Reds Reds		000		8 8	-
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class: Low Beds	, , ,	<b>&gt;</b> C					-,						· •			-	CO E E			100%		200	
Shops		00															Shops			100%		5	
	-				1		<u> </u>							Š	ster Dem	Water Demand Projections	CDOTHS						l
- 1			ı	Printed or of	ı	t	L	Liberth Challiston	Lotola I			Ves 19	Sural Demand	-	Liban demand	and Total	-io-	ndu-	Instit-	Health Comm-	Ľ	Cotal	Syera
Year Rural Population	Urban Population	Jation	Total	inestock:	- 44 - 44	Pupir Adi	Staff Colts	Hosp' Out	پيا	Bars	Shops			osks	Cs Kiosks			stry					Peak
High Merica I ow	HIGH WIN	Medium 1 ow		33		_		Beds patients		_			m3/d		듸	_	m3/d	m3/d	π3/α	-	m3/d n		13000
	S	L	_	912	-	11,929	e)	ľ			8	1997					20	•	5.5	27		3,527	25
		12,525 25,051		026		12,525	, co		9 6		0 0	880			3520	410 3,030	2 5		127	- <del>-</del> -			1 to
1999				949		201.21 2008.61	7 e				0	2000						•	13	ťδ			8
2000	4	13,609 27,616	20,03	26.0		14 500	) e)	1	1		0	2001		i	1	Ĺ.	_		6	5		ļ	2.08
7003	200.00	15.225 30.449		1 807		15,225	(B)				ō	2002	•			402 4,731		•	147	6			2 08
2003				1,027		15,983	<u>ო</u>		195		ö	2003	'				9 0		25. 24.	Φ i			208
2004		16,785 33,570	0 55,950	1,047		16,785					Ö	2004			4 272	475 5,290		'	2 6	- 1		786	2 6
2005				390.		17.524 B.E.D.R.	n 🔻				5 0	2008							2 2	. 60			200
2006		15,500 15,011		5.1		19.431	4				0	2007						•	187	18			2.07
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5000		21,422 42,845		95		21,422	4	0 (	236	00	00	2009	•	00	6541 4	445 6,987	25.00	'	202	5 6		7.22	88
2010			_	1 179		22,494	-	1			5	2017		1	_	1		-	/12	3		4	5







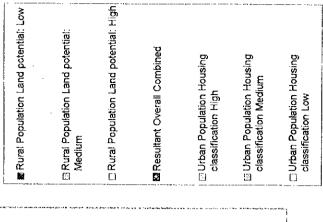
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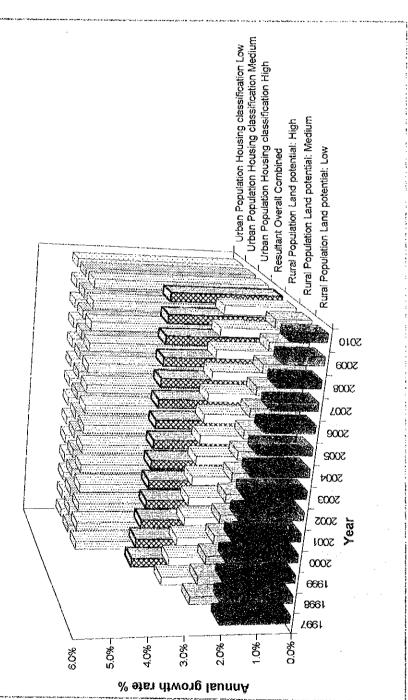
Water Demand Projection fo	nd Proje	tion for	r	Meru		For desí	For design Horizon of	on of			2002
Sub Location	Rural ICs m3/d	Rural Kiosks m3/d	Urban ICs m3/d	Urban Kiosks m3/d	Total Domestic m3/d	Live- stock m3/d	indu- stry m3/d	Instit- utional m3/d	Health m3/d	Comm- cial m3/d	Total Avg m3/d
Town	-	,	-		-	12	3,090	43	134	292	3,570
Ntima (3 Jook)	ı	ı	5.170	423	5,593	8	,	170	17	1	5,788
Ntakira	402	45	405	35	886	16	,	46	•	,	947
L. Jaoki	211	23	183	15	432	10	,	23	,	92	483
Nthimbiri	295	33	ı		328	17	,	24	,		368
Mpuri	249	28	1	1	277	9	ŀ	20		,	306
Ngonvi	290	32	1	ı	322	7	ı	23	•	1	352
Total Ntima	1,447	161	5,757	472	7,837	67	1	306	17	18	8,245
Nyaki											
Mulathanka	1	ı	971	62	1,050	~	ı	32	ı	ທ	1,094
Thuura	492	55	ı	ı	547	27	1	40	,	17	630
Chundu	748	83	1	1	831	4	1	09	,	,	896
Munthu	445	94	ı	ı	494	42	<b>~</b>	36	თ	72	602
Nkapune	202	22	,	1	224		t	10	თ		261
Total Muthambi	<b>\</b>	210	971	79	3,147	92	7	184	17	36	3,483
Upper Abothoguchi						1		(		(	7
Katheri	786	87	1	1	8/3	က က		53	•	77.	1,010
Githongo	393	44	,	,	437	17	,	32	17	27	530
Kithrune	482	54	,	1	536	37	ı	39	,	9	631
Total Mwonge	1,661	185	1		1,845	107	1	134	17	68	2,171
Total Scheme	4,994	555	6,728	552	12,830	277	3,097	667	185	414	17,470

器等

Water Demand Projection for	nd Projec	tion for	2	Weru		For desi	For design Horizon of .	n of			2010
	Rural	Rural	Urban	Urban	Total	Live-	lndu-	Instit-	Health	Comm-	Total
Sub Location	<u>S</u>	Kiosks	S	Kiosks		stock	stry	utional	7	Cial 2017	Avg %,4
	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/a	D/9/1	0/6/15	D/SIL
Town	ı			1	ſ	13	3,618	50	157	342	4,180
Ntima		******	000		7000	d		217	00	,	7.631
U.Igoki	, u	. c	05,870	927	1 200	» [-	, ,	- 4 - 53	2 '	. 1	1,271
Nakia 201	2 6	2 4	245		986	-				27	645
K. Igori	437	<u>γ</u>	· ·	. ,	455	0	,	26	,		200
Monei	358		,	,	384	<u></u>	ı	22	1	•	417
Ngook	429		,	1	446	œ	,	26	ı	1	480
Total Ntima	2,140	- 60	7,725	205	10,457	74	t	371	20	21	10,943
Nyaki						(		3	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	u	77
Mulathanka	'	,	1,302	84 44	1,387	x	1	<b>.</b>	ŀ	> (	7 0
Thuura	728	30		1	758	8	1	44	ı	OZ.	700
Chungu	1,107	46	,		1,153	ທ	1	67	1	,	1,224
Munthu	658	27	ı	l	685	47	ω	40	5	7-	807
Nkabune	299		1	ı	311	13	'	18	0	ı	352
Total Muthambi	CA.	116	1.302	84	4,295	102	8	210	20	42	4.677
Upper Abothoguchi	ıchi							í	-	Ć	()
Katheri	1,162	48	,	'	1,210	28	ı	0/	1	97	400,
Githondo	582	24	·	1	909	3	ı	35	20	32	712
Kithring	713		;	,	743	4	,	43		23	850
Total Mwonge	2,457		1	ı	2,559	118	1	148	20	80	2,926
Total Scheme	7 388	308	9.027	587	17.311	306	3,627	779	217	485	22,725
Total Collection	200,		12,0					-			

Population Growth Rate Variation with time

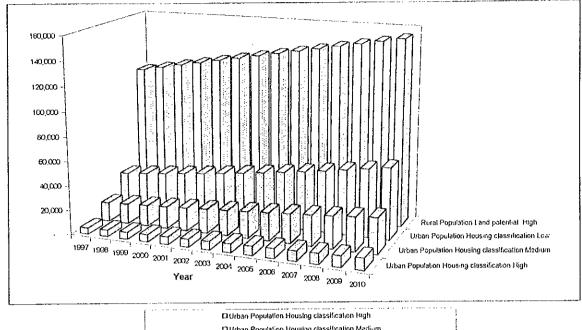






### **Population Projections**

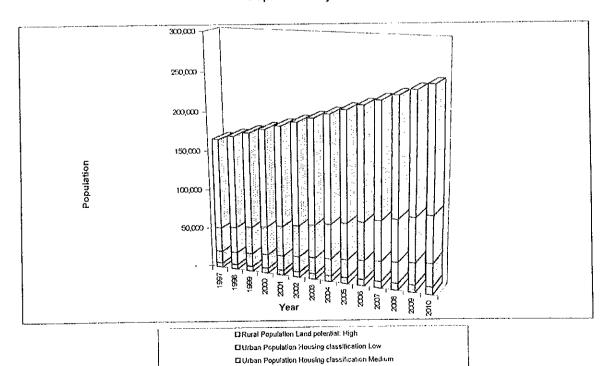
Population



☐ Urban Population Housing classification High ☐ Urban Population Housing classification Medium ☐ Urban Population Housing classification Low ☐ Rural Population Land potential High

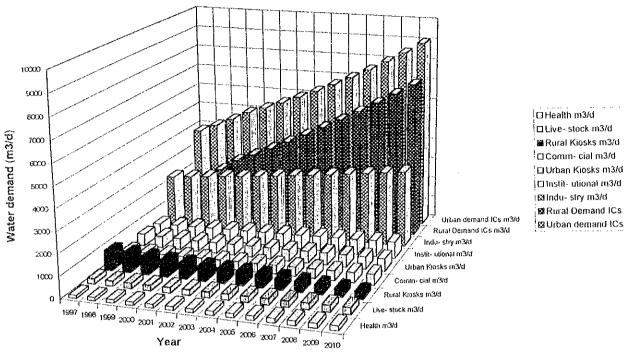


### **Population Projections**



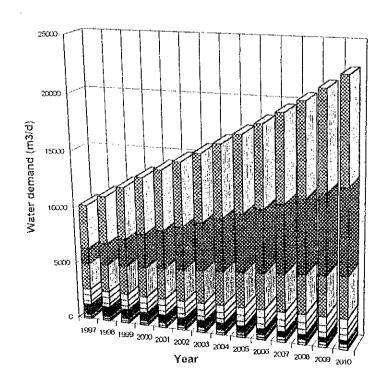
☐Urban Population Housing classification High

## Meru Water Demand Projections



# MiRural Demand ICs m3/d ☑Urban demand ICs m3/d

## Meru Water Demand Projections



⊠Urban demand ICs m3/d BRural Demand ICs m3/d ⊠ Indu- stry m3/d ⊟lastil- utional m3/d □Urban Kiosks m3/d □Comm- cial m3/d ■Rural Kiosks m3/d Dilive- stock m3/d ☐Health m3/d

