United Republic of Tanzania
Ministry of Water, Energy
and Minerals

Kingdom of the Netherlands
Ministry of Foreign Affairs
DGIS

Morogoro Domestic Water Supply Plan

Volume II

Water Supply Conditions

Final Report

August 1980

DHV

DHV Consulting Engineers

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PART A GEOGRAPHY

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1. INTRODUCTION

1.1. General

At the beginning of 1977, following the "Administrative Arrangement" between the Governments of Tanzania and The Netherlands, the International Technical Assistance Department of the Ministry of Foreign Affairs of the Netherlands charged DHV Consulting Engineers with the execution of the Morogoro Domestic Water Supply Plan (MDWSP). The Tanzanian Government appointed the Ministry of Water, Energy and Minerals as executive authority for the implementation of the project.

The aim of the MDWSP was to study the possibilities for improvement of the rural water supply in the northern part of the Morogoro Region. Carrying out a Domestic Water Supply Plan, instead of a Water Master Plan, implied that the study had to be focused on the supply of drinking water for the villagers only. During the discussion with the Tanzanian and Netherlands Governments on the determination of the Terms of Reference, the need was felt to incorporate an implementation component in the study. Based on information derived from earlier studies in the Morogoro Region it was decided to incorporate a drilling programme, for exploration and exploitation of deep ground water, in the survey.

A first report "Identification of the present conditions and problems of rural water supply in the northern part of Morogoro Region" was issued December, 1977.

In September, 1978, a Progress Report was presented, dealing with the surveys and studies carried out during the period May - August, 1978, and including the plan of operations of the team for the following months.

A first review of available and collected data concerning existing water supply systems, water quality aspect, hydrology and hydrogeology was presented in the interim report, which was submitted in April, 1979.

The domestic water supply plan is presented in this final report. The report consists of six volumes:

volume I	Main Report
volume II	Water Supply Conditions
volume III	Hydrology
volume IV	Hydrogeology
volume V	Water Supply Development
volume VI	Village Data Handbook

1.2. Aim

The aim of the geographical survey is to contribute to the determination of the water demand of the villagers in the survey area and to prepare up-to-date maps showing the location of the villages and the road pattern.

To this end the location of the villages, the number of inhabitants and the present water supply have to be investigated and established. In terms of a Domestic Water Supply Plan the term "rural" refers to people living in villages. Consequently, townships, minor settlements, railway camps and stations, estate camps, and other private and public institutions have been excluded.
The survey covers the northern part of the Morogoro Region viz. the Morogoro and Kilosa Districts. These two districts comprise 75% of the Region's population. Moreover, these districts prove to be the Region's problem areas in terms of rural water supply.

The objective of the survey is expressed in the following Terms of Reference

1. the preparation of a map (1:250,000) indicating the location of settlements and the road pattern
2. the assessment of the size and distribution of the rural population
3. the assessment of the present water supply conditions for domestic purposes in the rural parts of the Region
4. the identification of problem areas with reference of rural water supply.

2. APPROACH

An inventory carried out in the framework of the RIDEP study 1974 showed that the existing data concerning the situation of the survey area in the field of water supply and water demand were not up-to-date. Although some information about villages and areas suffering problems with water supply was available, there were no up-to-date records comprising facts and figures. Hence, within the scope of the MDWSP it was necessary to gather the existing data and to update it to the present situation. Since considerable resettlement of population has taken place in the last few years the available topographical maps and aerial photographs did not provide sufficient and accurate details of the village pattern within the Region.
The road pattern had also changed; new roads had been constructed, some roads were closed for public use, qualification of roads had to be re-established.

The lack of recent data necessitated the execution of a geographical survey of the area. This has involved the collection and review of existing data, and a field survey to gather recent data. Existing data were available in the offices of National, Regional and District Authorities. In the field survey simple questionnaires were used to collect village data about population, water supply and public facilities.

3. DATA COLLECTION AND EVALUATION

3.1. General

To meet the aim of the geographical survey and to respond to its Terms of Reference a combination of fieldwork, data collection and study of existing reports was selected.
The methods of data collection used in the study were:

- mapping of the locations of settlements and the present road pattern
- collection of data of population and water supply systems by means of recording schedules and locally gathered information
- discussions with authorities

The actual fieldwork was carried out in the period June-October 1977. Morogoro Town, the regional capital, served as the "homebase" of the team. During the field trips some 20,000 kilometres were covered in order to map the road pattern and to visit every village accessible by landrover.

3.2. Mapping

The location of settlements and roads was traced by using topographical maps 1:50,000 and aerial photographs. The aerial photographs were used whenever the topographical maps provided insufficient details, particularly in terms of contour lines.
The location of the settlements was indicated in the following way:

- in case of nucleated settlements the exact position of the nucleus was marked
- in case of dispersed settlements with a clear concentration of population this concentration was taken as the site of the settlement
- in case of scattered habitation the geographical centre was mapped.

About 25% of the settlements proved to be inaccessible by car. Therefore, the location of these settlements was determined with the assistance of informants familiar with the area of study.

The quality of roads was classified according to grade and weather standards on the basis of information from observations and from local informants. A first distinction was made between tarmac and non-tarmac roads. The latter were subsequently differentiated in main roads (all-weather), secondary roads (all-weather and dry-weather), and motorable tracks (all-weather and dry-weather).
All-weather roads, however, may still pose problems during heavy rains. In addition, a differentiation was made between public and non-public roads. In this report the term public road refers to the actual use (e.g. private estate roads open to public transportation to reach villages in the area were classified as public roads).
Boundaries of the various administrative units indicated on the map were taken from existing district maps and from sketch maps provided by the district authorities. However, these boundaries should not be considered as the official delimitations of these administrative units, since these maps are not accurate in this report.

3.3. Data collection by means of recording schedules

3.3.1. Population

In order to assess the total number of people living in villages a number of sources of existing population data have been drawn upon. In Tanzania detailed population figures are kept at the various administrative levels, viz. the village, the sub-division, the division, and the district. Whenever possible, figures from each of these sources have been obtained from the secretaries of the administrative units.
Data at village level could not always be obtained from the village secretary because there was no properly kept village population file. In addition, large differences and inconsistencies were encountered in the data available at the various administrative levels. These inconsistencies were due to the use of different definitions of the concept of village population (sometimes total population, sometimes only the able-bodied population), the use of figures from different years, and errors in adding, copying and typing.

During the survey efforts have been made to assess the total number of inhabitants per village as accurately as possible, by means of an evaluation of the data obtained at the various administrative levels and through observations and additional interviews, e.g. with school teachers, when visiting the village.

In view of these remarks, the population data gathered during the 1977 survey should be considered as a rough indication of the number of inhabitants of each of the villages.

At the beginning of 1979 the population figures based on the August 1978 census became available. This census was carried out by the Tanzanian Government on a country wide base.
The population figures were adjusted to the census figures for the villages in the Morogoro and Kilosa Districts.

3.3.2. Water supply

Information on types of domestic water supply has been collected at village level - the village secretary or the village chairman being the most important respondent. Information refers to the type of water supply, the differences in type of supply between the wet and the dry season, if relevant, the number of supply points per type, the rough proportion of the village population using the various types, the distance between the various supply points and the centre of the village, and the quality of the water. In the absence of a chemical and biological analysis during the geographical survey, the quality of drinking water has been based at this stage on the subjective assessment by the village population in terms of salt versus fresh water.

These water supply data provided a first impression of the present situation concerning the water supply in the districts and allowed the identification of the priority areas.

During the water supply surveys, carried out in 1978-79, a measurements programme was executed to collect data on the chemical and bacteriological quality of water supplied through the present systems. As these data are more detailed, they were applied in the final description of current conditions and of the water demand. Reference is made to Part B, Present domestic water supply - Water demand in which the method of collection and the output of data is presented.

3.4. Discussions with authorities

Prior to the start of the actual fieldwork, discussions were held with Tanzanian authorities concerning the objectives and the geographical restriction of the study and the methods of data collection. The findings of the fieldwork were discussed with both district and regional authorities. These discussions ultimately resulted in the identification of priority areas for further investigations.

4. RESULTS

4.1. Summary and conclusions

The geographical survey is the first step towards the realization of the Morogoro Domestic Water Supply Plan. It focuses on the location of settlements, the road pattern and the current water supply conditions in the rural areas of the Morogoro and Kilosa Districts with the aims of contributing to the determination of the water demand in the villages and of preparing up-to-date maps of the survey area. In addition, existing problem areas in the field of water supply have been identified on the basis of tentative water supply data gathered during the survey.

After the survey, population figures of the villages were adjusted to the figures of the August 1978 population census.

The identification of problem areas - where the possibilities of improvement of domestic water supply systems could be further investigated - was based on the criterion of need for water. This criterion comprises: distance to the source of water, duration of the problems of supply, quality of the water, number of persons involved and water shortage.

As more detailed and complex data became available during the water supply survey in 1978-1979, the final assessment of the current conditions of water supply and the water demand were established after this survey. For the water supply survey and the final results reference is made to Part B: Present water supply - water demand.

For the maps reference is made to the two 1:250,000 sheets, covering the survey area.

The following conclusions may be drawn from the geographical survey:

1. In the survey area one may distinguish three geomorphological zones, viz. the mountain areas, the transitional zone of foothills and steep piedmonts, and the flood plains.
2. In the Morogoro District the rural population is primarily found in the mountains and the adjoining piedmonts and in the foothills; in the Kilosa District the rural population is chiefly located in the foothills with concentrations in the northern part of this district and along the major roads.
3. The majority of the settlements in the survey area has a dispersed pattern.
4. Villages are mainly administrative units of varying size (between 400 and 5,000 inhabitants); the majority of the villages have a population in the range of 500 to 1,500 inhabitants.

5. The survey area has good inter-regional road connections; the intra-regional network is less well-developed, particularly in the mountain areas. Here, villages with about 20% of the total rural population of the survey area cannot be reached by car. The quality of the intra-regional roads is in general poor in the mountain areas and in the flood plains, particularly during the wet season.

6. The majority of the rural population make use of non-improved types of water supply; 20% of the rural population are served by improved types.

7. The survey area is rather well endowed with surface water resources, rivers and streams being the major sources of water supply, both during the wet and the dry season.

8. Local variations in availability and quality of drinking water are related to geomorphological zones. In the mountain areas there is sufficient water of good quality throughout the year.
In the foothills and the piedmonts and in the flood plains there are water shortages during the dry season with the exception of those areas where perennial streams occur, while during this period water frequently contains a high concentration of salt.

9. In the survey area the following improved systems of water supply may be distinguished in order of importance:
   - gravity piped water supply
   - pumped water supply from a well in or along the riverbed
   - pumped piped water supply from a borehole or shallow well
   - shallow well with a handpump

10. The location of the problem villages shows that there are three priority areas for further investigations in the Morogoro and Kilosa Districts:
    - the northern part of the Kilosa District
    - the Ngerengere area
    - the area between Mbigili and Manyinga

11. The Regional Officers consulted on the identification of problem areas and individual problem villages agreed with the priorities established.

4.2. The location and size of settlements and the road pattern

4.2.1. The rural settlement pattern

In the Morogoro Region some 800,000 people live in villages.
The rural population of the survey area was estimated at 557,000, in August 1978. The majority of this rural population are found in Morogoro District, i.e. 330,000 (59% of the total rural population of the survey area), while the remaining 227,000 (41%) live in the Kilosa District.
The rural population in the Morogoro District is highly concentrated in a few areas: the Uluguru and Nguru mountains and their adjoining piedmonts,

and in the foothills. In the latter area the population has especially settled along the major roads. In the Kilosa District the rural population is mainly found in the foothills. Two types of concentration may be distinguished here: the areas around Gairo and the Mamboya Division, and those along the major roads, i.e. the road connecting Kilosa Town with Mikumi and Gairo, and the one branching off at Dumila to the Morogoro District.

At present there are 360 villages in the survey area, i.e. 227 in the Morogoro District and 133 in the Kilosa District. These villages should not be associated with compact settlements but are administrative units. This is the result of the Government's policy of villagization, which came into effect in August 1974. The aim of this policy was to concentrate the nation's rural population in spatial units which would become the basis for future social and economic development. These units should preferably have the form of a nucleated settlement in order to facilitate the provision of services such as water supplies, health and educational facilities, agricultural extension services and marketing facilities.

In the survey area the villagization policy primarily resulted in what we would define as an administrative villagization, i.e. a number of small population clusters put together under an administrative umbrella, without generally achieving a single nucleated type of settlement.
Whenever a certain degree of concentration was achieved, it generally took the form of planned rows of houses. However, the majority of the villages in the survey area still consist of rather dispersed settlements, or even homesteads widely scattered over the village territory. This phenomenon is particularly common in the mountainous areas, such as the Uluguru, the Nguru and the Rubeho mountains. In these areas the concentration of a large number of houses is hampered by environmental conditions. But even in the lower parts of the survey area with more suitable environmental conditions for concentrated habitation, compact villages are the exception rather than the rule. Consequently, the envisaged effects of the villagization policy have not yet materialized.

4.2.2. The size of settlements

In the present report the size of settlements is understood in terms of the number of inhabitants of villages, because planning activities at grass-roots level in Tanzania focus on these administrative units. The average population size of the villages in the survey area is 1,500 persons. This average, however, is derived from a large range: the size of the individual villages varies between 400 and 5,000 persons. A frequency distribution of villages according to the total number of inhabitants reveals that some 60% of the villages is in the range of 500 to 1,500 inhabitants. Further details are given in the following table A 4.2-1.

Table A 4.2-1 Size distribution of villages (%)

Size of village	under 500	500 - 1,000	1,001 - 1,500	1,501 - 2,000	2,001 - 2,500	2,501 - 3,000	3,001 - 3,500	3,501 - 4,000	over 4,000	total
	3	24	29	19	13	6	3	1	2	100

No specific relation was found between the size of a village and the location within one of the three geomorphological zones. In general, the present size is mainly the result of the recent villagization policy and is as such the outcome of the interpretation of the general directives by the various officers in charge of the implementation of this policy.

4.2.3. The road pattern

The map showing the pattern of roads and motorable tracks in the survey area - attached to this report - makes clear that the survey area has rather good inter-regional road connections. The Tanzam Highway, with a tarmac surface, runs in a north-east/south-west direction, providing year-round transport possibilities with the coastal area with the south-western part of the country. In addition, the main road to Dodoma passes through the area. This Morogoro-Dodoma road has a surface of badly maintained engineered gravel. Some parts of this road occasionally suffer flooding as a result of heavy rains.
There are plans to upgrade this road so that in the near future Morogoro Town will have a bitumized road connection with Dodoma.
The only major change in the inter-regional road pattern will be the construction of a bitumized road connecting Chalinze (Coast Region) with the area south of the Uluguru mountains across the Ruvu flood plain.
This road will be constructed in the framework of the Rufiji River Basin Development Project and may give a strong impulse to the development of this sparsely populated area.

In contrast to the inter-regional road connections, the intra-regional road pattern is less well developed. Not all parts of the survey area are served by motorable roads and tracks. This applies in particular to the mountainous areas such as the Uluguru, the Nguru and the Rubeho mountains, where some 85 villages with not less than 20% of the total rural population of the survey area cannot be reached by car.
Another difference with the inter-regional road connections is the generally poorer quality of the intra-regional roads.

Quality is interpreted here in terms of accessibility throughout the year and is expressed by the qualifications all-weather and dry-weather.
The quality of the intra-regional roads differs per geomorphological zone.

In the mountainous areas transport is almost impossible during the wet season.
In the large flood plains of the Mkata, Wami and Ruvu Rivers accessibility is substantially reduced during the wet season when whole sections of the roads and tracks are flooded. On the other hand, the foothill area and the piedmonts are usually accessible throughout the year. Heavy rains may only cause occasional transport problems for short periods here. The combined effects of climatological characteristics and inadequate maintenance result in a deterioration of the quality of the intra-regional roads, particularly in the mountainous areas and the flood plains.

PART B - PRESENT DOMESTIC RURAL WATER SUPPLY AND FUTURE WATER DEMAND

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1. INTRODUCTION

1.1. General

At the beginning of 1977, following the "Administrative Arrangement" between the Governments of Tanzania and The Netherlands, the International Technical Assistance Department of the Ministry of Foreign Affairs of the Netherlands charged DHV Consulting Engineers with the execution of the Morogoro Domestic Water Supply Plan (MDWSP). The Tanzanian Government appointed the Ministry of Water, Energy and Minerals as executive authority for the implementation of the project.

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volume IV	Hydrogeology
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1.2. Aim

The description of the existing water supply conditions, and the survey of the present and future water demand constitute part of the Consultant's assignment to define rural water supply development programmes for those villages in the Morogoro and Kilosa Districts, which regularly experience constraints in their domestic water supply conditions.

2. APPROACH

2.1. Introduction

The survey of the existing water supply facilities, and the present and future water demand is defined as consisting of the following activities:

- mapping of all administrative villages in the survey area;
- a demographic survey to estimate the present population in these villages;
- an inventory of the existing water supply facilities, including traditional and improved water supply systems;
- a survey of the water quality, availability, accessibility, and the reliability of the present facilities;
- a survey of the public health conditions in the project area, especially an inventory of the occurrence of water-related diseases, as such data may have an impact on the choice between alternative improved water supply facilities;
- a survey of the domestic water demand based on consumption data, for short-term and long-term projections.

The outcomes of these surveys, together with the results of the hydrological and hydrogeological surveys regarding the water resources potential, constitute the background data for the establishment of phased rural water supply development programmes. These will be discussed in Part E.

2.2. Data collection and evaluation

2.2.1. Earlier studies in the survey area

Earlier studies in the survey area containing relevant data for the present study consist mainly of case studies of individual projects carried out by institutions such as BRALUP, CDTF and UNICEF. These studies are listed in Part B 2.5. Two studies which deserve special attention are:

- Integrated Development Plan for Morogoro Region
  Annex II. Water resources and development,
  International Technical Assistance Department, The Netherlands;
- A new method of determining rural water supply design parameters in conditions of a developing country in the equatorial zone - Tanzania by D.J. Stanislawski.

Annex II of the integrated development plan gives an overall picture of the present level of service in domestic water supply, it defines a number of priority villages, and it includes cost estimates for some specific development programmes.
Stanislawski describes some design criteria for rural water supply systems on the basis of detailed water demand studies for several improved water supply systems in the survey area.

2.2.2. Inventory of existing water supplies

Data on the existing village water supplies are a prerequisite for the definition of recommendations and programmes for future extensions and improvements of these supplies. The Consultant opted for a preliminary survey which was carried out by a team of two geographers. Their survey included a mapping of administrative villages, a demographic survey, a typology of the existing facilities, the population's subjective appraisal of the quality of the water supply, and the constraints in the water availability. The survey also included a typology of the settlement and road pattern. The outcomes of the preliminary survey served as a framework for more detailed studies by the Consultant's water supply section.
The geographical survey was carried out during the period June-October 1977, and the results were presented in a report "Identification of the present conditions and problems of rural water supply in the northern part of Morogoro Region" [3], issued in December, 1977. The geography of the survey area is described in Part A of this volume.

2.2.3. Water quality standards

Various national and international standards exist for drinking water quality. The most frequently applied standards are those of the World Health Organization [4]. Tanzania has adopted these standards with some slight alterations, to make them more suitable for the local conditions and the current level of development of the water supply sector. The Rural Water Supply Health Standards Committee has formulated its proposed Standards of Quality of Domestic Water in Tanzania in the document "Temporary Standards of Quality of Domestic Water in Tanzania" [5]. The document contains standards for bacteriological, physical, and chemical parameters. In addition, it describes standards for sanitary protection of water intakes and surrounding land. A complete description of the Temporary Standards is given in Annex BA 1. The parameters most relevant to the present survey are summarized in Table B 2.2-1.

Table B 2.2-1. Summary of the most relevant temporary standards for rural water supply in Tanzania [5].

Quality parameter	Temporary Standards - Tanzania (Rural Water Supply)
Physico-chemical parameters:	
Electrical conductivity (25 °C)	200 mS/m (2000 μS/cm)
Fluoride	8 mg/l
Nitrate	100 mg/l
pH	6.5-9.2
Bacteriological parameters:	
Coliforms	MPN 3/100 ml
Faecal Coliforms	MPN 0/100 ml

The Tanzanian Temporary Standards of physical and chemical quality of potable water deviate at some points, (relevant from the point of view of effects on human health) from the International WHO Standards, e.g. fluoride and nitrate.
The committee has relaxed the standards for these constituents to a value which enables the exploitation of considerable additional ground water resources, without so far causing any serious health effects.
Only some tentative standards exist for some of the substances which effect the palatability of water or its suitability for general domestic consumption. These tentative limits should be regarded as concentration limits above which the majority of water consumers would feel discomfort, and would consider the water unpalatable and a nuisance due to its slightly purgative effects or due to the accompanying scaling, deposit formation, corrosion, etc.

The standards of the bacteriological quality of drinking water are similar to the WHO Standards. The Consultant is of the opinion that also these standards could be relaxed to a certain extent, for the following reasons:

- the WHO Standards are rather stringent for hot climates and their application would lead to the condemnation of the vast majority of existing water supplies in low-income communities;
- the present knowledge of tropical epidemiology indicates that low-income communities in particular have high morbidity due to non-water-borne, faecal-oral or water-washed infections as a result of lack of water for personal hygiene or insufficiently hygienic practices. These disease problems will respond to improvements in water quantity, accessibility, reliability and hygienic practices rather than to improvements in water quality, and therefore the first mentioned improvements should always be a major focus of the design of new supplies

Feachem [6] suggests that the following bacteriological standards may be appropriate for many hot countries:

Table B 2.2-2. Proposed standards for bacteriological quality

E.Coli (Faecal Coliforms) MPN per 100 ml at 44½°C	Recommended procedure
< 10	supply untreated
10-100	treat if possible, if not, supply without treatment
100-1000	treat if possible, if not, supply without treatment or abandon depending on various other factors
>1000	treat if possible, if not, abandon or supply without treatment depending on various other factors

Source: Faechem [6]

The Consultant has used both the WHO Standards and the proposed standards given above for the evaluation of the results of the bacteriological survey of the existing water supplies. Feachem's proposed standards allow more detailed interpretation of the seriousness of the faecal pollution of the water sources, its impact on health conditions and the urgency for alternative water sources.

2.2.4. Water quality investigations

Water quality investigations during the preliminary survey were limited to the population's subjective appraisal of the water quality on the basis of sensory observations, such as taste and visual appearance. Electrical conductivity measurements by means of portable equipment started in May, 1978, as part of the field survey of the hydrological and hydrogeological sections. Detailed water quality monitoring was carried out during the period October-November, 1978, and February-March, 1979, as part of the field survey of the water supply section. This measurement programme is described in greater detail below.

2.2.4.1. Field survey and sampling programme

The field survey was aimed at becoming generally familiar with the present level of services, and at providing an inventory of the types of facilities and construction techniques applied for each of the various existing water supply systems.
The sampling programme covered both ground water and surface water supplies and was carried out in close co-operation with the hydrological and hydrogeological sections. The ground water resources were sampled from hand dug holes, lined shallow wells, and boreholes. The surface water resources were sampled from rivers, streams, springs and surface (piped) water supplies. The sampling programme for each water source surveyed consisted of:

- the collection of a one litre sample for detailed analysis at the Consultant's laboratory at Morogoro;
- the carrying out of a bacteriological test on site.

2.2.4.2. Physico-chemical aspects

Physico-chemical water quality parameters which may restrict the use of water for drinking water purposes are:

- substances which are toxic;
- substances which effect human health;
- substances which effect the palatability of water.

Toxic substances are not very common in natural waters, and are usually introduced into water bodies as a result of human activities, e.g. industrial development. Such activities are virtually absent in the survey area and therefore the determination of possible toxic substances was not considered. Substances which effect human health are mainly fluoride and nitrate. These parameters were part of the standard measurement programme. Substances which effect the palatability of water are many and comprehensive tests would be required to measure all of them. Within the standard measurement

programme the electrical conductivity and pH value were determined. In addition the organo-septic properties were recorded through sensorial observation, and expressed as "good", "fair" or "poor", in accordance with the general appearance of the water. Iron and manganese were measured at random for each of the various hydrogeological sub-areas to get a general idea of the concentration of these substances in the water resources. Only if the electrical conductivity (EC_{25}) was over and above 200 mS/m a more comprehensive test was carried out, including parameters such as calcium, magnesium, total hardness, iron, manganese, bicarbonate, chloride and sulphate. The objective was to collect more information about the composition of these relatively salty waters so as to be able to draw up explanations for the possible cause of these high salt contents (see also Part D).
The test programme for physico-chemical analyses is summarized in Table B 2.2-3.

Table B 2.2-3 Summary of the physico-chemical test programme of the MDWSP-survey

1. Standard measurement programme	EC_{25}, pH, F^-, NO_3^-, Sensorial observation
2. Random sampling programme	Fe, Mn
3. Comprehensive test if EC_{25} > 200 mS/m	EC_{25} pH, F^-, NO_3^-, Sensorial observation, Ca, Mg, TH, HCO_3^-, Cl^-, SO_4^{2-}

2.2.4.3. Bacteriological aspects

The presence of faecal material in water presents the most immediate hazard to health, since faecal material from either human or animal sources may contain pathogenic micro-organisms.
The indicator organisms commonly used in temperate climates to investigate the bacteriological quality of water include the following non-pathogenic groups of bacteria:

- Coliforms;
- Faecal Coliforms;
- Faecal Streptococci.

Diseases transmitted by faecal material may be caused by viruses, bacteria, protozoa or metazoa. Bacteria constitute the majority of the normal intestinal flora, and counts of intestinal bacteria can therefore be used to give a suitable test of the extent of faecal pollution of water.
The Coliform group is not considered to be suitable for investigations in hot climates as Coliform numbers can increase quite significantly in warm polluted waters. Moreover several of the species belonging to the Coliform group are present in unpolluted soil and water, so that the standard test for these organisms cannot be said to indicate specific faecal pollution.

Faecal streptococci are occasionally used as indicator organisms. They show little tendency to regrow outside intestinal conditions, but their rapid death rate in temperatures higher than 20 °C most likely diminishes their value as indicator organisms in tropical waters [6].

The faecal coliform test is at present the most frequent applied test for specific indication of faecal pollution. The E.Coli bacterium is exclusively faecal and constitutes over 90% of the coliform flora of the human intestines. Although in tropical waters some interference may be caused by other organisms of the coliform group, the faecal coliform test must be taken as the most sensitive and specific indicator of faecal pollution at present available.

The Consultant has adopted the Faecal Coliforms as the indicator organisms for recent faecal pollution. The test procedure applied was the membrane filtration technique as described in the WHO document "Surveillance of Drinking Water Quality" [7]. Portable field equipment was used to carry out the tests (see par. B 2.4.), and the test was part of the standard measurement programme for all water sources sampled.

2.2.5. Water quality and health

An adequate supply of water for drinking, personal hygiene and other domestic purposes is essential fot the public health and well-being of society as a whole. Such water supply is characterized by adequate standards with regard to quantity, quality, accessibility and reliability of the water supply system.
In order to assess whether a particular water supply is appropriate to the objective of improving the health of the people who use it, one needs to have a fairly precise knowledge of the relations between water, hygiene, sanitation and health. In tropical countries between twenty and thirty different infectous diseases may be influenced by changes in water supply. They are usually classified by the micro-organisms causing them, into viral, bacterial, protozoal and helminthic diseases. But this is not very helpful in considering the effects of improved water supplies. What is more relevant is the mode by which the diseases are spread, and in that way various categories of water-related diseases may be distinguished.

A classification of the infectious water-related diseases into distinct mechanisms by which diseases may be water-related is discussed in the next paragraph.

2.2.5.1. Typology of water-related diseases

Bradley [8] proposed a classification of water-related diseases which rests upon four distinct mechanisms by which a disease may be water-related. These mechanisms are water-borne, water-washed, water-based and water-related insect vectors. This classification, however, is not mutually exclusive for the first two mechanisms for the large group of faecal-oral diseases which are the main cause of high morbidity in low income communities. Faechem [6], therefore, suggests slightly revised categories which allows for assigning all the water-related diseases to one of these categories. These are summarized in Table B 2.2-4. Examples of the pathogenic agents and preventive strategies are given.

Table B 2.2-4. Categories of infectious water-related diseases and preventive strategies

Categories of transmission mechanism	Examples	Preventative strategy
1. Faecal-oral infections (water-borne or water-washed) (a) low infective dose (b) high infective dose	 typhoid, cholera bacillary disentery, infectious hepatitis	improve water quality (water-borne component) and improve availability, accessibility and reliability of water supply; improve hygiene.
2. Water-washed infections: - skin and eye infections - other	 trachoma, scabies louse-borne fever	improve water quantity and water accessibility, improve hygiene
3. Water-based infections: - penetrating skin - ingested	 schistosomiasis guinea worm	decrease need for water contact, control snail populations and improve water quality.
4. Infections with water related insect-vectors - biting near water - breeding in water	 sleeping sickness yellow fever, malaria	improve surface water management, destroy breeding sites of insects and decrease need to to visit breeding sites

Source: Faechem [6]

This classification of water-related diseases can facilitate the use of health improvements as design benefits and thus promote efficient resource allocation. If the principal water-related diseases in a region are identified and classified according to the table, then it is possible to identify the types of water supply improvements which will have the greatest impact on health, to consider the cost-benefit aspects of different schemes and to nominate local and regional priorities for supply development.

The Consultant will use the classification described above in the evaluation of the health statistics available in the survey area.

2.2.5.2. Occurrence of water-related diseases

For the inventory of water-related diseases prevailing in the survey area the Consultant has made use of the health statistics data as available from the Districts' Medical Officers. Such data are normally compiled on a monthly basis by the District's Governmental hospital, the rural health centres, and the dispensaries.

The Governmental medical centres are expected to send monthly reports to the District Medical Officer containing data on the disease pattern and the number of first attendances and re-attendances for each disease with a breakdown for sexes and various age groups.

From a number of monthly reports over the year 1978, data were obtained on the first attendances for the following water-related diseases:

- faecal-oral diseases	: cholera - bacillary dysentery - diseases of the digestive system - diarrhoeal diseases
- water-washed diseases	: skin and eye diseases, ulcers
- water-based diseases	: schistosomiasis, helminthiasis
- water-related insect vectors	: malaria

The data obtained are far from complete and this has hampered the carrying out of a comprehensive analysis of the health conditions prevailing in the survey area. From the data available some general conclusions have been drawn with regard to these public health conditions, and its relation to the present level of services in domestic water supply. Recommendations have been formulated for the improvement of the domestic water supply systems and hygienic practices required to arrive at maximum health benefits.

2.2.6. Water demand studies

Water demand studies require input data such as water consumption per capita per day, present population in each supply area, and the estimated population growth in that area. Additional water demand will be created by livestock, agriculture (irrigation), public and private institutions (schools, health centres, guest houses) and the industrial sector (sisal estates, sugar estates).
The MDWSP study is primarily concerned with domestic water supply for rural communities. Public institutions such as primary schools, rural health centres and dispensaries constitute essential facilities for these rural communities, and the water demand generated by these institutions has therefore been included in the future domestic water demand projections. Water demand, other than domestic water demand for rural dwellers, has been left out of the water demand projections. An exception has been made for domestic livestock, i.e. small groups of livestock returning to the homestead during the night, as they are considered part and parcel of a village community. The livestock water demand on the one hand, and the water resources and cost implication on the other hand, constitute essential data in deciding when livestock watering may be included in a public water supply system and when other water sources for livestock have to be arranged for.

Summarizing, the following have been incorporated in the future water demand estimates:

- rural population;
- village primary schools;
- rural health centres and dispensaries;
- domestic livestock.

The MDWSP staff conducted a demographic survey as part of the preliminary survey of the project area in the period June-October, 1977. The outcomes were reported in the First Report [3]. In September, 1978, however, the Tanzanian Government carried out a national population census. The data from this census are considered to be more up to date and comprehensive than the MDWSP demographic survey, and have been used as input data for the water demand studies. The population census data were obtained from the Bureau of Statistics of the Ministry of Finance and Planning.
During the last quarter of 1978, a similar census was conducted for livestock. The results of this census were obtained from the Districts' Livestock Officers in Morogoro and Kilosa. These data have been used for the water demand projections for domestic livestock. Large cattle herds of parastatals and educational training institutions have been left out of consideration, for reasons explained above.

Data on the location of village primary schools in the survey area were obtained from the District's Educational Officers. Information on the location of Governmental rural health centres and dispensaries were collected from the District's Medical Officers.

The criteria required for the water demand projections have been adopted from Ministerial directives [9] and the current practice of the RWE's Office.
For the future development of rural water supply systems the Ministry applies a criterion of water allowance per capita, rather than water demand per capita. The water allowance is set at 30 l/c/d for a period of 20 years. The main objective of this policy is to save capital expenditure on rural water supply systems. A specific capital budget will then allow for the construction of improved water supply systems for more villages and facilitate the attainment of the long-term targets in rural water supply (see pararagraph B 2.3.)
The MDWSP has largely followed these directives for the water demand projections but has, in contrast with the current practice in the Morogoro Region, included an allowance of 25% for losses due to leakages and wastage. Similar allowances for losses are applied in other regions in Tanzania (e.g. Kilimanjaro Region).

Domestic livestock has been expressed in Livestock Units, one Livestock Unit (L.U.) being 1 head of cattle, 5 sheep or 5 goats. The water demand for a Livestock Unit was taken to be 22.5 l/L.U./d, as used by the RWE's Office.

Water demand for primary schools, health centres and dispensaries has been based on data for primary school enrolment (30% of the village population at the maximum), and estimates for attendances and staff in health centres and dispensaries (450 attendances and 15 staff members, 400 attendances and 10 staff members at the maximum respectively).

The present average population growth rate amounts to 2.7%, that for livestock is unknown. The current procedures of the Ministry and the RWE's Office have been adopted for the future water demand projections, viz. for population 50% increase in 10 years, and 100% in 20 years; for livestock 25% increase in 10 years, and 50% in 20 years.

The water demand estimates have been carried out for four periods:

- todate (1978) indicating the present water demand;
- 5 years (1983) for short-term projections
- 10 years (1988) for medium-term projections
- 20 years (1998) for long-term projections

2.3. Identification of problem areas

2.3.1. Introduction

Various criteria may be adopted to identify problem areas and select priority villages for the construction of domestic water supply systems, e.g. economic, political, or humanitarian criteria. The economic criterion refers to a situation of development potential in which a lack of sufficient drinking water inhibits or hampers the exploitation of the productive capacities of an area while other factors for such exploitation, e.g. soil conditions, precipitation, infrastructure, are relatively favourable. Political considerations leading to a high priority identification for water supply improvements may comprise aspects, such as a favourable response to Government policies in certain areas, or alternatively a means to make the population of certain areas adopt a specific Government policy. Humanitarian criteria refer to the selection of a priority area on the basis of its very poor water supply system - in relation to quality, availability, accessibility and reliability of the supply - without giving much attention to other potential benefits.
The major strategic choice is between a "worst first" and a "growth point" strategy. The policy of concentrating water supply investments in growth points which possess complementary facilities will increase the probable economic and health impact but is in direct conflict with a policy of priority to the poorest areas. This latter is likely to be a high cost policy with a low probable pay-off. There may be greater operation and maintenance problems and little likelihood of a significant proportion of total costs being raised by rates.

The Tanzanian Government has formulated its own national objectives for domestic water supply in rural areas. It aims at providing a sufficient and suitable water supply to all rural dwellers as a free commodity.

The MDWSP study is part of the Government's efforts to speed up the development of the rural water supply sector, in strong support of its villagization programme which was virtually completed in 1977.
The Consultant has undertaken to define development programmes for village water supply in accordance with these objectives, subject to resources constraints. Priority has been given to problem villages, and these problem villages have been identified by comparing the present water supply conditions of all villages in the survey area with the Government's objectives and policies for village water supply. These objectives will be briefly discussed in the next paragraph

2.3.2. Tanzania's objectives and targets for village water supply

The Tanzanian Government has established the following objectives for the development of the rural water supply sector:

- to provide a source of clean, potable and dependable water within a reasonable distance of every village by 1981 as a free basic service;
- to provide a reliable water supply with clean, potable water to the rural areas by 1991, so that all people will have ease of access (i.e. a distance of 400 m) to a public domestic water point. This supply should preferably consist of a piped system with communal water points, but a shallow well with hand pump also complies with the requirements.

The short-term objective allows for considerable subjective interpretation with regard to the types of facilities which should be catered for. Sometimes the "reasonable" distance mentioned in the 1981 target is defined at some 4 km, but this largely depends on the geographical, hydrological and hydrogeolocial conditions of the area. The current practice in internationally sponsored crash-programmes, which are undertaken to relieve the immediate needs for water supply in less favoured areas and villages, is to adopt a walking distance of 1.5 km (1 mile) to the newly constructed water sources. Examples of such programmes are the Shallow Wells Construction Projects in Shinyanga, Lindi - Mtwara and Morogoro.

The majority of the villages in the survey area comply with the 1981 target as far as the distance of 4 km to the water source is concerned, but there is a lot of room for improvement with regard to the requirements clean, potable and dependable.

The long-term objective, the 1991 target, defines clearly that the Government wishes to embark upon a nation-wide programme of public domestic water points at a relatively short distance from the homesteads. The inclusion of shallow wells with hand pumps in the technical solutions, which comply with the long-term objective, considerably increases the feasibility of the implementation of this objective.

2.3.3. MDWSP criteria for the selection of problem villages

The Consultant has formulated a number of criteria for the appraisal of the present village water supply conditions as compared to the requirements laid down by the short-term objectives. This appraisal has enabled the ranking of the villages in accordance with the seriousness of their water supply problems, and has resulted in the identification of distinct problem villages.

Within the context of the national policies, the following criteria for the identification of priority villages in the survey area have been adopted in the MDWSP study:

- relation between the present water demand and the present water availability;
- quality of the source (labelled good, fair or poor);
- average distance to the water source (km);
- reliability of the present water source or water supply facility, expressed as the time period of the year (in %) during which water availability matches with water demand;
- quality of the water, using the electrical conductivity as the quality standard;
- size of village.

For this comparative analysis, the village has been the smallest unit considered and the worst conditions (i.e. end of the dry season) have been taken as the reference level. The villages were given a score for each of these six criteria, and their total score has determined their ranking on the priority list of problem villages.
The suggested scoring procedure is summarized in Table B 2.3-1.

Table B 2.3-1. Scoring procedure for the assessment criteria used for the appraisal of existing village water supplies

Selection criteria	Scores		
	3	2	1
Water demand/availability	< 0.5	0.5 - 1.0	> 1.0
Quality of Source	poor	fair	good
Average distance to source (km)	> 2.5	1.0 - 2.5	< 1.0
Reliability of supply (%)	< 75	75 - 100	100
Quality (EC in mS/m)	> 200	100 - 200	< 100
Village population (1978)	> 2000	1000 - 2000	< 1000

The Tanzanian Government wishes to provide a water supply to as many rural dwellers as possible within the available development budgets. Therefore, the implementation costs per capita of rural water supply development programmes may play an important role in the final ranking of priority villages for implementation programmes. This activity is part of more detailed studies of the problem areas in Part E.

2.4. Equipment

The equipment which was used for the water quality studies can be divided between equipment for physico-chemical determinations, and equipment for bacteriological tests.

1. Physico-chemical determinations.
   The majority of the tests were carried out with the HACH portable field kit, Type DR-EL2.
   This field kit contains an electrical conductivity meter, a spectrophotometer, and equipment and reagents for titration tests.
   The electrical conductivity meter is automatically corrected for a temperature of 25 °C and has a range of 20 - 2000 mS/m (200 - 20,000 µS/cm).
   The spectrophotometer was used to determine iron, manganese, nitrate, sulphate and silica.
   The titration technique was used to determine calcium, magnesium, bicarbonate, and chloride.
   An Orion specific ion meter, type 401, with selective (combined) electrode systems was used to determine pH values, and fluoride.
   The pH determination was by direct measurement, whereas standardized solutions, using TISAB buffer, were prepared to measure the fluoride concentration.

2. Bacteriological tests.
   The bacteriological tests were performed with the Millipore portable Water test kit Cat. nr. XX63 001 50.
   This test kit is based on the membrane filtration technique and contains all basic apparatus, including a field-sterilizable filterholder operated by a valve syringe used as a vacuum pump. Petri dishes, membrane filters (0.45 mm), ampouled culture mediums, and a battery operated incubator.
   The kit may either be used to determine Total Coliforms or Faecal Coliforms, depending on incubation temperature and culture medium applied.
   During the MDWSP field survey the Millipore field kit was used to determine Faecal Coliforms (E.Coli) at an incubation temperature of 44.5 °C during a period of 24 hours, with MF-C broth (Cat. nr. M 000 000 2F) as the culture medium.

A laboratory for the MDWSP survey was established in the team's office at the Maji yard in Morogoro Town. Apart from the equipment mentioned above the laboratory contained some furniture such as a cupboard, tables, and chairs, and a refrigerator for the proper storage of the ampoules containing culture medium.
Distilled water for the water analysis test procedures was obtained from the Maji laboratory at Ubungo.

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3. DATA COLLECTION AND EVALUATION

3.1. Existing water supply facilities

3.1.1. Typology of present water supply systems

Availability of clean water in the village is considered to be a major factor influencing rural development. This fact has been duly recognized by the Tanzanian Government. Therefore, it has pursued a policy of improving domestic water supply conditions with emphasis on the rural areas.
Yet, in spite of all efforts and achievements, the majority of the country's rural population still uses the traditional ways of obtaining drinking water. This also applies in the survey area.
The present water facilities may be distinguished in:

- traditional and semi-improved systems, i.e. hand dug holes (on village ground or in river bed), rivers, streams, springs, and lined open shallow wells. The lining of such shallow wells may consist of sheet metal (open ended oildrums), masonry or concrete work
- improved systems, i.e. lined shallow wells with hand pumps and piped water supplies, either gravity or pumped systems

Table B 3.1-1. summarizes the various ways in which the villagers of the survey area obtain their drinking water during both the wet and the dry season.

Table B 3.1-1. Distribution of the rural population according to the type of domestic water supply by season - 1978 (%)

	Traditional and semi-improved supply			Improved supply			
Season	river stream spring reservoir	Hand dug holes	lined open shallow well	shallow wells with hand pump	piped supplies gravity	piped supplies pumped	Total
Wet	52	15	11	4	8	10	100%
Dry	47	25	9	4	6	9	100%

The table shows that the large majority of the rural population in the survey area (557,000 inhabitants in 360 villages) depends on traditional and semi-improved systems. The traditional systems are either natural or man-made with relatively slight effort, using simple technology and constructions materials. The semi-improved systems are made by self help, e.g. open shallow wells lined with sheet metal, or by the RWE's office, e.g. open shallow wells lined with masonry or concrete work.

Roughly 20% of the total rural population is served with improved systems. These are, in general, lined shallow wells with hand pumps and piped public domestic water supply systems, most of which are constructed by the RWE's office. In addition, some people living in villages make use of non-public improved systems, which are formally owned by private institutions and parastatals but are in fact open to public use. In most cases these are piped water supply systems with one or more taps for public use. In the analysis of the various types of improved water supply systems, these non-public supplies are left out of account. In public domestic water supply systems, water may be obtained from public supply points or by means of a private connection. In the former case water is provided free of charge, whereas in the latter case water has to be paid for (Tshs 2.20/m^3). These private connections are found in six villages in the survey area, viz. Kichangani (Turiani), Kidugallo, Mikese, Mvomero, Legezamwendo (Kingolwira) and Ngerengere. For the purposes of this survey improved rural water supply systems have been differentiated as follows:

- gravity piped water supply from a river or spring;
- pumped piped water supply from a well in, or along, the river bed;
- pumped piped water supply from a borehole;
- pumped piped water supply from a shallow well;
- shallow well with hand pump.

3.1.2. Traditional and semi-improved water supply systems

Compared with many other parts of Tanzania, the survey area is fairly well endowed with surface water resources. A large number of rivers and streams are perennial and supply a considerable percentage of the area's population with a sufficient quantity of water throughout the year. Ground water resources, which are easily exploited by the villagers because of the high ground water table, are found in a limited number of areas, i.e. alluvial river valleys and some areas with swamp deposits.

During the wet season 52% of the rural population rely on river water, whereas 10% obtain water from hand dug holes. No more than 5% depend on hand dug holes in the river bed of those rivers and streams which only occasionally contain water and on other sources, i.e. natural lakes, ponds and waterpools. During the dry season the picture changes. Rivers and streams remain the major source of drinking water, but quite a number of water courses dry up, especially towards the end of the dry season. Therefore, people dig holes in the river bed, because in many cases the alluvial deposits have a relatively high ground water table. Consequently, this source of supply increases in importance during the dry season, when some 16% of the total rural population make use of this source. Hand dug holes elsewhere decrease slightly in importance during the dry season because of the lowering of the ground water table.

In the survey area shallow wells without a hand pump provide water for 60,000 people living in 30 villages during the wet season, and to 49,000 people in 24 villages during the dry period. Most of these wells are located in the flood plains and in those parts of the foothill areas and piedmonts where the water table is high enough to make construction a viable undertaking, in the sense that the well will provide sufficient water for the greater part of the year.

This general picture, however, obscures local variations in availability and quality of water. Such variations largely coincide with the geomorphological zones, especially with the mountainous areas on the one hand and the piedmonts, foothill areas and flood plains on the other. In general, water problems do not occur in the villages located in the well-watered mountainous parts of the survey area, i.e. the Uluguru mountains and the Nguru and Rubeho mountains. In these areas the high average annual precipitation sustains a number of springs and large and small perennial water courses, which contain sufficient water of a good quality, not seriously polluted by human beings, during both the wet and the dry season.
In the remaining parts of the survey area the problems encountered are related to the availability of water in sufficiently large quantities, and to the quality of the water. In these parts there is a greater variety of traditional supply systems: perennial streams, hand dug holes in river beds, and hand dug holes elsewhere.

Because of the large number of perennial streams coming down from the mountainous areas a number of villages located in the piedmonts and foothill areas and in the flood plains have no problem in obtaining sufficient drinking water.
However, these water courses become more polluted downstream as a result of population concentrations in the upstream areas.
On the other hand, there are a considerable number of villages located along or near rivers and streams which only contain water during the wet season. Therefore, the villagers are compelled to dig holes in the river bed during the dry season.
In most cases these hand dug waterholes yield a sufficiently large quantity of water, but the quality is usually of a poor standard, i.e. the holes yield salty water. The hand dug waterholes elsewhere are mainly found in villages located in the flood plains and in the foothill areas. These holes provide sufficient water of a fair quality during the wet season. During the dry period, however, these rather shallow holes - most of them being not deeper than two to three metres - have modest to low yields.
More detailed information about the various types of water supply for individual villages is given in volume VI, the Village Data Handbook.

3.1.3. Improved water supply systems

Some 50 villages in Morogoro and Kilosa Districts are served by improved rural water supply systems. For some of these villages the improved systems constitute the only source of water supply; for other villages they are the most important source; and for a third group of villages water provided by means of improved systems is of minor importance as it is available to only a small proportion of the village population. The survey revealed that in 1978 around 110,000 people, or 20% of the total rural population of the survey area, were served by improved domestic water supply systems.

Table B 3.1-2. shows the relative importance of the various types of improved systems.

Table B 3.1-2. Relative importance of various types of improved domestic water supply systems (1978)

Type	No. of people served				No. of villages			
	wet season		dry season		wet season		dry season	
	total	%	total	%	total	%	total	%
Gravity piped water supply systems	45,000	37	35,000	33	22	42	18	39
Pumped piped water supply from river	33,300	28	29,500	28	15	28	13	28
Pumped piped water supply from borehole	14,600	12	13,300	13	5	9	4	6
Pumped piped water supply from shallow well	4,400	4	4,400	4	2	4	2	4
Shallow well	22,800	19	22,800	22	9	17	9	20
Total	120,100	100	105,000	100	53	100	46	100

All data on existing water supplies contained in this paragraph are based on the total village population in each supply area. Therefore, the estimate of the total population served by improved water supplies will be somewhat optimistic, but it still offers a fairly good impression of the current domestic water supply facilities in the survey area.
Piped water supply systems, owned by private institutions or parastatals, which are open to public use are not included in this inventory. A short summary of such facilities is given in Annex BA 2.

Gravity piped water supply systems

Gravity piped water supply is one of the most important types of improved water supply. The system consists in general of a water intake structure, where the water is diverted from a river, stream or spring, a gravity transmission main (sometimes provided with break-pressure tanks), one or more storage tanks, distribution systems and domestic water points.
This type of supply provides water to around 45,000 people in 22 villages (see Table B 3.1-3. and Figure B 3.1-1.). The spatial distribution is partly determined by the availability of perennial sources of water and partly by suitable relief. However, technical improvements have facilitated the distribution of water over large distances. Therefore, areas lacking perennial water sources and those with inadequate or poor quality ground water

Table B 3.1-3 Existing piped water supply systems for village water supply in the survey area (1978)

Village	District	Source	Year of completion	Population 1978	Design flow (l/s)	Transmission system	Manufacture and Specifications of Pumps and Engines	Total length Transmission main (km)	Capacity Storage Tank (m^3)	Total length of Distribution lines (km)	Distribution lines (m/cap)	Number of D.W.P.	Cattle trough (CT) Cattle dip (CD)	Drawing number	Remarks
Mvomero, and	M	R	1975	3458	} 4.03	G	-	4.37	135 L	5.1	1.5	17		17153	
Dibamba	M	R	1975	801		G	-	2.9		1.8	2.2	5		17153	
Kitungwa	M	R	1960	2211)		G	-	-	-	8.1)		2	)		
Legezamwendo	M	R	1960	1373)	1.75	G	-	-	-	1.62[1])	2.03	1	)	7545	[1] from Kitungwa line
Misongeni	M	R	1960	1428)		G	-	-	-	0.43[1])		2	)		[1] from Kitungwa line
Pangawe	M	R	1975	886		G	-	5.1	45 L	1.6	1.8	8		17202	
Kisinga	M	R	1976	738		G	-	6.94	-	7.9	10.7	5		17202	
Kauzeni	M	R	1971	781	0.63	G	-	1.5	22.5 L	2.2	2.8	8		17121	
Changarawe	M	R		1305	1.7[2]	G	-			1.5		1			[2] design flow estimated
Langali	M	R	1974	2201		G	-	4.1		1.9	0.9	5			
Mtamba	M	S	1967	3160	4[2]	G	-		3x1 L	4.1	1.3	3		17103A	[2] design flow estimated
Turiani, and	M	R	1967	3593	} 2.5	P	Godwin(2),Lister(2)	1.4	45 H	2.8	0.8	10		17092	
Kilimanjaro	M	R	1967	2235		P	- see Turani -	0.5	22.5 H	0.2	0.1	3		17092	
Mkata Ujamaa	M	RSW	1969	388		P	KSB, Lister	2.1	22.5 H	5.0	12.9	4			
Mlali, and	M	RIW	1969	2196	} 2.6	P	Godwin(2),Lister(2)	1.2	45 L	3.4	1.6	7		17095A	
Kipera	M	RIW	1969	2280		P	- see Mlali -	3.0	22.5 L	1.2	0.5	3		17095A	
Bwakira Chini	M	RSW	1970	1379	3.0	P	Mather Platt, Kiloskar	1.0	45 H	2.8	2.0	5		17093A	
Lukenge	M	RIW	1971	864	1.03	P	Mather Platt, Kiloskar	1.4	22.5 H	0.5	0.6	3		17139	
Kiswira	M	RIW	1972	1230	3.8	P	Grundfos, Bukh	0.2	45 H	2.4	2.0	12		17148	
Kikundi	M	RSW	1972	1489	1.38	P	Grundfos, Bukh	2.1	22.5 L	1.6	1.1	6		17138	
Melela	M	SW	1977	3489	13.81	P	Mather Platt (2), Kiloskar (2)	5.3	225 L	10.6	3.0	17		17231	
Kambala	M	B	1972	1009	2.06	P	Seha, Lister	7.8	45 H	11.4	11.3	6		17120	
Kidugallo	M	B	1968	2138	1.15	P	Mono, Lombardini	1.7	45 H	2.8	1.3	5		17097	6 private taps
Mikese	M	B[3]	1968	2081	3.76	P	Mono, Lister	1.1	22.5 H	2.2	1.0	9		17300	[3] abandoned
Kisitwi	K	R	1972	2130)		G	-	5.7	45 L[4]	2.0	0.9	3	CT	17085	[4] two of these tanks
Rubeho	K	R	1972	2872)		G	-	6.2	90 L	3.0	1.0	2	CT	17085	
Kwipipa	K	R	1972	1273)	11.5	G	-	2.0	45 L	3.0	2.4	1		17085	
Msingise	K	R	1972	1582)		G	-	4.3	45 L	3.7	2.3	3	CD	17085	
Luhwaji	K	R	1972	879)		G	-	-	-	3.2	3.6	1		17085	supply from Msingise tank
Gairo	K	R	1972	5008)		G	-	7.0	135 L[5]	9.9	2.0	11		17085	[5] in addition 22.5 H
Ukwamani	K	R	1972	1609	} 1.03	G	-	5.5	-	0.1	0.05	1		17166	supply from transmission main to Majawanga
Majawanga	K	R	1973	955		G	-	10.5	45 L	3	3.1	3		17166	facility utilized by Meshugi and Mkalama
Kibedya	K	R	1974	3271	}	G	-	14.9	45 L	1.0	0.3	4		17165	
Chakwale	K	R	1975	4416		G	-	6.1	135 L	3.0	0.7	15		17165	
Maguha	K	RSW	1975	1827	3.64	P	KSB(2), Lister(2)	0.6	45 H	4.2	2.3	7		17218	
Berega	K	RIW	1970	2890	1.88	P	KSB(2), Lister(2)	2.2	225 L[6]	3.8	1.3	14		17113	[6] in addition 22.5 L
Mvumi	K	RIW	1972	3406	2.81	P	Mather Platt, Kiloskar	0.35	22.5 H	2.1	0.6	6		17143	
Msowero	K	RIW	1972	4845	2.2	P	Mather Platt, Kiloskar	1.5	22.5 H	2.9	0.6	13		17142	
Kivungu	K	RIW	1972	2265	1.44	P	Mather Platt, Kiloskar	1.6	22.5 H	2.6	1.2	7		17123	
Kilangali	K	RIW	1970	2357	2.05	P	Mather Platt, Kiloskar	0.3	22.5 H	2.4	1.0	7	CT,CD	17129	
Kiduhi	K	RSW	1978	452	10.5	P	KSB(2), Lister(2)	9.0	90 H	2.3	5.0	3	CT,CD	17193	
Meshugi	K	B	1961	1240		P	Climax, Peter	0.05	22.5 L	0.2	0.2	1	CT,CD	7045	abandoned
Magubike	K	B	1966	2916	1.0	P	Mono, Lombardini	0.5	22.5 H	0.6	0.2	2		17089	saline water
Magole	K	B	1977[6]	3752	1.88	P	Mono, Lister	4.7	45 H	4.7	1.3	6		17219/2/4	[6] still under construction

Legend:
M = Morogoro District
K = Kilosa District
R = River intake
S = Spring

RSW = riverside well in, or along, river bed
RIW = intake well with direct surface recharge
B = borehole
SW = shallow well

G = gravity diversion
P = pumped supply
L = storage tank at ground level
H = storage tank on raiser

Note: The Maji Department normally does not make as-built drawings of its piped water supply systems. The data summarized in this table were obtained from the RWE's Office and are partly based on drawings, partly on memory of technicians, and partly on field visits. The date should be handled with care and not be used for design purposes.

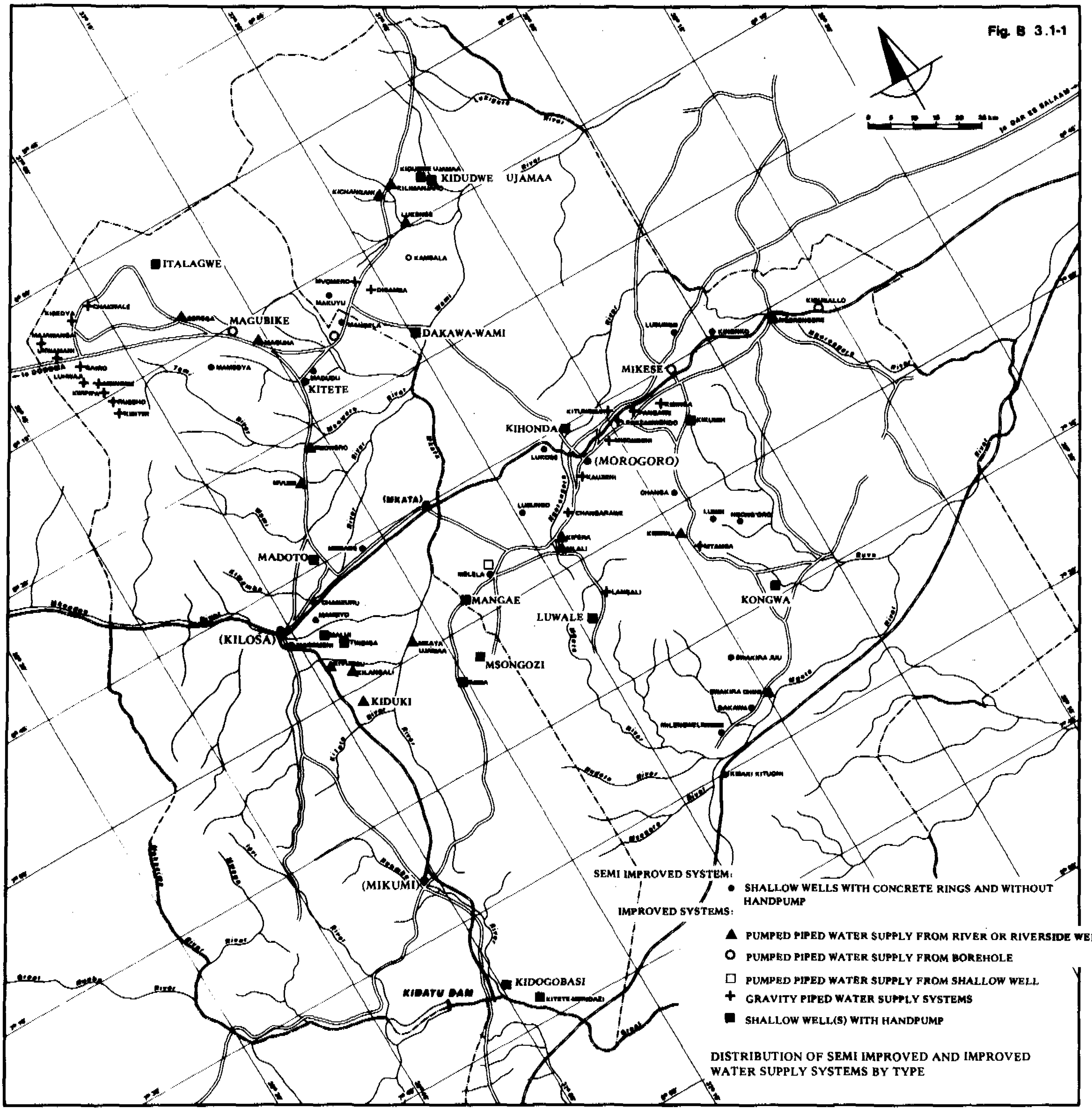

Figure B 3.1-1 Distribution of semi-improved and improved water supply systems by type.

sources may also be served. Consequently, the spatial distribution of the gravity water supply system may be heavily influenced by Government authorities, and available development budgets.

The existing gravity water supply schemes as far as relevant to village water supply will be described briefly below. The possible improvements to the systems will be discussed in Part E.

1. The Gairo gravity scheme

The most widely extended gravity supply system, with domestic water points in 10 villages, is found in the Gairo - Rubeho area, in the north-eastern part of Kilosa District. This system also provides water to people coming in from surrounding villages.
The system obtains water from two little rivers, the Mahero and tributary located in the Mamwira Forest Reserve in the Ukaguru Mountains near Masenge. The two intakes consist of little concrete reservoirs with a total storage capacity of less than 10 m^3, at a height of 1920 metres aMSL. Water flows from the first reservoir through a 10 cm (4") pipe to the second reservoir. It then flows through a small sand trap before it is conveyed to the amphitheatre shaped escarpment near Kisitwe through a 15 cm (6") gravity main. Several break pressure tanks and in-line storage tanks are part of the gravity transmission system which follows a traject along Kisitwe, Rubeho and Msingise towards Gairo.
At present the following villages are supplied by the system: Kisitwe, Rubeho, Kwipipa, Msingise, Luhwaji, Gairo, Ukwamani, Majawanga, Kibedya, and Chakwale. The altitude of the villages served lies between 1000 and 1400 metres.
A first system using the same sources was built in the 1950's by a European farmer. The system served the Kisitwe area. In the early sixties the Maji Department constructed a new system which served Kisitwe and Rubeho. The present system was partly constructed in 1971-1972 and then served villages up to and including Gairo. In fact, the extension to Gairo was made to provide that village with a new water supply after the borehole supply, which was constructed in 1966, had to be taken out of operation due to increase of salinity of the water source.
The system was expanded in 1972 to supply Ukwamani and Majawanga, and in 1974 - 1975 to supply Kibedya and Chakwale. The former villages are supplied from the storage tank in Gairo, the latter from the break pressure tank in Msingise. A layout of the present system is given in Figure B 3.1-2. The 1.4 km^2 catchment area is not inhabitated and is heavily forested. Hence most of the time, water with good physical and chemical qualities is assured. Only during heavy rains can some sediment be found in the water. It appears, however, that the catchment area is occasionally used by cattle herding people living adjacent to the catchment area. This increases the risk of faecal pollution of the water, as was confirmed by the bacteriological survey carried out at the source and in the supply area in the period of 26 - 28th February, 1979. The test results indicated that the whole supply system was contaminated with E.Coli (see Data BD 1, Table BD 1-1). During the same field trip, it was observed that the sand trap cannot function properly as its overflow is located at too low a level compared with the level of the overflow of the storage reservoir.

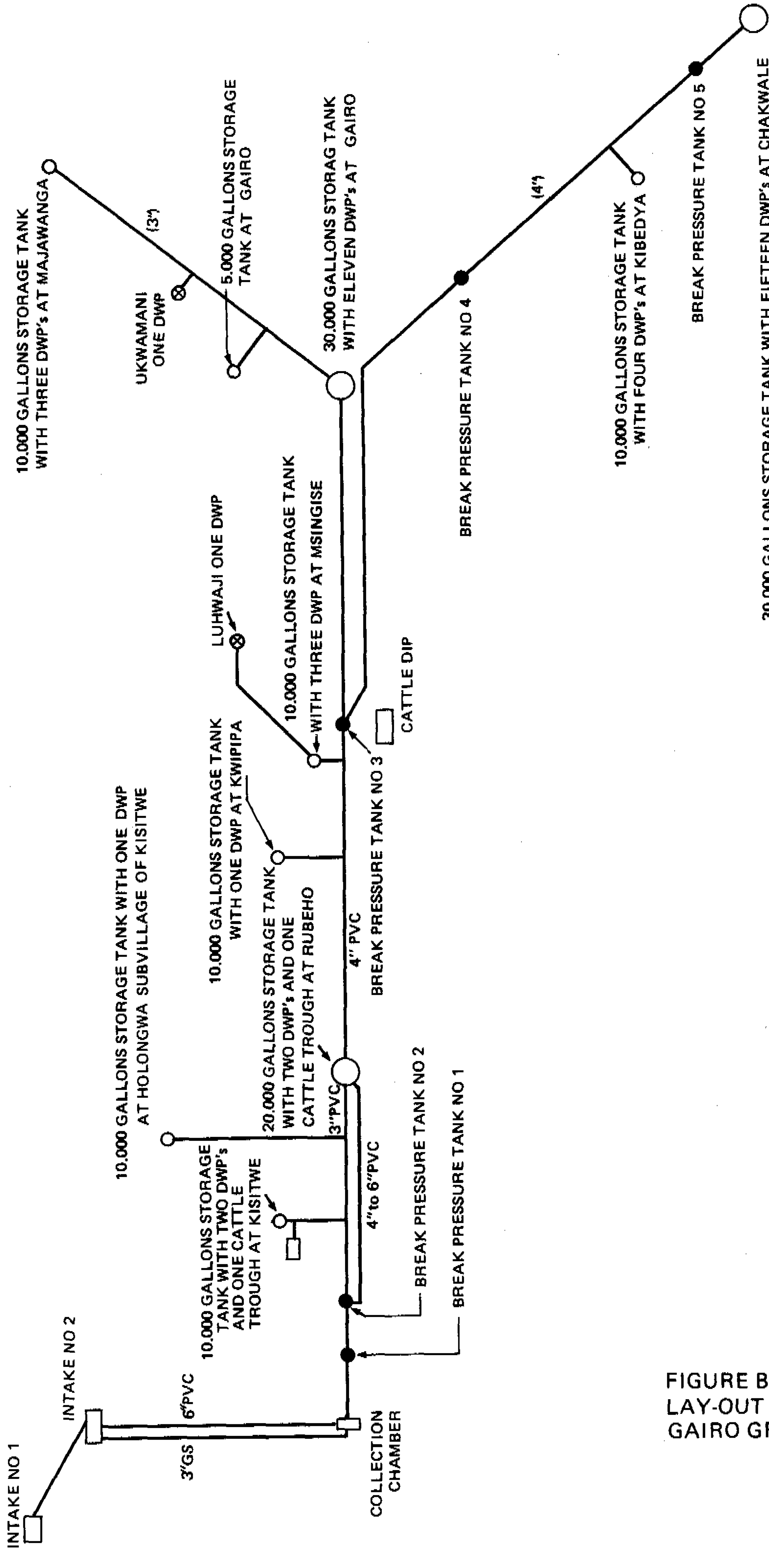

FIGURE B 3.1-2
LAY-OUT OF EXISTING
GAIRO GRAVITY SCHEME

Consequently the major part of the river flow passes through the sand trap, resulting in very poor hydraulic conditions for the proper sedimentation of sand particles.
The gravity transmission main has been designed for a flowrate of 10.6 l/s (8500 GPH). The actual flow, however, may be much lower due to large scale sedimentation of suspended material in the first stretch of the gravity main. At the edge of the Kisitwe escarpment a free flow as low as 3 l/s was measured, although the intake reservoir was overflowing at the time.

The present water demand of the 10 villages connected to the system is estimated at 11.5 l/s (see subparagraph B 3.4.2), and additional water demand is created by villagers from Meshugi and Mkalama who also make use of the system. In addition, extensive stock herding activities exist in the area and several villages have cattle watering facilities connected to this gravity system. The present livestock demand in the 10 villages is estimated at 7.4 l/s.
From this data it can be concluded that at present the system is not able to cater properly for its supply area, and this becomes even more serious if its capacity is under-utilized due to the partial clogging of the first stretch of the gravity main.
This situation is confirmed by the prevailing water supply conditions in villages such as Majawanga, Kibedya and Chakwale, where the villages may only receive limited amounts of water during two or three days a week.

2. The Mgolole gravity schemes

The River Mgolole emerges from the Uluguru Mountains 7 km east of the River Morogoro and flows parallel to it.
The first gravity scheme for village water supply was constructed in 1960 as a run-of-the-river supply, and still provides water to Misongeni, Legezamwendo (Kingolwira) and Kitungwa.
In 1975 a gravity scheme was constructed to Pangawe to replace its borehole supply of which the water had become too saline. From the Pangawe storage tank a distribution line was extended to Kisinga village in 1976.
Several other institutions, such as the Kingurunyembe Teacher Training College, the Bigwa Rural Training Centre, the Bigwa Secondary School, the TPDF at Pangawe, and the Lutheran Junior Seminary also draw water from the River Mgolole by means of gravity diversions.
At present three diversion weirs exist. They are located at 580, 600 and approximately 620 metres aMSL. A layout of the existing gravity schemes depending on the Mgolole River is given in Figure B 3.1-3.
The total design flow of all seven schemes together amounts to 15.1 l/s, whereas the 5% and 10% low flows of the river are estimated at 14 l/s, and 17 l/s respectively. In other words, there is no room for additional schemes to supply new areas, unless a comprehensive study of the future water requirements of the villages and institutions at present depending on the river shows otherwise. An evaluation of the water rights given to each of these consumers constitutes an essential part of this survey.
Although there may be no room for schemes to new supply areas, the present facilities in the villages receiving water from the Mogolole River are very limited and allow for some improvements. (See part E).

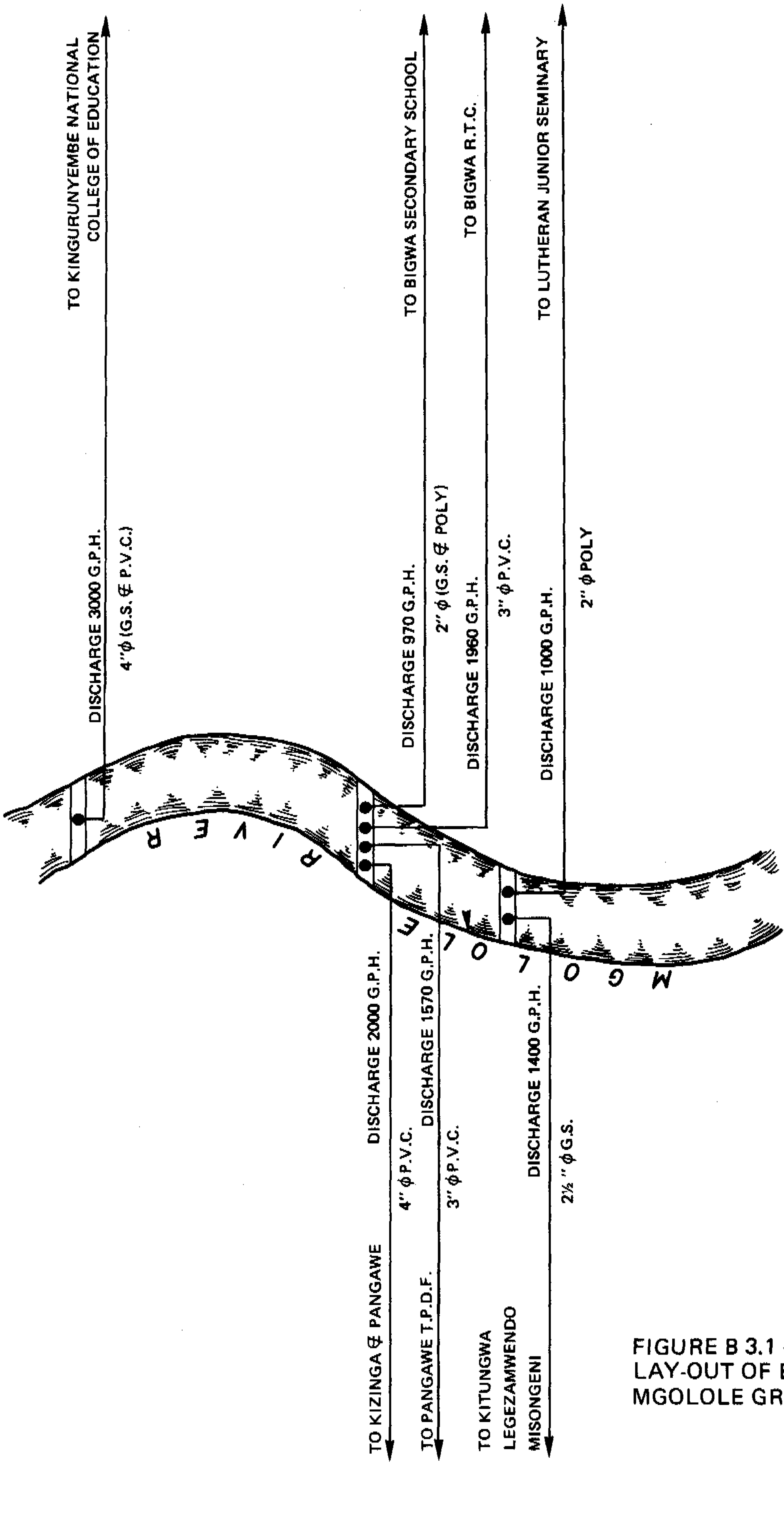

FIGURE B 3.1 – 3
LAY-OUT OF EXISTING
MGOLOLE GRAVITY SCHEMES

3. The Mvomero gravity scheme

The intake of this gravity scheme, which provides water to Mvomero and Dibamba, is located on the River Mvomero, 5 km West of Mvomero. The system was constructed in 1975 with a design flowrate of 4 l/s. The present water demand of both villages amounts to 2.1 l/s and the future demand (in 1998) to 4.3 l/s. The system contains a rather well developed distribution network with some 17 domestic water points, and could therefore serve the two villages for another 20 years approximately , if it was not for the fact that the river was running dry towards the end of the dry season.
During about two months each year, the villagers have to rely for their domestic water supply on lined shallow wells and hand dug holes (mainly in the river bed of the River Mvomero).
The system has been out of operation since November, 1978, when heavy rains caused a rupture of the gravity main. To date, 5 months later, the main has not yet been repaired.

4. Upper Ngerengere gravity schemes

Upstream from Konga - Vikenge, three intakes are located in the River Ngerengere which feed gravity diversions to Kauzeni, Mzumbe institute, Changarawe and Mapate (future TPDF camp). The intake structure for Kauzeni is located about 1 km off the road leading from Konga - Vikenge to Kauzeni, at an altitude of 550 metres aMSL. Kauzeni village itself is located at an altitude of 520 metres aMSL, some 3 km to the North of the intake. The system was constructed in 1971 and has a design flowrate of 0.63 l/s. The present and future water demand amount to 0.37 l/s and 0.75 l/s respectively. This allows the system to cater for the village water requirements for another 15 years.
Two other intakes are located near Tangeni mission. The oldest one, at an altitude of about 620 metres aMSL, is virtually within the mission grounds and comprises three gravity diversion lines, one to the Tangeni mission itself, and two to Mzumbe Institute. The structure dates from about 1956. Slightly upstream from this intake, another intake was constructed in 1975. The latter intake, at an altitude of 640 m aMSL, contains inlets for a gravity main (dia. 10 cm) to Mzumbe Institute, located below 600 m aMSL some 4 km from Tangeni, and for a gravity main (dia. 20 cm) to the future Mapate TPDF camp.
From the Mzumbe Institute a small line supplies water to one tap in part of Konga - Vikenge village, and another line (probably 2") provides water to a kiosk in Changarawe. Its capacity is estimated at 1.7 l/s which is enough to cater for the future water demand of that village in the year 1998. The single water point, however, causes frequent queuing and long waiting periods.

All three intakes span the full width of the river, and contain sluices for reservoir draining. The inlets to the gravity mains are located in small sand traps which are fed by a simple aperture in the sidewall. The concrete structures at all intakes are in need of repair.

5. The Langali gravity system

This run-of-the river system which was constructed in 1974 serves a dispensary and the centre of Langali village, or about 35% of the present population which lives very dispersed. The intake is located in the River Mzinga, a tributary of River Mgeta. The river discharges an abundant amount of water, and there are ample possibilities for future extensions.

6. The Mtamba Scheme

Mtamba village lies in the S.E. foothills of the Ulugurus in the Karst area. Part of the population makes use of a gravity water supply which consists of three separate little systems. The sources are three little springs at a hill slope just above Mtamba to the south. These springs flow into three separate small reservoirs, which are usually overflowing, and are conveyed under gravity to one domestic water point each. The system was constructed in 1967, with a total design flow of 4 l/s. Under the present conditions of the intake structures a 5% low flow of 0.25 l/s is estimated. The present water demand of Mtamba village amounts to 1.5 l/s, and the future water demand (in 1998) is estimated to be 3.04 l/s. During periods of shortage of water the population makes use of hand dug holes in nearby river beds.

Pumped water supply system

The pumped village water supply systems normally consist of a water intake structure, a pumphouse with pump(s) and engine(s), a rising main, a reservoir and a gravity distribution system. The distribution system feeds a number of domestic water points usually distributed over the village area. The water intake structure may consist of a direct river intake, an infiltration well along the river bed, a shallow well, or a borehole. This type of supply provides water to around 52,300 people in 22 villages (see Table B 3.1-3 and Figure B 3.1-1).

The existing pumped water supply systems, where relevant to village water supply systems, will be briefly described below. Recommendations for possible improvements to the systems will be discussed in Part E.

1. Turiani and Kilimanjaro water supply

These two villages are provided with water from a pumped water supply using the River Diwale as water source. The intake well is located close to the bridge where the main road crosses the River Diwale.
The intake well is partly fed by a gravity line having its intake a few hundred metres upstream from the intake well and partly by direct inflow of surface water into the well. The pumphouse is located on the riverbank adjacent to the intake well, and each village is provided with a storage tank and a number of domestic water points (see Table B 3.1-3). The system was constructed in 1967, with a design flowrate of 2.5 l/s. The present water demand for both villages is 2.84 l/s and the future water demand in 1998 is estimated at 5.79 l/s, requiring a design capacity of 5.7 l/s and 11.6 l/s respectively for a pumping schedule of 12 hours daily. Already at present the pumping unit and storage tanks are not able to cope with the demand. This often results in queuing, long waiting periods and taps running dry.

The supply system, as well as the River Diwale itself, is contaminated with E.Coli (see Data BD 1, Table BD 1-1).

2. Mkata water supply

Mkata Ujamaa village is provided with a pumped water supply using the River Mkata as the water source. The intake consists of a infiltration well along the River Mkata. The system was constructed in 1969. The design capacity is unknown.
The 1998 water demand of this small village is estimated te be 0.56 l/s, and therefore the present system will most likely be able to cater for the water requirements of the village for another 10 - 20 years, provided the pumping unit can be kept running properly.

3. Mlali and Kipera water supply

These two villages have a common water supply which was constructed in 1969. The intake is located south of Mlali and consists of an intake well in the bed of the River Mlali. The recharge of this well is rather low, and therefore an aperture was made in the side wall of the well to ensure direct surface inflow of river water. The pumphouse is located on the river bank, and each village has its own storage tank feeding a limited number of domestic water points. The system has a design flowrate of 2.6 l/s, whereas the present water demand is estimated at 2.21 l/s, requiring a transmission capacity of 4.42 l/s for a pumping schedule of 12 hours daily. This explains why people in Kipera and its subvillages are frequently confronted with taps which run dry. They are then forced to get their water from traditional sources such as hand dug holes in the bed of the River Mlali. At the sampling date, the distribution system was contaminated with E.Coli, most likely due to the poor structure of the intake well. (See Data BD 1, Table BD 1-1).

4. Bwakira Chini water supply

The intake well for this pumped water supply is constructed in the middle of the bed of the River Bwakira, which runs dry towards the end of the dry season. The recharge through the bottom of this properly constructed well appears to be fairly good, and the village does not experience any shortages in its water supply. The system was constructed in 1970, with a design flowrate of 3 l/s. The 1998 water demand is estimated at 1.32 l/s, so that in fact this system is oversized.
The distribution system appeared to be free from faecal pollution at the sampling date (see Data BD 1, Table BD 1-1).

5. Lukenge water supply

The River Diwale serves as source for this water supply. In the past, two wells were constructed in the wet season river bed, but these are not used any more as the suction head often became too high for the pump (according to information obtained from the Regional Maintenance Unit). At present the inlet of the suction line is located slightly above the wet season river bed surface. In other words, water of even quite poor quality can only be pumped into the system during part of the wet season if the water level in the river is high enough. During the dry season people have to collect

water from the River Diwale, of which the water is occasionally seriously polluted by the effluent from a nearby sugar factory.
The system was constructed in 1971, with a design flowrate of 1.03 l/s. The present and future water demand (1998) are estimated at 0.41 l/s and 0.83 l/s respectively. The transmission system is, therefore, large enough to serve the village for another 15 - 20 years. The present distribution system does not serve all parts of the rather dispersed village and requires some extensions.

6. Kiswira water supply

The intake is a well along the perennial River Mvizigo, one of the tributaries of the River Ruvu. Surface water flows directly into the well through a hole in its sidewall. The system was constructed in 1972, with a design flowrate of 3.8 l/s. The future water demand is estimated to be 1.18 l/s, requiring a transmission capacity of 2.36 l/s for a pumping schedule of 12 hours daily. Hence the system will be able to serve the village population for another 20 years provided proper operation and maintenance is performed.

7. Kikundi water supply

The intake structure consists of an intake well along the river bed of a small non-perennial river. No data are available on the yield of this well, but it seems to be enough for at least the present water demand of the village. The system supplies water to some six domestic water points in Kikundi village, whereas its subvillages still use traditional water sources. The system was constructed in 1972 with a design flowrate of 1.38 l/s. The present and future water demand (in 1998) for the whole Kikundi area are estimated at 0.78 l/s and 1.62 l/s respectively. This requires a system capacity of 1.56 l/s and 3.24 l/s respectively for a pumping schedule of 12 hours daily. It is estimated that the system is suitable for the present supply area, but it will require an increase in capacity in the near future. Extension of the distribution system to subvillages will only be possible after the proposed construction works have been completed. The distribution system appeared to be slightly contaminated with E.Coli at the sampling date (see Data BD 1, Table BD 1-1).

8. Berega water supply

This system uses the River Berega as water source. This river is not perennial, but carries a significant subsurface flow. Water is abstracted by means of an infiltration well in the river bed at the intersection with the terras slope. The system was constructed in 1970, with a design flowrate of 1.88 l/s. It contains an elevated storage tank of 22.5 m^3, a ground-level storage tank of 225 m^3, and a fairly extensive distribution system. The village has, however, a dispersed settlement pattern and part of the population uses hand dug water holes in the bed of the River Berega for its water supply. Some years ago a new pumphouse was constructed as the suction head turned out to be too high at the former location of the pumphouse.
The present and future water demand (1998) is estimated at 1.37 l/s and 2.78 l/s respectively. This requires transmission capacities of 2.74 l/s and 5.56 l/s respectively, for a pumping schedule of 12 hours daily. In

other words, the system will require an increase in capacity shortly, in order to be able to cope with the water demand from the village.
During the heavy rains in November 1978 the intake well was washed away, and the system has not been operating since. The River Berega bed is heavily contaminated with organic matter of faecal origin, mainly due to large cattle herds which frequently cross the area (see Data BD 1, Table BD 1-1).

9. Mvumi water supply

The source for this supply is the River Tami. The intake structure consists of an intake well along the river bed which is mainly fed by direct surface inflow through a hole in the sidewall of the well. The system was constructed in 1972 with a design flowrate of 2.81 l/s. The present and future water demand (1998) are estimated at 1.69 l/s and 3.46 l/s respectively, requiring system capacity of 3.38 l/s and 6.92 l/s for a pumping schedule of 12 hours daily. Consequently the system is not able to cope with the present demand and this situation is aggrevated by regular shut-downs of the system due to lack of fuel or other operation and maintenance problems. The villagers therefore frequently use the traditional way to obtain water from the River Tami.
The distribution system as well as the River Tami itself appeared to be contaminated with E.Coli on the sampling date (see Data BD 1, Table BD 1-1).

10. Msowero water supply

The intake structure consists of a well on the bank of the River Msowero. Water is conveyed to this intake well by a short gravity main whose inlet is located about 150 m upstream from the well. The water is mainly distributed to an Ujamaa settlement in the northern part of Msowero village.
The majority of the villagers have to go to the river for their water requirements. The system was constructed in 1972, with a design flowrate of 2.2 l/s. The present and future water demand (1998) are estimated at 2.38 l/s and 4.85 l/s respectively. This requires system capacities of 4.76 l/s and 9.70 l/s for a pumping schedule of 12 hours daily.
The system requires, therefore, a significant increase in capacity before any extensions of the distribution system to other parts of the village can be considered a viable undertaking.

The inlet structure of the gravity line to the intake well is poorly designed, and causes a significant load of suspended matter to be carried into the system. The construction of an infiltration well is hardly possible as the basement reaches the surface in that stretch of the river.
In 1977, the Maji Department drilled a borehole into the basement at about 1 km distance from the present intake. The construction works for the connection of this borehole to the existing system have not started yet. Moreover, its yield is most likely to be too low to make this borehole serve as a suitable alternative water source for the Msowero water supply.

11. Kivungu water supply

The intake well is located along the River Miyombo, and is mainly fed by direct inflow of river water through a hole in the side wall of the well. The system was constructed in 1972, with a design flowrate of 1.44 l/s.

The present and future water demand (1998) are estimated to be 1.15 l/s and 2.37 l/s respectively, requiring system capacities of 2.30 l/s and 4.74 l/s for a pumping schedule of 12 hours daily.
Hence, the system is not able to cope with the estimated present water demand and will need extension in the near future.

12. Kilangali water supply

The River Miyombo serves as the water source, and water is pumped to the village from an intake well along the river bed. The recharge of this well is mainly realized by direct inflow of river water through a hole in the side wall of the well.
The system was constructed in 1970, with a design flowrate of 2.05 l/s. The present and future water demand (1998) are estimated at 1.19 l/s and 2.46 l/s respectively requiring system capacities of 2.38 l/s and 4.98 l/s for a pumping schedule of 12 hours daily. In other words the system is already too small to comply with the water demand from the present population, and some people use traditional ways to obtain water for domestic purposes. Moreover, the village water supply system also provides water to a cattle trough and cattle dip, causing a considerable increase in the water demand. Extensions are required in the near future to make the system comply with this demand.

13. Kiduhi water supply

The Kiduhi water supply is mainly meant to provide water to the large cattle herds of this Masai settlement. The system was first constructed in 1975, using a shallow well as water source. When this failed, efforts were made to construct a borehole to feed the system which existed already. Again this turned out to be unsuccessful and finally, in 1977 - 78, a new rising main was constructed from an intake well along the River Miyombo. The transmission capacity of this system amounts to 10.5 l/s. The future population demand (1998) is estimated to be 0.43 l/s, the future livestock demand (1998) to be 9.08 l/s, requiring a total transmission capacity of 18.16 l/s for a pumping schedule of 12 hours daily. The system will, therefore, be able to cater for the future population demand and part of the future livestock demand. The capacity of the storage tank (90 m^3) is rather small, and may require extension in the near future.

14. Maguha water supply

The water intake structure consists of two infiltration wells in a swampy area, using a nearby spring as water source. The system was constructed in 1975 with a design capacity of 3.64 l/s. The present and future water demand (1998) are estimated to be 0.87 l/s and 1.76 l/s respectively, requiring system capacities of 1.74 l/s and 3.52 l/s for a pumping schedule of 12 hours daily. The yield of the infiltration wells seems to be high enough to cope with these demand figures, and therefore no extensions will be required in the years to come.

15. Melela water supply

This system is the largest scheme constructed during the last few years. Construction started in 1977, and is not completed yet. The system provides water to Melela and its surrounding sub-villages. It includes a large storage tank and a fairly extensive distribution system. The design includes a provision to supply water to the MODECO cattle farm, but at a later stage this parastatal opted for its own water supply. Consequently the system has a large overcapacity as the design flow amounts to 13.81 l/s, and the present and future population water demand (1998) are estimated to be 1.73 l/s and 3.54 l/s respectively.
The water sources for the system are two shallow wells, of which the recharge is not able to cope with the pumping capacity of the two largely oversized, parallel pumping units. Each pumping unit has a capacity of about 45 m^3/h (12.5 l/s), and empties the shallow well in less than 20 minutes after start-up. Hence a very intermittent pumping programme has to be followed, leading to increased wear and tear of the pumping units and increased fuel consumption.
The shallow wells are disinfected at regular intervals by means of a sodiumhypochlorite solution, and no faecal contamination was found in the distribution system at the sampling date (see Data BD 1, Table BD 1-1).
At present, the Maji Department is considering the construction of a borehole as an alternative water source for the Melela water supply.

16. Kambala water supply

This water supply is also known as Wakwavi water supply and was constructed, among other things for the watering of the large cattle herds present in the area. Kambala village is a Masai settlement. The water source consists of two boreholes which were constructed in 1970. The system has a design flowrate of 2.06 l/s and provides water to six domestic water points and a few small cattle troughs spread out over a rather large area. Some of the taps suffer from a permanent break down. The present and future water demand (1998) for population and livestock are estimated at 0.48 - 0.97 l/s, and 3.17 - 4.75 l/s respectively. This requires total system capacities of 7.3 l/s and 11.44 l/s for the present and future total water demand at a pumping schedule of 12 hours daily. In other words apart from the population only a small proportion of the cattle can be served by the system.
The storage tank is relatively small and will require an increase in capacity in the near future to be able to serve even the population alone in a proper way. The system has frequent shut-downs due to operation and maintenance problems, and the lack of fuel. On such occasions the people have to walk to the River Wami, a distance of about 7.5 km, for their water supply.

17. Kidugallo water supply

The water source is a borehole, and the system provides water to quite an extensive distribution system which even includes a number of private connections. The system was built in 1968, with a design flowrate of 1.15 l/s.

The present and future water demand (1998) are estimated at 1.01 l/s and 2.05 l/s respectively for a pumping schedule of 12 hours daily. It appears that the scheme will shortly require an increase of capacity. During periods of water shortage or breakdowns due to engine problems or lack of fuel, the village population makes use of hand dug holes and small dams for its domestic water supply.

18. Mikese water supply

This system was originally built in 1968, with a borehole as the water source. The system was abandoned recently as the yield of the source became virtually zero. The water had been very saline for a longer period of time and was in fact only used for laundry and dish washing. Water for human consumption was and still is obtained from the railway station (an open lined shallow well). In 1978 the Maji Department constructed a successful borehole which will be brought into operation during the 1979/80 budget year. It will be connected to the present system, which will also undergo some rehabilitation and extension works.
In the meantime, the Maji Department constructed a shallow well with hand pump to alleviate the most urgent needs of the village.
The present piped water supply system has a design capacity of 3.76 l/s, whereas the future water demand (1998) is estimated at 2.19 l/s. This will require a system capacity of 4.38 l/s for a pumping schedule of 12 hours daily. The future construction works should be based on a design flow of approximately 4.4 l/s.

19. Meshugi water supply

The water source is a borehole which was constructed in 1960/61. The system contains one domestic water point, a cattle trough and a cattle dip. The system is only operated during part of the year, as the borehole runs dry during the dry season.
The borehole water is too saline for human consumption, and the system is unsuitable for rehabilitation. The villagers walk to Majawanga for their domestic water supply (distance of about 5 km).

20. Magubike water supply

The water source is a borehole which is yielding salty water, not suitable for human consumption. The villages make use of hand dug holes in a river bed for at least part of their requirements. The system was built in 1966 with a design flowrate of 1 l/s. It supplies water to two domestic water points and one private connection at the dispensary.

21. Magole water supply

The water source for this system, which is at present under construction, is a borehole. The borehole was constructed in 1977 and has been tested for quite some time before the decision was taken to construct the storage tank and distribution works. During the test period the water was pumped to a small temporary storage tank which conveyed the water to three nearby domestic water points.

This temporary system is still being used at present as the construction works have been delayed considerably due to lack of cement and other materials.
The system is designed for a flow of 1.88 l/s, whereas the future water demand (1998) will amount to 3.80 l/s. This will require a system capacity of 7.60 l/s for a pumping schedule of 12 hours/day. In other words the system is largely underdesigned for the future requirements of the village. The system is however, somehow considered to be a temporary solution, as the Maji Department has included Magole village in its proposed Kisungusi gravity scheme (see Part E).

Operation and maintenance of piped water supplies

A summary of the present conditions and functioning of the piped water supply systems described above is given in Table B 3.1-4.

Tabel B 3.1-4 Appraisal of conditions and functioning of existing piped village water supply systems

Facility	Total Nos. of supplies	Supplies with poor water in-take structure	Supplies with undersized capacity	Supplies with regular O & M problems	Nos. of satis-factory systems
Gravity diversions	7	3	2	1	2
Pumped water supplies					
- borehole	6	4	4	3	-
- river intake	14	9	7	9	5
- shallow well	1	1	-	-	-
TOTALS	28	17	13	13	7

The water distributed from the semi-improved or improved water supplies is neither treated nor disinfected. Such water treatments only exist in some urban areas such as Morogoro and Kilosa Townships.
The daily operation time of improved systems depends on the type of system. Gravity mains are normally operated for 24 hours a day, and pumping equipment for pumped supplies for 8 - 12 hours a day. Transmission and distribution systems are designed for a future water demand of 30 l/c/d, and the consumption is assumed to take place during 6 hours a day, 3 hours in the morning (6 - 9 a.m.) and 3 hours in the afternoon (3 - 6 p.m.).
The piped water supply systems consist of fairly robust elements such as blockwork pumping houses, blockwork storage tanks and blockwork domestic waterpoints. Transmission and distribution systems consist mainly of PVC and galvanized steel pipes. The pipework is normally properly buried, and damage to these pipes can only occur in areas with substantial landslides. In one case it was observed that PVC pipes were visible at the surface in some stretches of this gravity main. Under such conditions quick aging of

the PVC material will take place under the influence of ultra-violet rays in the sunlight. Such unwelcome conditions also frequently occur at places where PVC piping material is temporary or permanently stored in the open air (e.g. at building sites and at Maji Yards).

Operation and maintenance of improved water supplies is one of the major constraints at present. The RWE's Office experiences a serious shortage in skilled manpower, transport facilities, and spare parts and tools. New projects suffer from the delays in delivery of essential items such as pipe material and cement.
Several pumped water supply systems have regular break-downs caused by the poor condition of the pumping unit, a lack of spare parts, or a lack of fuel. Some systems have to be shut down for shorter or longer periods due to the drying up of the source.

Shallow wells with hand pumps

A shallow well with a hand pump is relatively simple to provide, and several of these water supply systems were constructed by RWE's Office during recent years. Nowadays, the lining of these shallow wells is entirely made out of blockwork, and the wells have a diameter of 2,4 m (8ft).
Table B 3.1-5 lists the villages in the survey area which have this type of water supply system (see also Figure B 3.1-1). The table does not include the shallow wells with hand pumps which are being constructed at present by the "Morogoro Wells Construction Project".

It is estimated that some 22,800 people in both districts make use of shallow wells with hand pump.

Table B 3.1-5. Existing shallow wells with hand pumps in the Morogoro and Kilosa Districts (1978)

Villages	Year of completion	Population 1978	No's. of shallow wells	Manufacturer of hand pump	Remarks
Morogoro District:					
Kidudwe Ujamaa	1971	649	2	Ubungo	both out of order
Kongwa	1975	1157			
Msongozi	1978	1423	1	Intersigma	
Mikese	1978	2081	1	Intersigma	
Mangae	1978	952	1	Intersigma	
Dakawa-Wami	1978	1774	2	Intersigma	
Kihonda	1978	1707	1	Intersigma	too saline
Kidudwe	1978	2183	1	Intersigma	
Luale	1978	2303	1	Intersigma	
Doma	1978	2801	1	Intersigma	
Kilosa District:					
Malui	1976	2977	1	Ubungo	
Tindiga	1976	3941	1	Ubungo	
Kitete-Msindazi	1973/77	1542	2	Intersigma	one out of order
Kidogobasi	1978	3424	1	Intersigma	
Italagwe	1978	3014	1	Intersigma	
Madoto	1978	1731	2	Intersigma	

3.2. Relevant water quality aspects of existing supplies

3.2.1. Physico-chemical aspects

Fieldwork to investigate the physico-chemical water quality of existing water supply facilities was conducted in the period October - November, 1978, and some additional fieldwork was carried out in the period mid February - mid March, 1979. During these periods only part of the survey area could be covered. Heavy rains started towards the end of November, 1978, and interfered with the field survey considerably.

All together some 156 water supply points have been sampled. Table B 3.2-1 summarizes physico-chemical quality parameters of these samples for the various types of water supply facilities. As discussed in subparagraph B 2.2.4.2. only some elementary quality analyses, relevant to health considerations or palatability, were carried out. The detailed analysis data are presented in Data BD 1.

The following conclusions may be drawn from the analysis data, using the Temporary Standards of Quality of Domestic Water in Tanzania as the guideline:

1. Quality parameters with a direct impact on human health:
   - fluoride is present in fairly low concentrations. All samples have concentrations lower than 2 mg/l (as F). Some 90% of the samples have fluoride concentrations below 1 mg/l. A disease as fluorosis may therefore be considered to be absent in the villages which depend on the water sources sampled
   - nitrate in general occurs in low to acceptable concentrations. About 5% of the nitrate determinations, however, show higher concentrations, up to 260 mg/l nitrate (NO_3). These high levels are most likely caused by organic pollution of natural origin. Children, below the age of 1 year, who depend on such water sources may obtain "methaemoglobinaemia" (blue babies sickness) if the exposure is prolonged over relatively long periods. This is, however, a low risk as children of this age are normally breast-fed and the nitrate is not conveyed to the mother milk
   - the electrical conductivity, used as a measure for the total dissolved solids content, is in general quite suitable for domestic water supply. Some 85% of all samples have an EC_{25} level below 125 mS/m (1250 µS/cm) and only about 8% of all water sources sampled contain higher amounts of dissolved solids resulting in EC_{25} values over and above 200 mS/m. In some cases, the villagers have rejected such water sources for human consumption, and apply them only for laundry and dish washing.

2. Other quality parameters:
   - The pH of the water sources sampled is between the acceptable limits for over 95% of all samples. About 5% of the samples show a pH value which is slightly below the lower limit of 6.5. The majority of these samples were taken shortly after the first rains in November, 1978, which provides a suitable explanation for these low values.
   - Manganese and, to a lesser extent, iron appear to be present in concentrations often exceeding the maximum allowable limits of the International WHO Standards. These quality parameters, however, have no direct impact on health. The standards are mainly set for general convenience (laundry), palatability, and technical considerations in relation to piped water supplies. No concentration over 3 mg/l of iron or magnesium have been observed so far. Manganese and iron are therefore considered not to cause serious limitations to the existing ground water exploitation.

Table B 3.2-1. Results of physico-chemical tests for 156 samples of various water sources in the survey area

	Hand dug hole			River/ stream			Shallow well lined				Spring			Borehole		Impoundment			Total
	field	river bed	sub total	unpiped	piped	sub total	without hand pump	with hand pump	piped	sub total	open	piped	sub total	no's.	sub total	swamp	reservoir	sub total	
EC < 75	20	3	23	33	2	35	32	1	2	35	2	1	3	1	1	2	-	2	99
[mS/m] 75-125	4	5	9	-	-	-	18	2	2	22	2	-	2	-	-	-	-	-	33
125.1-200	2	5	7	-	-	-	9	-	-	9	-	-	-	-	-	-	-	-	16
> 200	1	3	4	-	-	-	4	-	-	4	-	-	-	-	-	-	-	-	8
																			156
F^- < 0.5	18	6	24	31	2	33	27	1	3	31	1	-	1	1	1	2	-	2	92
[mg/l] 0.5-2.0	9	10	19	2	-	2	36	2	1	39	3	1	4	-	-	-	-	-	64
2.1-8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
> 8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
																			156
NO_3^- < 10	11	13	24	12	-	12	35	2	1	38	2	1	3	-	-	1	-	1	78
[mg/l] 10-50	1	2	3	-	-	-	8	-	1	8	-	-	-	-	-	-	-	-	12
51-100	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-	2
> 100	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-	3
																			95
pH < 6.5	5	-	5	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	6
6.5-7.5	20	5	25	24	2	26	48	3	3	54	3	1	4	-	-	2	-	2	111
7.6-9.2	2	11	13	9	-	9	15	-	1	16	1	-	1	-	-	-	-	-	39
> 9.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
																			156
Fe < 0.1	9	9	18	2	-	2	28	2	-	30	-	-	-	-	-	-	-	-	50
[mg/l] 0.1-0.3	-	3	3	1	-	1	9	-	-	9	-	-	-	-	-	-	-	-	13
0.31-1.0	2	2	4	1	-	1	1	-	1	2	-	-	-	-	-	-	-	-	7
> 1.0	1	1	2	-	-	-	-	1	-	1	1	-	1	-	-	-	-	-	4
																			74
Mn < 0.1	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
[mg/l] 0.1-0.5	7	3	10	1	-	1	14	2	-	16	-	-	-	-	-	-	-	-	27
0.51-1.0	1	-	1	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	2
> 1.0	-	3	3	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-	6
																			37
General Appearance good	1	3	4	13	2	15	31	2	2	35	3	1	4	-	-	-	-	-	58
fair	1	7	8	12	-	12	12	1	2	15	-	-	-	-	-	-	-	-	35
poor	24	6	30	5	-	5	20	-	-	20	1	-	1	1	1	2	-	2	59
																			152

- For some samples, carrying high contents of dissolved solids, more comprehensive analysis were carried out including calcium, magnesium, bicarbonate, chloride and sulphate. It appears that especially calcium, magnesium and chloride may occur at fairly high levels. Water sources carrying such quantities of dissolved solids are confined to some specific problem areas where surveys are in progress to find more suitable water sources for domestic water supply.
- All water samples were given a qualification "good", "fair" or "poor" from their general appearance (sensorial observation). Some 40% of all samples obtained a "poor" qualification, caused by relatively high levels of turbidity mainly due to clay and loam.
  The improvement in the palatability of the water by decreasing these high turbidity levels should deserve full attention in rural water supply upgrading projects

The water analyses data summarized above show that in general the water quality is very satisfactory for the large majority of physical and chemical components. An aspect which requires due attention is the general palatability of the water, as many water sources yield water which is seriously polluted by suspended matter such as clay and loam.
The Consultant would like to remark that the general appraisal of the water quality in the survey area as described above does not cover each and every village, because the fieldwork was seriously hampered by the very poor weather conditions during most of the survey period.

3.2.2. Bacteriological aspects

The bacteriological survey was carried out along with the physico-chemical investigations. The bacteriological tests were carried out with the Millipore portable kit. E.Coli was used as indicator organism, with MF-C broth as culture medium. The samples, amounting to 5 - 200 ml, depending on the turbidity of the water, were incubated at the sampling site, and contained in the incubator during a period of about 24 hours at 44½ °C before the number of E.Coli cultures was determined. Table B 3.2-2 summarizes the results. The data are expressed in the MPN per 100 ml.

From the results of the bacteriological survey the following conclusions may be drawn:

- about 24% of the samples of traditional and semi-improved supplies did not contain E.Coli. This figure is higher than expected, as similar studies in other regions of Tanzania indicate that virtually all traditional water sources are more or less polluted by organisms of faecal origin. A possible explanation for the present results may be found in the fact that many water sources sampled contained a high concentration of silt, and allowed for the application of only small sampling quantities (5 - 20 ml). About 45% of the samples which contained less than 1 E.Coli had such high turbidities. Application of larger sampling volumes could have resulted in minimum MPN values of 5 - 20/100 ml. Another aspect which may hamper the correct determina-

tion of the MPN-value is the clogging of the membrane filter by very fine silt particles. The clogged filter may prevent the penetration of culture medium through the filter so as to become available for the micro organisms. The micro organisms will either die off, or not multiply themselves sufficiently to enable visual determination.
From all water sources, traditional or improved, about 27% of the samples had a MPN value < 1/100 ml

- some 21% of the samples showed only limited pollution by E.Coli (MPN: 1 - 10/100 ml), and these water sources may be considered to be still suitable for human consumption (see subparagraph B 2.2.3.)
- about 52% of the samples contained more or less significant concentrations of E.Coli (MPN > 10/100 ml), and should be considered to be suspect for domestic water supply. Some water sources, including four piped water supply systems, were seriously polluted by faecal organisms (MPN > 100/100 ml), and regular occurrence of water-related diseases may be expected from such supplies

Table B 3.2-2. Results of bacteriological tests (E.Coli, MPN/100 ml) for 168 samples of various water sources in the survey area.

MPN Sources	< 1	1-10	11-100	101-1000	> 1000	Total
Hand dug holes						
- in village grounds	5	6	4	7	4	26
- in river bed	-	1	2	-	-	3
River/Stream						
- unpiped	5	4	14	6	10	39
- piped	4	3	6	3	1	17
Shallow wells (lined)						
- without hand pump	22	16	15	9	3	65
- with hand pump	4	3	-	-	-	3
- piped	2	1	-	-	-	3
Spring						
- open	2	-	1	-	1	4
- piped	1	-	-	-	-	1
Borehole	-	1	-	-	-	1
Impoundment						
- swamp	-	-	1	1	-	2
Total	45	35	43	26	19	168

The detailed data of the bacteriological field survey are given in Data BD 1, Table BD 1-1.

3.3. Domestic water supply and health aspects

3.3.1. Occurrence of water-related diseases

The Governmental medical facilities are offered through Regional and District Hospitals, Rural Health Centres and Dispensaries. The Morogoro and Kilosa districts each have one District Hospital offering services for both in-patients and out-patients. The Morogoro hospital also serves as Regional Hospital. The Rural Health Centres have a limited number of beds for relatively simple diseases or emergency cases. Dispensaries normally provide only services to out-patients. A summary of the Governmental medical facilities in the survey area is given in Table B 3.3-1. The table does not include medical centres of missions and other private institutions.

Table B 3.3-1. Governmental medical facilities in the survey area

Facilities	Morogoro District	Kilosa District
District Hospital	1	1
Rural Health Centres	5	3
Dispensaries	36	29

All medical centres are supposed to provide the District Medical Officers with monthly reports containing data such as health statistics of new patients. From these reports the following data were obtained for the first attendances for various water-related diseases during the year 1978:

- faecal-oral diseases : cholera, bacillary dysentery, diseases of the digestive system, diarrhoeal diseases
- water-washed diseases : skin and eye diseases, ulcers
- water-based diseases : schistosomiasis, helminthiasis
- water-related insect vectors : malaria

The records which could be collected were far from complete. Many monthly reports of various dispensaries could not be traced any more in the files of the DMO's office. The data obtained are presented in Data BD 2, Table BD 2-1. This table summarizes the total amount of first attendances, and the percentage of each of the four water-related disease categories, as obtained from each monthly report.
A summary of these data is given in Table B 3.3-2. It presents the annual weighted average for each of the four water-related disease categories for those rural health centres and dispensaries for which 5 or more monthly reports were obtained.

Table B 3.3-2 shows that a significant and in some cases relatively high percentage of disease was caused by water-related infectious organisms. Faecal-oral and water-washed diseases together accounted for some 15 - 60% of the diseases which were identified at the Governmental medical centres.

Table B 3.3-2. Annual weighted average percentage of water-related diseases as reported by some rural health centres and dispensaries in the survey area (1978)

Village	faecal-oral (%)	water-washed (%)	water-based (%)	water-related insect vectors (%)	Total faecal-oral and water washed (%)	Total water related diseases (%)
Morogoro District:						
Dakawa Wami	26	5	5	20	31	56
Doma	16	8	6	10	24	40
Kanga	20	7	10	24	27	62
Kibangile	15	9	< 1	21	24	46
Kibati	32	9	11	10	41	62
Kikundi	13	14	6	23	27	57
Kinda	16	8	4	16	24	44
Kiroka	8	12	2	8	20	30
Kisaki	23	6	8	12	29	49
Konga	21	5	11	25	26	61
Maharaka	10	9	11	9	19	39
Maskati	30	8	8	4	38	50
Melela	13	6	3	15	19	37
Mkata	30	7	9	14	37	60
Mngazi	29	5	3	13	34	51
Mtombozi	19	6	4	14	25	43
Mvomero	13	10	5	18	23	45
Mvuha	29	9	6	18	38	62
Mziha	14	4	10	9	18	38
Ndole	17	7	2	16	24	42
Turiani	11	14	2	32	25	60
Visaraka	11	11	1	13	22	36
Kilosa District:						
Gairo	5	12	1	10	17	28
Ibido	20	18	6	5	38	49
Iyogwe	27	23	1	16	50	68
Kidete	10	23	3	13	33	49
Kilangali	29	31	-	24	60	83
Kimamba	9	8	2	34	17	53
Kisanga	17	26	6	7	43	56
Kivungu	14	19	4	18	33	55
Lumuma	23	10	< 1	21	33	54
Madege	20	17	3	4	37	44
Magole	13	2	3	36	15	54
Malangali	14	9	5	20	23	48
Malolo	17	15	1	16	32	49
Mamboya	17	21	4	7	38	49
Mbamba	19	6	4	12	25	41
Msimba	11	16	2	18	27	46
Msowero	14	17	11	18	31	60
Muhenda	19	15	26	14	34	74
Mwasa	19	13	6	9	32	48
Rudewa	2	19	1	8	21	30
Ulełing'ombe	24	17	5	18	41	64

Water-based diseases, in particular schistosomiasis, were only significanct in some parts of the survey area, whereas malaria was found throughout both districts at rather elevated levels. The total percentage of all water-related diseases as identified by the dispensaries' staff varied between 28 and 83%.

The data from the monthly reports of the Morogoro District Hospital were processed in a similar way, and the weighted average percentage for the various related diseases is summarized in Table B 3.3-3.

Table B 3.3-3. Weighted average percentage of water-related diseases as reported by the Morogoro District Hospital (period January - August, 1978)

District Hospital Morogoro	faecal-oral %	water-washed %	water-based %	water-related insect vector %	Total Water-related diseases %
- in-patients	12	-	< 1	9	21
- out-patients	14	4	2	10	30

The occurrence of water-related diseases was lower than in the Rural Health Centres and Dispensaries, but still rather significant for this urban area. Water-related diseases accounted for 21 - 30% of all disease patterns, of which 12 - 18% were faecal-oral or water-washed, and 9 - 12% water-based or caused by water-related insect vectors.

3.3.2. Relation between water-related diseases and existing water supplies

A correlation study between the existing water supply facilities and the occurrence of water-related diseases may offer some better understanding of the crucial bottle-necks in the present rural water supply conditions. The results of such a study will produce guidelines for the improvements in domestic water supply with regard to quality, quantity, accessibility, or reliability, or improvements in public health conditions such as personal hygiene and general hygienic practices, which should get special attention so as to achieve maximum health benefits.

The Consultant has carried out such a correlation study for all those villages in the survey area which have either a rural health centre or a dispensary. The study revealed that no significant correlations exist between:

- the total average weighted percentage of faecal-oral and water-washed diseases versus the existing water supply conditions.
- the average weighted percentage of water-washed diseases versus the existing water supply conditions.

- the average weighted percentage of village attendances for faecal-oral and water-washed diseases versus the existing water supply conditions.

The appraisal of the existing village water supply conditions as used for this comparative analysis is described in Chapter B 4. The area and population served by every dispensary is not precisely known. The choice was made to compare the health data of each dispensary with the water supply conditions in the village where it is located.

From the results of this correlation study it can only be concluded that improvements in village water supply do not have any real health benefits unless, at the same time, programmes on health education are implemented which are geared towards improved personal and domestic hygiene. This general conclusion, although subject to the limited availability of health data, compares fairly well with similar studies in rural areas of other Third World countries. It appears time and again that improved village water supplies will often only have measurable effects on health if they occur simultaneously with extensive programmes on health education [6]. Once proper hygienic practices are observed, improvements in public health conditions may be expected from the increase of the water availability and accessibility, i.e. more water sources at shorter distance, increase of the reliability of the supply, i.e. construction of water sources which yield water throughout the year, and improvement of the water quality, i.e. construction of high standard water intakes so as to prevent contamination by faecal matter, e.g. protected springs, infiltration wells along river beds, and closed shallow wells provided with hand pumps or diesel-driven pumping units.

3.4. Water demand studies

3.4.1. Criteria for water demand projections

Data on the actual water consumption from domestic rural water supply facilities are not available in the RWE's office. Water meters are installed only in a very limited number of house connections in small townships, and the water consumption at such provisions is not considered to be representative for village water supply conditions prevailing in the survey area. A recent SIDA report [13] mentions an average domestic water consumption of about 13 l/c/d for the rural dwellers in the Morogoro Region. Other sources indicate similar values [8]. Such figures are applicable for villages with traditional water supply systems. For villages with improved water supply systems, the water consumption will be in the order of 30 l/c/d [2].
For design purposes, the RWE's office applies a water consumption figure of 45 l/c/d (10 GPD) for the present water consumption from rural piped water systems, whereas a water allowance of 30 l/c/d is used as a design criterion for long-term projections (more than 10 years). This limitation to 30 l/c/d is part of the Government's policy to save capital expenditure for rural water supply systems, so as to provide as many people as possible with a suitable water supply.

The Consultant has carried out separate water demand projections for population, including water requirements for village primary schools, Government health centres and dispensaries, and domestic livestock. These estimates for future water demand were carried out for each individual village in the survey area, and were based on the Maji design criteria for long term projections.
An allowance has been incorporated for leakages in transmission and distribution lines, and wastage at the domestic water points. It has been assumed that these losses constitute 25% of the water distributed from the source, and therefore the water requirements at the source will amount to 40 l/c/d, for the population, and 30 l/LU/d for the domestic livestock.
The criteria which are used to carry out the water demand projections are summarized in Table B 3.4-1.

Table B 3.4-1. Water demand criteria for rural water suppy systems in the MDWSP survey area.

Consumers	Water allowance	Remarks	Total maximum water allowance including losses (25%)
Village population	30 l/c/d	for next 20 years	40 l/c/d
Primary school	3.8 l/c/d	1)	5 l/c/d
Rural Health Centre	14 m^3/ centre/d	450 attendances, 15 staff (30 l/c/d)	18.5 m^3/centre/d 1)
Dispensary	12.3 m^3/ disp./d	400 attendances, 10 staff (30 l/c/d)	16.5 m^3/disp./d 1)
Domestic Livestock	22.5 l/ LU/d	1 LU = 1 cattle, 5 sheep or 5 goats	30 l/LU/d

1) See Table B 3.4-2

A maximum period of 20 years has been considered for the future water demand projections. The criteria adopted for the population growth and livestock increase are expressed as a correction factor for the present census data, and are given in Table B 3.4-2.

The attendance capacities of rural health centres and dispensaries are not yet fully utilized. At present, the water demand will therefore be less than the maximum estimated amount as given in Table B 3.4-1. It will gradually approach this maximum in the years to come. A similar process will occur with primary school enrolment. The present and future percentage of the village population attending a primary school have been estimated from detailed data in relation to the present primary school enrolment.

The relevant data were obtained from the District Educational officer in Morogoro. Table B 3.4-3 summarizes the factors which have been applied to calculate the gradual increase of water demand of population, livestock, and the institutions mentioned above for each of the future water demand projections.

Table B 3.4-2. Criteria for future water demand, taking into account population increase, livestock increase, and increase in the utilization of specific Governmental Institutions.

Consumer Group	Water Allowance	Increase of future water demand			
		1978	1983	1988	1998
Population (P)	40 l/c/d	1	1.25xWD78	1.5xWD78	2xWD78
Livestock (LU)	30 l/LU/d	1	1.125xWD78	1.25xWD78	1.5xWD78
Primary School	5 l/c/d	0.2xPxWA	0.25xPxWA	0.3xPxWA	0.3xPxWA
Rural Health Cent.	18.5m^3/centre/d	0.4xWA	0.6xWA	0.8xWA	1xWA
Dispensary	16.5m^3/disp/d	0.4xWA	0.6xWA	0.8xWA	1xWA

where: WA = water allowance
WD78 = water demand in 1978

3.4.2. Future water demand in the survey area

The data used for the water demand projections include:

- population census 1978 (from Bureau of Statistics);
- livestock census 1978 (from Districts' Livestock Officers);
- enrolment of primary schools (from Districts' Educational Officers);
- location of rural health centres and dispensaries (from Districts' Medical Officers).

The detailed results of the water demand estimates are presented in Data BD 3, Table BD 3-1. The table contains water demand estimates for the following years:

- 1978, estimates to give an impression of the present water demand;
- 1983, estimates to be used for the short-term development programmes;
- 1988, estimates to be used for the design of pumping units of those piped water supplies which will be implemented shortly;
- 1998, estimates for long-term development programmes.

The total present and future water demand (1998) for population and domestic livestock in the villages of the survey area is summarized in Table B 3.4-3.

Table B 3.4-3 Estimates of present and future water demand for population and livestock in the survey area.

Consumer Group	Census 1978	Water demand 1978		Water demand 1998	
		l/s	m^3/year	l/s	m^3/year
Population	557,000	268	8.5×10^6	549	17.3×10^6
Livestock	255,000	89	2.8×10^6	133	4.3×10^6
Total		357	11.3×10^6	682	21.5×10^6

A frequency distribution of the future water demand of individual villages may offer useful information with regard to the design capacities which normally will have to be selected for individual village water supplies. The feasibility of a standardization programme for village water supplies will depend on the outcome of such a statistical analysis.
A frequency distributiontable for the number and percentage of villages in each of various categories of population water demand and livestock water demand is given in Table B 3.4-4. It appears from this table that the majority of the villages have a present population water demand lower than 2 l/s, and a future population water demand (1998) lower than 3 l/s. The majority of the villages have a water demand for domestic livestock lower than 1 l/s for the present conditions, and lower than 2 l/s for the future. In other words, design and construction activities for individual village water supplies have to be focused on design capacities ranging between 0.5 - 3 l/s for gravity supplies, operating 24 hours a day, and 1 - 6 l/s for pumped water supplies with a pumping schedule of 12 hours/day. It is recommended that a limited number of typical village water supply systems which cover this range of design capacities should be designed. (See Part E).
Only a limited amount of villages will have a future population water demand of 3 - 5 l/s, or a future livestock demand of 2 - 5 l/s. A few villages with large cattle herds, e.g. Masai villages, have future water requirements for livestock higher than 5 l/s. In group supply systems, total future water demand may considerably exceed the capacity ranges mentioned above and for such systems it is not feasible to prepare typical designs within a standardization programme.

Table B 3.4-4 Breakdown of village water demand for population and livestock in various demand categories

	POPULATION DEMAND						LIVESTOCK DEMAND						
	0-0.5 l/s	0.5-1.0 l/s	1-2 l/s	2-3 l/s	3-5 l/s	5 l/s	0-0.25 l/s	0.25-0.5 l/s	0.5-1 l/s	1-2 l/s	2-3 l/s	3-5 l/s	5 l/s
1978	113	158	81	5	1	-	105	20	23	12	2	1	4
%	32	44	23	1	-		63	12	14	7	1	-	3
1988	35	141	148	28	5	1	100	21	19	15	7	1	4
%	10	40	41	8	1	-	60	13	12	9	4	-	2
1998	10	101	156	70	17	4	97	21	16	16	10	3	4
%	3	28	43	20	5	1	58	12	10	10	6	2	2

4. IDENTIFICATION OF PROBLEM AREAS

4.1. Introduction

In accordance with the Terms of Reference, the MDWSP survey was concentrated mainly on the problem areas and problem villages which were identified in the Integrated Development Plan for Morogoro Region [1], and the preliminary village survey [3]. The comprehensive field survey of the various MDWSP team members confirmed that the majority of the villages located in these problem areas indeed experience constraints in their domestic water supply facilities. The Consultant has undertaken, however, to make an assessment of the present water supply conditions of all villages in the survey area to make sure that no needy villages are accidentally left out of consideration. This assessment is based on the visits the geographers paid to some 280 villages during the period June - October, 1977, and the fieldwork of the MDWSP team members who covered some 200 villages during comprehensive field investigations in the period June, 1978 - March, 1979. A number of villages are located in areas which are not easily accessible and could not be visited by any of the MDWSP team members, due to the heavy rains in the period November, 1978 - April, 1979. The appraisal of the present water supply conditions in such villages has been based on information obtained from the Maji Department, and the Consultant's general hydrological and hydrogeological knowledge of the areas where these villages are located. In fact, the majority of these villages are located in mountainous areas, and are therefore fairly well endowed with suitable perennial surface water sources.

4.2 Assessment of the village water supply conditions

The assessment procedure for the appraisal of the present water supply conditions was described in general in paragraph B 2.3. The Consultant would like to call attention to the fact that occasionally insufficient data were available to give a clear-cut assessment to each of the appraisal criteria. In such cases, the assessment has been carried out to the best of the Consultant's knowledge of the hydrological and hydrogeological conditions in the area. Some degree of subjectivity, however, can hardly be excluded.
The scores for each of the assessment criteria are applicable for the quality of the existing water supply conditions as compared to the requirements of the 1981 Government's targets.
Some more details regarding the assessment criteria will be briefly discussed below.

Water availability and reliability

The score for the water availability versus the present water demand is determined for the water sources used at present in their worst condition at the end of the dry season. The score for the reliability is dependent on the period during which the water availability matches the present water demand. In those cases where a village is provided with an improved water supply which suffers from breakdowns or lack of sufficient distribution facilities, the aggregate scores for availability and reliability represent a combined assessment of the improved water source and possible traditional water sources. For example, if a village is provided with a malfunctioning pumped water supply from a nearby perennial river, the availability criterion receives a score 1, and the reliability criterion a score 2 or 3. In those cases where people depend on temporary structures as water sources, e.g. hand dug holes in river beds, the score for the availability criterion depends on the aquifer conditions in those river beds. Under such conditions, scores of 2 or 3 were often given to the reliability criterion, as these temporary water sources are not considered to be very dependable in catering for the domestic water demand.

Quality of the source

This criterion refers to the general conditions of the source, and includes an assessment of some water quality aspects, such as its general appearance, palatability and bacteriological quality. It does not cover the mineral content of the water, as a separate score was given for its EC-value.
In general the various sources were given a score as listed below:

- Score 1: Boreholes, properly sealed infiltration wells, small perennial streams in the upper parts of mountainous areas, and gravity systems with intakes in virtually non-inhabitated areas;
- Score 2: perennial streams and rivers in more populated areas, with a fair general appearance and relatively low bacteriological contamination of the water, and lined open shallow wells;
- Score 3: hand dug holes in unconfined aquifers (e.g. in river beds), fairly polluted rivers, and direct surface water intakes from such rivers.

Water accessibility

This criterion refers to the walking distance to the most common water source at the end of the dry season.

Quality of the water

The mineralization of the water, expressed as the EC_{25}-value, was given its own score in the assessment of the present water supply facilities. The score is based on the average EC_{25}-value of the water sources which are used at the end of the dry season.

Village population

The village population has been included in the assessment in the context of the strategy to optimize between the total amount of population served and financial resources required in future water development programmes (see Part E). With similar water supply conditions this approach gives a slight advantage to the larger villages, as more people can be served at most probably lower per capita costs.

The assessment results for each individual village in the survey area are given in Data BD 4, Table BD 4-1. The aggregate scores could vary between 6 and 18 points. The former score relates to a village water supply where no problems exist regarding the Government's targets (1981), and the latter score relates to serious constraints regarding these targets. For the villages in the supply area, the scores vary between 6 and 16 points.
Table B 4.2-1 summarizes the distribution of scores for all villages in the survey area.

Table B 4.2-1 Frequency and cumulative distribution of aggregate scores for present water supply conditions.

Scores	Frequency distribution of villages		Cumulative distribution of villages	
	Nos.	%	Nos.	%
> 16	-	-	-	-
16	1	< 1	1	< 1
15	1	< 1	2	1
14	10	3	12	3
13	21	6	33	9
12	44	12	77	21
11	41	11	118	33
10	42	12	160	44
9	57	16	217	60
8	83	23	300	83
7	45	13	345	96
6	15	4	360	100
TOTAL	360	100%	360	100%

The villages have been divided into three categories in accordance with their aggregate score. Villages with an aggregate score of 12 or more points, indicating rather serious constraints in village water supply conditions, have been listed in category I. Villages with a score from 9 up to and including 11 points, indicating moderate problems in village water supply conditions, were listed in category II. Villages with a score between 6 and 8 points, indicating slight or no problems in village water supply conditions were listed in category III. It can be concluded from Table B 4.2-1 that 77 villages or 21% of the villages are in category I, 140 villages or 39% in category II and 143 villages or 40% in category III. The distribution of the three categories over the survey area may be seen in Map B 1. Each category was given its own colour code: red, orange and green for category I, II and III respectively. The villages of category II were subjected to a further differentiation. Villages, in this category, which received the maximum score of 3 points for the water accessibility criterion (walking distance to the source) were given a red contour and thereafter included in category I. This adjustment was carried out in anticipation of the 1981 targets, and included 5 villages.

On the other hand, villages which obtained a score between 9 and 11 points only because of high scores for the population criterion, were given a green contour. They were thereafter included in category III, as the water supply conditions themselves appeared to be satisfactory with regard to the 1981 targets. This adjustment concerned 73 villages.
In conclusion, the assessment procedure adopted and subsequent adjustments have produced a categorization as summarized in Table B 4.2-2.

Table B 4.2-2 Categorization of villages in accordance with their present water supply conditions.

Categories	Nos. of villages	% of villages	Cumulative % of villages
Category I	82	23	23
Category II	61	17	40
Category III	217	60	100

The various assessment scores have been further evaluated by calculating the frequency distribution of the scores for all assessment criteria. The results of this evaluation are given in Table B 4.2-3. It appears that the major problems in the present water supply conditions mainly concern the quality of the water sources, and to a lesser extent the reliability of supplies and the quantity water available.
The average walking distance to the village water sources is for the large majority of the villages in accordance with the 1981 targets. The EC values of the water sources are good to satisfactory for virtually all villages.

Table B 4.2-3 Frequency distribution of scores for the various assessment criteria in respect of the present village water supply conditions in the survey area.

Criteria	SCORES (%)		
	1 (good)	2 (fair)	3 (poor)
Water availability versus demand	61	31	8
Quality of source	22	58	20
Average distance to source	79	14	7
Reliability of supply	53	28	19
Water quality	87	11	2

4.3. Selection of priority villages

The visualization of the appraisal of the existing water supply conditions of all villages in the survey area, as presented in Map B 1, shows that the following problem areas may be distinguished:

- the Gairo division, and the N.W. part of Mamboya Division;
- the area along the Turiani-Kilosa-Mikumi road, covering parts of the Division Turiani, Mamboya, Masanze and Ulaya;
- the Ngerengere Division;
- part of Mlali Division;
- the areas, directly East and South of the Ulugurus, covering parts of the Matombo and Bwakira Divisions.

The Terms of Reference of the MDWSP survey call for an identification of the most seriously hit villages with regard to the state of their present water supply, and the recommendation of a short term implementation programme to alleviate the constraints experienced by these villages.

The procedure followed by the Consultant to identify and select the most needy villages was described in the previous paragraph. The category I villages are considered to cover the requirements set by the Terms of Reference, and it is recommended that these villages form the basic group for a short-term improvement programme.
The villages concerned are listed in Table B 4.3-1 in alphabetical order together with their aggregate assessment score. The recommendations for the improvement of the water supply conditions of these villages will be discussed in Part E.

Table B 4.3-1 List of priority villages

VILLAGE	AGG. SCORE	VILLAGE	AGG. SCORE	VILLAGE	AGG. SCORE
Bwakira Juu	12	Kondoa	12	Mtumbatu	13
Chakwale	12	Kunke	12	Mugudeni	13
Chanyumbu	12	Leshata	13	Muhenda	15
Chanzuru	12	Lubungo	14	Mwandi	12
Dakawa	12	Luhindo	10	Ngerengere	12
Difinga	12	Lukobe	13	Ngerengere Dar.	12
Diguzi	12	Mabula	12	Ngiloli	11
Dihinda	14	Machatu	14	Nguyami	14
Dumila	12	Madege	16	Nyarutanga	13
Fulwe	13	Madizini (Tur.)	13	Rudewa Batini	12
Gairo	12	Madudu	12	Rusanga	12
Gomero	14	Magubike	14	Sangasanga (Mla)	12
Ibindo	12	Maharaka	13	Sasasaga	12
Ibuti	12	Makuyu	12	Seregete A	13
Idibo	12	Mandela	12	Seregete B	12
Ihenje	14	Manza	12	Tabu Hotel	13
Ilakala	14	Maseyu	13	Tindiga	13
Iyogwe	12	Matuli	12	Tungi	14
Kambala	12	Mbigili	12		
Kibedya	12	Mbili	12		
Kidogobasi	12	Meshugi	13		
Kidudwe	12	Mfulu	12		
Kiegea	12	Mirama	12		
Kihonda	13	Mkalama	13		
Kilama	13	Mkambarani	12		
Kinonko	12	Mkonowamara	13		
Kiroka	13	Mkulazi	10		
Kisemu	12	Mkundi (Mam)	12		
Kitaita	13	Mkundi (Nge)	12		
Kitete	12	Mlilingwa	11		
Kiwege	14	Msonge	10		
Kiziwa	13	Mtamba	12		

5. PRESENT WATER SUPPLY CONDITIONS AND WATER DEMAND SUMMARY AND CONCLUSIONS

5.1. Introduction

A first inventory of the existing rural water supply facilities, in terms of the types of facilities, general quality, and population served was carried out in 1977 by two of the Consultant's geographers. This survey also included a general geographical and demographic survey, and a mapping of the (new) location of villages which resulted from the national resettlement programme. The geographical survey has been described in Part A. The results of the demographic survey have been discarded from the Final Report, as they were superseded by the more recent data of the Government's population census of 1978.
This first inventory did not include a detailed technical assessment of the existing facilities with regard to the identification of problem areas, and with regard to the definition of water resources development programmes for village water supply in the Morogoro and Kilosa districts.
These development programmes should aim at providing the rural population of these districts with a safe and sufficient water supply in accordance with the Government's policies as laid down in the national development plans and the 1981 and 1991 targets.

The water supply section started its activities on October 1st, 1978. Within the scope of this part of the MDWSP study the following activities have been carried out

- an inventory of the existing water supply facilities, including traditional and improved water supply systems;
- a survey of the physical, chemical and bacteriological water quality, its availability, and accessibility, and the reliability of the present facilities;
- a survey of the public health conditions in the project area, especially an inventory of the occurrence of water-related diseases;
- a survey of the domestic water demand based on consumption data, and additional criteria for projections of future water demand.

The results of these surveys, together with the results of the hydrological and hydrogeological surveys regarding the water resources potential, constitute the background data for the establishment of phased rural water supply development programmes, which will be discussed in Part E.

5.2. Appraisal of existing water supply facilities

Availability of a safe and reliable water supply in the villages is considered to be a major factor influencing rural development.
The survey area is fairly well endowed with surface water resources. A large number of rivers and streams are perennial and supply a considerable percentage of the area's rural population with sufficient and dependable water sources throughout the year. Ground water resources, which are easily exploited by the villagers because of the high ground water table, are found in a limited number of areas, i.e. alluvial river valleys and some areas with swamp deposits.

This general picture, however, obscures local variations in availability, accessibility and quality of clean water. Such variations largely coincide with the geomorphological zones, especially with the mountainous areas on the one hand and piedmonts, foothill areas and flood plains on the other. In general, water problems do not occur in the villages located in the well-watered mountainous parts of the survey area, i.e. the Uluguru, Nguru and Rubeho mountains. In these areas the high average precipitation sustains a number of springs and large and small perennial water courses, which are exploited by the inhabitants as traditional water sources. In the remaining parts of the survey area, the problems encountered are related to the availability, accessibility and reliability of water supply systems. In these areas various types of traditional, semi-improved and improved water supply systems can be found.
The present village water supply facilities may be distinguished in:

- traditional and semi-improved systems, i.e. hand dug holes (on village ground or in river bed), rivers, streams, springs, and lined open shallow wells. The lining of such shallow wells may consist of sheet metal (open ended oil drums), masonry or concrete work;
- improved systems, i.e. lined shallow wells with hand pumps and piped water supplies, either gravity or pumped diversions.

The relative importance of each of the various water supply systems is summarized in Table B 5.2-1.

Table B 5.2-1 Relative importance of various water supply systems (%)

Water supply systems	No. of people served (%)	
	Wet Season	Dry Season
Traditional supplies	67	72
Semi-improved supplies	11	9
Gravity piped supplies	8	6
Pumped piped supplies:		
. river intake	6	5
. borehole	3	3
. shallow well	1	1
Shallow wells with hand pump	4	4
TOTAL	100	100

It may be concluded from this table that in spite of all efforts and achievements, the majority of the rural population in the survey area still uses the old traditional ways of obtaining drinking water.
The piped water supply systems consist of fairly robust elements such as blockwork pumping houses, blockwork storage tanks and blockwork domestic waterpoints. The civil works of these structures are in general in good condition. Transmission and distribution systems consist mainly of PVC and galvanized steel pipes. The pipework is normally properly buried, and damage to these pipes can only occur in areas with substantial landslides.

On a few occasions it was observed that PVC pipes were exposed to direct radiation of ultra-violet rays in sunlight, and under such conditions quick aging of these pipes may be expected.
The water distributed from the semi-improved or improved water supplies is neither treated nor disinfected. Such water treatments only exist in some urban areas such as the Morogoro and Kilosa Townships.
The daily operation time of improved systems depends on the type of system. Gravity mains are normally operated for 24 hours a day, and pumping equipment for pumped supplies for 8 - 12 hours a day. Transmission and distribution systems are designed for a future water demand of 30 l/c/d, and the consumption is assumed to take place during 6 hours a day: 3 hours in the morning (6 - 9 a.m.) and 3 hours in the afternoon (3 - 6 p.m.)

Operation and maintenance of improved supplies is one of the major constraints in the functioning of such systems.
Several pumped water supplies have regular breakdowns caused by poor condition of the water intake structure, failure of the pumping unit, lack of spare parts, or lack of fuel.
The design and construction of intake structures often does not meet the technical standards required for a reliable supply and frequently causes breakdowns in other parts of the system. The sand and suspended matter conveyed through the system may damage pumps, and cause clogging of appurtenances in the transmission and distribution lines.
The results of such failures will be that the villagers are forced to return to the traditional water sources, which in turn may have serious adverse public health effects.
Besides, the RWE's office has a serious shortage of skilled manpower, transport facilities, spare parts and tools. New projects suffer from the delays in delivery of essential items such as pipe materials and cement.

5.3. Water quality conditions

Fieldwork to investigate the physical-chemical, and bacteriological water quality of existing water supply facilities was conducted in the periods October - November, 1978, and February - March, 1979. During these periods only part of the survey area could be covered. Heavy rains started towards the end of November, 1978, and interrupted the field survey considerably.
From the water quality investigations, it appears that the water quality is in general fairly good as far as physical and chemical aspects are concerned. The "Temporary Standards of Quality of Domestic Water in Tanzania" were used as the guideline for the evaluation of the water quality investigations.
Physical, and chemical water quality parameters which may restrict the use of water for drinking water purposes are:

- substances which are toxic;
- substances which effect human health;
- substances which effect the palatability of water.

Toxic substances are not very common in natural waters and are usually introduced in water bodies as a result of human activities, e.g. industrial development. Such activities are virtually absent in the survey area, and therefore the determination of possible toxic substances has not been considered in the water quality investigations.
Water quality parameters with a proven negative health impact, such as fluoride and nitrate, were included in the standard measurement programme for all water sources surveyed. It appeared that these components were present in low or acceptable concentrations.

The electrical conductivity, used as a measure for the total dissolved solids content, and influencing the general palatability of the water, indicated the occurrence of three district problem areas: the Gairo division, the N.W. part of Mamboya division, and the Ngerengere area. The electrical conductivity had quite acceptable values in the other parts of the survey area.
Some 85% of all samples had an EC_{25} level below 125 mS/m (1250 µS/cm) and only about 8% of all water samples contained high amounts of solids resulting in EC_{25} values over and above 200 mS/m. In some cases, the villagers have rejected such water sources for human consumption, and use them only for laundry and dish washing.

All water samples were classified as "good", "fair" or "poor" from their general appearance (by sensorial observation). Some 40% of all samples obtained a "poor" qualification, caused by relatively high levels of turbidity mainly due to clay and loam.
The improvement of the palatability of the water by decreasing these high turbidity levels should receive full attention in rural water supply upgrading projects.

The bacteriological survey has been carried out along with the physical, and chemical investigations. The bacteriological quality was unsatisfactory for the majority of the water sources. They contained lower or higher quantities of E.Coli, which indicates recent pollution by faecal matter of human origin. Even piped water supplies conveyed such suspect waters.
About 73% of the water sources sampled contained E.Coli (MPN > 1/100 ml), and should be considered to be suspect for domestic water supply. Some water sources, including four piped water supply systems, were seriously polluted by faecal organisms (MPN > 100/100 ml), and regular occurrence of water-related diseases may be expected from such supplies.

5.4. Public health conditions

An adequate supply of water for drinking, personal hygiene and other domestic purposes is essential for the public health and well-being of a society as a whole. Such a water supply is characterized by adequate standards with regard to quantity, quality, accessibility and reliability of the water supply system.
In order to assess whether a particular water supply is appropriate to the objective of improving the health of the people who use it, one needs to have a fairly precise knowledge of the relations between water, hygiene, sanitation and health. In tropical countries, between twenty and thirty

different infectious diseases may be influenced by changes in water supply. They are classified according to four distinct mechanisms by which a disease may be water-related: faecal-oral (water-borne or water-washed), water-washed, water-based and water-related insect vectors.
This classification of water-related diseases can facilitate the use of health improvements as design benefits and thus promote efficient resource allocation. If the principal water-related diseases in a region are identified and classified, then it is possible to identify the types of water supply improvements which will have the greatest impact on health, to consider the cost-benefit aspects of different schemes and to nominate local and regional priorities for supply development.

A more or less reliable evaluation of data from Government hospitals, rural health centres, and dispensaries on the prevailance of diseases revealed that water-related diseases occur very frequently in the survey area.
From a number of monthly reports of medical centres over the year 1978, data were obtained on the first attendances for the following water-related diseases:

faecal-oral diseases	: cholera, bacillary dysentery, diseases of the digestive system, diarrhoeal diseases
water-washed diseases	: skin and eye diseases, ulcers
water-based diseases	: schistosomiasis, helminthiasis
water-related insect vectors	: malaria

In the health centres which were included in the evaluation, water-related diseases accounted for 30 - 80% of all diseases reported. Faecal-oral and water-washed diseases occurred throughout the survey area, and amounted to 15 - 60% of all diseases reported. Schistosomiases had in general a low incidence, apart from some locations where schistosomiasis appeared to be endemic (5 - 25% of disease pattern). Malaria prevailed in the whole survey area (5 - 40% of disease pattern).

A correlation study between the existing water supply facilities and the occurrence of water-related diseases revealed that no significant correlation between these two parameters existed. This result compares rather well with similar studies in rural areas of other Third World countries. It appears, time and again, that improved village water supplies have only measurable effects on health if they occur simultaneously with extensive programmes on health education.

For village water supply, the high incidence of faecal-oral and water-washed diseases requires development programmes which firstly concentrate on improvements in the availability and quality of water sources.
Simultaneously, comprehensive programmes on health education should be implemented to make the rural population aware of the relation between water and health, and to improve their individual hygienic practices.

5.5. Water demand studies

Water demand studies require input data such as water consumption per capita per day, present population in each supply area, and the estimated population growth in that area.
Additional water demand will be created by livestock, agriculture (irrigation), public and private institutions (e.g. schools, health centres, guest houses) and the industrial sector (e.g. sisal estates, sugar estates).
The MDWSP study is primarily concerned with domestic water supply for rural communities. Public institutions such as primary schools, rural health centres, and dispensaries constitute essential facilities for these rural communities, and the water demand generated by these institutions has therefore been included in the future domestic water demand projections.
Water demand for irrigation, industrial activities and private institutions such as missions has been left out of consideration. An exception has been made for domestic livestock, i.e. small groups of livestock returning to the homestead during the night, because they are considered part and parcel of the village community.

In conclusion, the following have been included in the future water demand estimates:

- rural population;
- village primary schools;
- rural health centres and dispensaries;
- domestic livestock;

Data on the present population of the villages in the survey area are based on the Governments' population census in 1978, the results of which were obtained from the Bureau of Statistics. A similar census was conducted for livestock, and the relevant data were obtained from the Districts' Livestock Officers. Data on the location and enrolment of primary schools were collected from the Districts' Educational Officers, and data on the location of medical centres from Districts' Medical Officers.

The criteria required for the water demand projections are largely based on directives of the Maji Department. An essential aspect of these ministerial criteria is the policy of considering a water allowance rather than a water demand for future projections. This policy is part of the Government's directives to save capital expenditure on rural water supply systems, so as to provide as many people as possible with a dependable water supply. The Consultant has introduced some additional criteria, such as the incorporation of an allowance for leakages in transmission and distribution lines and wastage at the domestic water points.
It has been assumed that these total losses can amount to 25% of the water distributed from the source. No data are available on actual water losses, but the adopted criterion is comparable to the current practice in some other regions in Tanzania. In accordance with this the water allowance for the next 20 years for the population has been set at 40 l/c/d and for the domestic livestock at 30 l/L.U./d.

The application of a water allowance of 40 l/c/d may be considered to be quite acceptable for piped water supplies based on distribution via public domestic water points. The physical effort of carrying water over a certain distance to the homestead constitutes the main limiting factor for a further increase in the consumption.
The future water demands have been estimated for 1983, 1988 and 1998, using the situation in 1978 as the reference level for estimates of population growth and livestock increase. In accordance with the Ministerial directives for the design of piped water supplies, the population increase is assumed to be 50% in 10 years and 100% in 20 years; for livestock 25% increase in 10 years and 50% in 20 years.

The estimated water demand of the present population amounts to 268 l/s for a population of 557,000 people in 360 villages; the future water demand (1998) is estimated at 549 l/s or 17.3 x 10^6 m^3/year. The present and future livestock water demand are estimated at 89 l/s and 133 l/s respectively, based on a present livestock population of 255,000 livestock-units. The estimated total present and future water demand will then amount to 357 l/s and 682 l/s, respectively.

A frequency distributiontable for the population and livestock water demand for all individual villages in the survey area shows that the majority of the villages have a future population water demand (1998) less than 3 l/s, and a future livestock water demand (1998) lesser than 2 l/s. In other words, design and construction activities for individual village water supplies, catering only for the population, have to be focused on design capacities ranging between 0.5 - 3 l/s for gravity supplies operating 24 hours a day, and 1 - 6 l/s for pumped water supplies with a pumping schedule of 12 hours daily.
Detailed estimates of future population and livestock water demand are given for each village separately in Data BD 3.
For all divisions, the water demand is very small in comparison to the average annual precipitation, and no serious problems should be encountered in meeting this demand, as long as no specific adverse hydrogeological or hydrological mechanisms occur. Some areas do suffer from such drawbacks, and under these conditions transmission of suitable water over fairly long distances may be required, e.g. Gairo division and N.W. part of Mamboya division.

5.6. Identification of problem areas

A first general inventory of the areas and villages experiencing problems in domestic water supply was given in the Integrated Development plan for Morogoro Region.
A more detailed inventory was made during the MDWSP and the Consultant has undertaken to make an assessment of the present water supply conditions for all villages in the survey area in order to make sure that no needy villages were accidentally left out of consideration. The identification of problem areas was based on an appraisal of the present water supply conditions of each individual village using six assessment criteria. These assessment criteria cover all aspects of the Governmental policies towards rural water supply as laid down in the 1981 targets.

The targets established by the Tanzania Government with regard to the development of rural water supply are the following:

- to provide a source of clean, potable and dependable water within a reasonable distance of every village by 1981 as a free basic service;
- to provide a reliable water supply with clean potable water to the rural areas by 1991, so that all people will have ease of access (i.e. a distance of 400 m) to a public domestic water point. This supply should preferably consist of a piped system with communal water points, but a shallow well with hand pump also complies with the requirements.

Within the context of the national policies, the following criteria for the identification of problem villages have been adopted in the MDWSP study:

- ratio of the present water demand to the present water availability;
- quality of the water source (labelled good, fair or poor);
- average distance to the water source (km);
- reliability of the present facilities, expressed as the time period of the year (in %) during which water availability matches with water demand;
- quality of the water, using the electrical conductivity as the quality standard;
- size of the village.

The villages received a score for each of these six assessment criteria. The scoring procedure adopted is summarized in Table B 5.6-1.

Table B 5.6-1 Scoring procedure for the assessment criteria used for the appraisal of existing village water supplies

Selection criteria	Scores		
	3	2	1
Water demand/availability (ratio)	< 0.5	0.5 - 1.0	> 1.0
Quality of source	poor	fair	good
Average distance to source (km)	> 2.5	1.0 - 2.5	< 1.0
Reliability of supply (%)	< 75	75 - 100	100
Quality (EC in mS/m)	> 200	100 - 200	< 100
Village population (1978)	> 2000	100 - 2000	< 1000

The aggregate score for each village for the six assessment criteria determined its ranking on the village assessment list.

The outcomes of the appraisal procedure have been visualised in Map B 1. This map shows that the following problems areas may be distinguished:

- the Gairo division, and the N.W. part of Mamboya division;
- the area along the Turiani-Kilosa-Mikumi road, covering parts of the divisions Turiani, Mamboya, Masanze and Ulaya;
- the Ngerengere division;
- part of Mlali division;
- the areas directly East and South of the Ulugurus, covering parts of the Matombo and Bwakira divisions.

The 360 villages of the survey area have been divided in three categories in accordance with their aggregate score.
The 77 villages with a score of 12 points or more, and 5 villages with a lower score but being more than 2.5 km from the water source were classified in category I. This group of 82 villages has been selected as the most needy group which should get first priority in a short-term implementation programme aimed at the improvement of village water supply conditions. The villages of category I are listed in Table B 5.6-2.
The second category includes 61 villages which experience moderate problems in their domestic water supply conditions, and the remaining group of 217 villages is considered to have no or only slight shortcomings in regard to the 1981 targets.

A frequency distributiontable of the scores for all assessment criteria shows that the major problems in the present water supply conditions are related to the quality of the sources, and to a lesser extent the reliability of supplies and the water availability. The average walking distance to the village water sources complies with the Government's targets for 1981 for the large majority of the villages. The EC values of the water sources are good to satisfactory for virtually all villages.

The people living in the problem areas, however, experience various difficulties with their water supply such as:

- serious water shortage for a fairly long period towards the end of the dry season;
- remoteness of suitable water sources and occasionally distances of 5 - 10 km have to be covered to arrive at the dry season water source;
- high salinity of water sources during part of the year or throughout the year.

The Tanzania Government wishes to offer water supplies to as many rural dwellers as possible with the available budgets. Therefore, the implementation costs per capita of rural water supply development programmes play an important role in the final ranking of priority villages for implementation programmes. Such considerations are part of the more detailed studies in Part E (Volume V).

Table B 5.6-2 List of priority villages

VILLAGE	AGG. SCORE	VILLAGE	AGG. SCORE	VILLAGE	AGG. SCORE
Bwakira Juu	12	Kondoa	12	Mtumbatu	13
Chakwale	12	Kunke	12	Mugudeni	13
Chanyumbu	12	Leshata	13	Muhenda	15
Chanzuru	12	Lubungo	14	Mwandi	12
Dakawa	12	Luhindo	10	Ngerengere	12
Difinga	12	Lukobe	13	Ngerengere Dar.	12
Diguzi	12	Mabula	12	Ngiloli	11
Dihinda	14	Machatu	14	Nguyami	14
Dumila	12	Madege	16	Nyarutanga	13
Fulwe	13	Madizini (Tur.)	13	Rudewa Batini	12
Gairo	12	Madudu	12	Rusanga	12
Gomero	14	Magubike	14	Sangasanga (Mla)	12
Ibindo	12	Maharaka	13	Sasasaga	12
Ibuti	12	Makuyu	12	Seregete A	13
Idibo	12	Mandela	12	Seregete B	12
Ihenje	14	Manza	12	Tabu Hotel	13
Ilakala	14	Maseyu	13	Tindiga	13
Iyogwe	12	Matuli	12	Tungi	14
Kambala	12	Mbigili	12		
Kibedya	12	Mbili	12		
Kidogobasi	12	Meshugi	13		
Kidudwe	12	Mfulu	12		
Kiegea	12	Mirama	12		
Kihonda	13	Mkalama	13		
Kilama	13	Mkambarani	12		
Kinonko	12	Mkonowamara	13		
Kiroka	13	Mkulazi	10		
Kisemu	12	Mkundi (Mam)	12		
Kitaita	13	Mkundi (Nge)	12		
Kitete	12	Mlilingwa	11		
Kiwege	14	Msonge	10		
Kiziwa	13	Mtamba	12		

TEMPORARY STANDARDS OF QUALITY OF DOMESTIC WATER IN TANZANIA

By The Rural Water Supply
Health Standards Committee[2]

1. DEFINITIONS:

1.1 Temporary Standards of Quality of Domestic Water in Tanzania are those Standards which will be in use until such time that circumstances permit the full application of International Standards of quality of domestic water.

1.2 Urban Water Supplies are those water systems serving cities, municipalities and townships.

1.3 Large Scale Rural Water Supplies are those water systems serving a rural population of more than 5,000 people.

1.4 Small Scale Rural Water Supplies are all other organised water sources not defined under 1.2 and 1.3 above.

2. APPLICABILITY

2.1 International Standards of Quality of Domestic Water will apply to waters distributed through water sources defined under 1.2 and 1.3, and all those water systems which have treatment systems more complex than simple sedimentation and/or rapid filtration appliances.

2.2 Temporary Standards of Quality of Domestic Water will apply for waters defined under 1.4.

1 -The paper presents the Standards of Quality of Domestic Water in Tanzania proposed by the Committee in compliance with the Committee's terms of reference (Section 3.)

2 -Members of the RWSHSC are:

Dr. Shaba	—Central Pathology Laboratory, Dar es Salaam.
Dr. Ivanov	—Central Pathology Laboratory, Dar es Salaam.
Dr. Kreysler	—Central Research Station, Ilonga, Kilosa.
Mr. Madati	—Ministry of Health, Chemical Laboratory, Dar es Salaam.
Mr. Simbeye	—Ministry of Health, Dar es Salaam.
Mr. Brooms	—Ministry of Water Development and Power, Operation & Maintenance Division, Dar es Salaam.
Mr. Kraft	—W.H.O., Dar es Salaam.
Mr. Bushaijabwe	—Ministry of Water, Development and Power, Research & Training Division, Dar es Salaam.
Mr. Bardecki	—Ministry of Water, Development and Power, Research & Training Division, Dar es Salaam.
Mr. Milkov	—Ministry of Water Development and Power, Project Planning & Preparation Division, Dar es Salaam.

3. TEMPORARY STANDARDS

The Temporary Standards of Quality of Domestic Water in Tanzania are divided into three categories, as shown below:

3.1 Bacteriological Standards

3.1.1 Frequency and location of sampling

(i) Distances from the source to the testing laboratory should be such as to enable effective supervision of the bacteriological quality of the water supply.

(ii) All waters defined under 1.2 and 1.3 should be examined according to International Standards of Quality of Domestic Water.

(iii) Frequency of sampling should be based on (a) size of the population served, (b) risk of pollution i.e. distance from and nature of pollution source, (c) nature and extent of sanitary protection of the source.

(iv) All waters defined under 1.4 should be examined at the following intervals:

Type of Source \ Population served	Up to 1,000	Up to 2,000	Up to 5,000
Borehole deeper than 8m. (26.25 feet)	6 months	4 months	3 months
Well less than 8m. (26.25 feet)	2 months	1 month	1 month
Surface water, lakes, rivers, Springs, dams	1 month	2 weeks	2 weeks

(v) The minimum number of samples to be taken from a distribution system is calculated at the rate of one sample per 500 population in addition to the intake or source.

(vi) The above prescribed frequency of sampling refers to those water supplies which on previous examination showed total absence of faecal coli. If the result of bacteriological examination indicates faecal pollution, the water supply in question should be re-examined within a fortnight, at the latest, irrespective of the type of source or population served.

(vii) Water engineers should determine key points on the distribution system from which samples should be collected. On each occassion samples should be taken from different points.

3.1.2 Standards of bacteriological quality of drinking water

Drinking water should not contain any organism of faecal origin. The presence of coliform organism should be considered as an indication of remote faecal pollution. The presence of Escherichia coli (faecal califorms) indicates recent faecal pollution, and hence dangerous condition if found in consecutive samples of water tested. Coliform organisms are those organisms which are capable of fermenting lactose with the production of acid and gas at 35 — 37°C in less than 48 hours, and are Indole negative. Escherichia coli (faecal coliforms), are those organisms which are capable of fermenting lactose with the production of acid and gas at 44°C in less than 24 hours, and which are Indole positive. The bacteriological standard to be aimed at is the same as the W.H.O. one which demand that there be no coliforms (E. coli) in each 100 ml portions (piped water supplies).

3.1.3 Standard and classification of non-chlorinated piped water supplies:

Class of piped water \ Type of test count	Caliform count per 100 ml at 37°C	E. Coli (faecal caliform) count per 100 ml at 44°C
Excellent	0	0
Satisfactory	1—3	0
Suspicious	4—10	0
Unsatisfactory	More than 10	1 or more

For each individual sample coliforms should be estimated in terms of the "Most Probable Number" in 100 ml of drinking water, which is often designated as MPN index or Coli index. Occurance of E. coli (faecal coli) in consecutive samples, in less than 100 ml of drinking water is an indication of faecal pollution and hence a dangerous situation needing urgent rectification.

3.1.4 Methods for bacteriological examination of rural waters

Whenever conditions permit (see below) the microfilter technique, as described in the various microfilter water testing guides or in the Standard Methods for the Examination of Water, Sewage and Industrial Wastes, 12th Edition, published by the American Public Health Association, Inc., employing faecal coli selective M—FC Medium (Difco) at 44.5°C temperature of incubation, should be employed, as described by Geldreich inter alia. (1) If, on the other hand, high turbidity or thick sediments of water or over-growth of algae or colonies other than E. coli render filtration impossible then the standard Lactose fermentation technique at 44°C followed by the confirmatory indole test as described in the Standard Methods Book mentioned above, as well as the W.H.O. Operation and Control of Water Treatment Process should be employed.

3.2 Physical and Chemical Standards

3.2.1 Frequency of Sampling: Irrespective of the size of population, all types of waters should be tested at least two times per year — once under dry conditions and once under rainy conditions.

3.2.2 The Tanzanian Temporary Standards of Physical and Chemical Quality of Drinking Water are given on Table I (See page 66) and compared with Standards of other countries as well as W.H.O. (International Standards).

3.3. Standards of Sanitary Protection of Water Intake and Surrounding Land

3.3.1 The Committee urges the Ministry of Water Development and Power and/or Ministry of Health to expedite the formation of an advisory Board which should define and set up sanitary zones, basing these on the following general guidelines, and these should be an integral part of every Rural Water Supply System.

3.3.2 Distance to Source of Contamination: When considering the following suggested distances from sources of pollution, the views of experienced Health Officers and/or Water Engineers, after inspecting each installation, should always be taken into account:

50 meters for pit privies, septic tanks, sewers.
100 meters from borehole latrines, seeping pits, trenches and sub-surface sewage disposal fields.
150 meters from cesspools, sanitary land field areas and graves.

In addition to the above minimum distances, the following precautions must also be observed:

(i) Domestic livestock and other animals should be kept away from the intake by fencing the area of a minimum radius of 50 meters from the installation.
(ii) Defecation and urination around the intake should be completely prohibitted, by law.
(iii) Drainage and run off waters should be led away from intakes.
(iv) The water source should be guarded against inundation by the flooding of nearby rivers.
(v) Soil erosion should be prevented by reforestation and other methods.
(vi) Algal growth should be prevented by draining swamps and pools around the intake or reservoir.

TABLE 1.—THE TANZANIAN TEMPORARY STANDARDS OF PHYSICAL AND CHEMICAL QUALITY OF POTABLE WATER COMPARED WITH STANDARDS OF OTHER COUNTRIES AND OF WORLD HEALTH ORGANISATION

No.	Water Classification and Substances	STANDARDS OF WATER QUALITY OF DIFFERENT COUNTRIES								
		Units	International (a)		European (b)	American (c)	Swedish (d)	French (e)	Bulgarian (f)	Tanzanian (g)
			Acceptable	Allowable						
1.	Water causing toxic effects									
1.1	Lead, Pb	mg/l	n.m.	0.05	0.10	0.05	0.02/0.05	n.m.	0.10	0.10
1.2	Arsenic, As	mg/l	n.m.	0.05	0.05	0.05	0.01/0.05	n.m.	0.05	0.05
1.3	Selenium, Se	mg/l	n.m.	0.01	0.01	0.01	0.01/0.05	n.m.	0.05	0.05
1.4	Chromium (b+), Cr	mg/l	n.m.	0.05	0.05	0.05	0.02	n.m.	0.05	0.05
1.5	Cyanide, CN	mg/l	n.m.	0.20	0.05	0.01	0.01/0.20	n.m.	0.01	0.20
1.6	Cadmium, Cd	mg/l	n.m.	0.01	0.01	0.01	0.01	n.m.	0.05	0.05
1.7	Barium, Ba	mg/l	n.m.	1.00	1.00	1.00	n.m.	n.m.	1.00	1.00
1.8	Mercury, Hg	mg/l	n.m.	n.m.	n.m.	n.m.	0.001/0.005	n.m.	n.m.	n.m.
1.9	Silver, Ag	mg/l	n.m.	n.m.	n.m.	0.05	n.m.	n.m.	n.m.	n.m.
2.	Water affecting human health									
2.1	Fluoride, F	mg/l	n.m.	1.5	0.7—1.7	0.8—1.7	1.5	n.m.	0.7—1.0	8.0
2.2	Nitrate, NO_3	mg/l	n.m.	30.0	50/100	45	30	44	30	(100)
3.	Water for general domestic use									
3.1	Water being organo-septic									
3.1.1	Colour	mgPt/l	5	50	n.m.	15	10	n.m.	15	50*
3.1.2	Turbidity	$mgSiO_2/l$	5	25	n.m.	3	weak	n.m.	30cm(y)	30*
3.1.3	Taste	—	n.o.	n.o.	n.m.	nil	weak	n.m.	nil	n.o.*
3.1.4	Odour	—	n.o.	n.o.	n.m.	3(x)	n.m.	n.m.	2bal(y)	n.o.*
3.2	Water of salinity and hardness									
3.2.1	pH	—	7.0—8.5	6.5—9.2	n.m.	n.m.	6.0—8.0	n.m.	6.5—8.5	6.5—9.2*
3.2.2	Total filtrable residue	mg/l	500	1500	n.m.	n.m.	200	2000	n.m.	2000*
3.2.3	Total hardness	$mgCaCO_3/l$	n.m.	n.m.	500	n.m.	n.m.	300	450	600*

TABLE 1.—THE TANZANIAN TEMPORARY STANDARDS OF PHYSICAL AND CHEMICAL QUALITY OF POTABLE WATER COMPARED WITH STANDARDS OF OTHER COUNTRIES AND OF WORLD HEALTH ORGANISATION

No.	Water Classification and Substances	STANDARDS OF WATER QUALITY OF DIFFERENT COUNTRIES								
		Units	International (a)		European (b)	American (c)	Swedish (d)	French (e)	Bulgarian (f)	Tanzanian (g)
			Acceptable	Allowable						
3.2.4	Calcium, Ca	mg/l	75	200	n.m.	n.m.	n.m.	n.m.	150	n.m.
3.2.5	Magnesium, Mg	mg/l	50	150	125	n.m.	n.m.	125	50	n.m.
3.2.6	Magnesium—Sodium Sulphate	mg/l	500	1000	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.
3.2.7	Sulphate, SO_4	mg/l	200	400	250	250	25/250	250	250	600*
3.2.8	Chloride, Cl	mg/l	200	600	600	250	25/250	250	250	800*
3.3	Water with non toxic metals									
3.3.1	Iron, Fe	mg/l	0.3	1.0	1.0	0.3	0.2	0.2	0.2	1.0*
3.3.2	Mangenese, Mn	mg/l	0.1	0.5	0.05	0.05	0.05	0.1	0.1	0.5*
3.3.3	Copper, Cu	mg/l	1.0	1.5	0.05/3.00	1.0	0.05/1.0	0.2	0.2	3.0*
3.3.4	Zinc, Zn	mg/l	5.0	15.0	5.0	5.0	0.3/5.0	3	3	15.0*
3.4	Water with organic pollution of natural origin									
3.4.1	BOD 5	mgO2/l	n.m.	6.	n.m.	n.m.	2	n.m.	2.6	6.0
3.4.2	PV (Oxygen abs. $KMnO_4$)	mgO_2/l	n.m.	10	n.m.	n.m.	20	n.m.	nil	20
3.4.3	Ammonium, NH_3	mg/l	n.m.	0.5	0.05	n.m.	0.1	n.m.	n.m.	n.m.
3.4.4	Total Nitrogen, exclusive Nitrate	mg/l	n.m.	0.1	n.m.	n.m.	n.m.	n.m.	n.m.	1.0
3.5.	Water with organic pollution introduced artificially									

(Continued on page 73)

(Continued from page 72)

TABLE I.—THE TANZANIAN TEMPORARY STANDARDS OF PHYSICAL AND CHEMICAL QUALITY OF POTABLE WATER COMPARED WITH STANDARDS OF OTHER COUNTRIES AND OF WORLD HEALTH ORGANISATION

No.	Water Classification and Substances	STANDARDS OF WATER QUALITY OF DIFFERENT COUNTRIES								
		Units	International (a)		European (b)	American (c)	Swedish (d)	French (e)	Bulgarian (f)	Tanzanian (g)
			Acceptable	Allowable						
3.5.1	Surfactants ABS	mg/l	0.5	1.0	n.m.	n.m.	n.m.	n.m.	n.m.	2.0*
3.5.2	Organic matter as carbon in chloroform extract	mg/l	0.2	0.5	0.5	0.2	nil	n.m.	1.0	0.5
3.5.3	Phenolic substance as phenol	mg/l	0.001	0.002	0.001	0.001	n.m.	n.m.	0.001	0.002

Notes:

n.m. = not mentioned
n.o. = unobjectionable
(x) = Odour scale in use in U.S.A.
(y) = Transparency measured as thickness of water layer through which standard type can be read.
(z) = Bal-unit of odour in the scale used in U.S.S.R.
(a) = Intern. Standards for Drinking Water, WHO, Geneva, 1963
(b) = Europ. Standards for Drinking Water, WHO, Geneva, 1970
(c) = U.S. Public Health Service Drinking Water Standards.
(d) = Report on Water Quality Criteria for Swedish Surface Waters, National Swedish Conserv. Office, 1969.
(e) = Handbook of Water Treatment, Societe Degremont. Paris, 1965.
(f) = Date of issue unknown, similar standards are in force in Eastern Europe.
(g) = Proposed temporary standards for Rural Water Supplies by RWSHSC, 1973.
* = tentative figures.

3.3.3 Surface Water Intakes: When water is drawn from rivers, streams, lakes and reservoirs, the following shall be observed in respect of intakes:

Intake should be so placed and designed as to draw water that is as clean and palatable as the source of water supply can provide:

(a) River Intake should be constructed upstream from villages and industrial factories, and the intake should be in deep water close to a stable bottom.

(b) Small Stream Intake should comprise an intake-pool which can also act as a settling "basin".

(c) Lake Intake should as much as possible avoid shore water, avoid stirring up of sediments, and seek the clean bottom water.

3.3.4 Sanitary Protection: Chlorination of newly built water supplies is advisable before handing over the water supply to the public.

4. COMMENTS

4.1. Bacteriological Standards: No further comments

4.2. Comments on Pysical and Chemical Standards:
International Standards as well as the proposed Tanzanian Temporary Standards categorise the standards into three distinct sub-sections:

(i) Substances which are toxic.
(ii) Substances which affect human health, which would result in chronic states if ingested in large quantities over a long period.
(iii) Substances which affect palatability of drinking water or affect the suitability of water for general domestic purposes.

4.2.1 Standards for substances classified as toxic for Tanzania are those that are designated toxic in the International Standards:

(a) these substances, if present in water, may cause immediate and serious toxic effect to the water consumers' health.

(b) they are not very common in natural waters but are usually introduced to the body of water as a result of human activities, such as discharged industrial effluents, etc.

(c) wherever factories or other sources of pollution are known to discharge their wastes into water sources, the waters should be checked, and remedial measures taken, in order to minimize the toxic hazards.

4.2.2 Standards of substances which affect human health

4.2.2.1 Fluorides

In Tanzania 95% of the population live in rural areas where from 3.5% (Coast Region) to 59% (Mwanza Region) of the water supplies contain concentrations of fluorides which are well above the International (W.H.O.) recommended level (2).

Although dental surgeons (3) are very firm about the negative effects of high levels of fluoride in drinking waters, the W.H.O. Manual on Fluorides and Human Health (4) insinuates that the dental damage caused by excessive concentrations of fluoride in water may not be per se a reflection of the fluoride concentration, but may in fact be the result of the combination of excess fluoride levels in water plus other as yet unspecified dietary habits.

Medical and veterinary evidence regarding systematic changes attributable to high concentrations of fluorides in water in Tanzania is still scanty. Judging from the questionnaires returned by doctors from all over Tanzania (5), fluorosis appears to be rare in all parts of Tanzania except in Kilimanjaro and Arusha. In view of this scanty information regarding systematic fluorosis, the Ministries of Health and Agriculture, in conjuction with the Ministry of Water Development and Power should conduct sample surveys in areas of high and low endemicity.

In view of the fact that concentrations of fluoride in drinking water of up to 8 mg/l do not produce abnormal effects on bones in man but do in fact benefit the elderly from bone decalcification, the Committee has deemed it fit to recommend this level of 8 mg/l as the maximum tolerable concentration, in declaring drinking waters temporarily adequate for human consumption.

If this figure of 8 mg/l is observed, then up to 95.5% of all waters in Tanzania would require no defluoridation, whereas only 24% in Singida, 18% in Arusha, 12% in Shinyanga and 10% in Mwanza Regions would require defluoridation.

In the cases of excessive levels of fluorides, treatment by the filtration method (3) should be employed.

4.2.2.2 Nitrates

These have been known to cause methaemoglobinaemia in infants who are fed on artificial diets when nitrate/nitrite Nitrogen concentration is higher than 10.2 mg/l in the water utilised for preparing such infants diets.

High nitrate/nitrite Nitrogen levels are unlikely to cause methaemoglobinaemia in Tanzania where the great majority of infants in the rural areas are breast fed for at least one year, and since the toxic agents are not normally secreted into mother's milk.

This, coupled with the facts that most surface waters and groundwaters in Tanzania, particularly in central regions, contain high levels of nitrates, and there being no feasible means of denitrating such waters the Committee deemed it fit to stipulate no strict limit to nitrates occuring in water due to natural causes other than artificial pollution. However, when nitrate concentration of a water exceeds the International (W.H.O.) limit of 100 gm/l the water authorities concerned will have to alert the appropriate health authorities to the possibility of infantile methaemoglobinaemia.

4.2.3 Standards of substances which affect the palatability of water or its suitability for general domestic use

The figures appearing on theTable 1 and market with asterisk are tentative, because the Committee feels that a considerable volume of investigation of purely sociological nature still remains to be carried out to ascertain at what levels of these ingredients in water the palatability or suitability of water for domestic use is interfered with.

It should be emphasised that no severe harm to human health can be done by ingesting or using for domestic purposes a water which contains the concentrations of these substances shown on Table 1. Thus, the tentative limits quoted for these substances in Table 1 should be regarded as their concentration limits above which the majority of water consumers would feel discomfort, and would consider the water unpalatable and a nuisance due to their slightly purgative effects or due to their accompanying scalling, deposits formation, or corrosion, etc.

When more data on the extent of this discomfort and unacceptability is obtained for a much wider cross section of the population, the pros and cons of altering these tentative limits may be considered.

References:

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ANNEX BA 2

Table BA 2-1 gives a short inventory of private water supply systems which are open for public use.

Table BA 2-1 Inventory of private water supply systems open for public use

Village	Description of facility
Bigwa	1 communal water point (14 taps), supplied from Bigwa mission; gravity supply from River Bigwa (non perennial)
Changarawe	1 tap (kiosk), supplied from Mzumbe institute; gravity supply from River Ngerengere
Dakawa Wami	some people make use of the water supply of NAFCO; pumped supply from River Wami
Fulwe	population makes use of 1 public tap at police station; pumped water supply from River Ngerengere
Iwemba	1 tap at Iwemba Mission Compound; gravity supply from River Iwemba
Kibungo (kib)	1 tap at the Kibungo mission compound, used by a small part of the population
Kidete St.	some people make use of the water supply of the railway station; gravity supply from River Lumuma
Kigugu	1 tap at Chazi Hospital, used by a small part of the population; gravity supply from River Chazi
Kihonda	some people make use of water supply of Kihonda prison sisal estate; pumped supply from River Ngerengere
Kikeo	1 tap, supplied from Kikeo mission; gravity water supply system
Kisaki/ Kituoni	3 domestic water points, connected to water supply of railway station; pumped supply from medium depth well
Konga/ Vikenge	1 tap, supplied from Mzumbe institute; gravity supply from River Ngerengere
Luhindo	1 tap, and small storage tank, provided by Wami sisal estate; pumped supply from River Wami
Madizini	some people make use of the water supply of the Mtibwa sugar estate; pumped supply from River Diwale
Madoto	1 tap, supplied from Madoto sisal estate; pumped supply from shallow well
Mikese	the population makes use of a open lined shallow well at the railway station
Mkambarani	the population makes use of the water supply of the Kingolwira/Pangawe sisal estate; pumped supply from River Ngerengere
Mkata Ranch	part of the population makes use of the water supply of the Mkata Ranch railway station; pumped supply from River Mkata
Peapea	1 tap, supplied from the Rudewa sisal estate; pumped supply from River Wami
Rudewa/ Gongoni	1 tap, supplied from sisal estate; pumped supply from River Wami

Table BA 2-1 (continued)

Village	Description of facility
Rusanga	1 tap, supplied from Mtibwa teak project; gravity supply from River Mjonga
Singisa	1 tap, supplied from Singisa mission; gravity water supply system
Tundu	1 tap, at primory school compound; gravity supply from River Tundu
Tungi	distribution line with a few taps supplied from the Tungi sisal estate (under construction); pumped supply from River Ngerengere

DATA BD 1

Table BD 1-1 Water analysis data

Village	Date	Lab.No.	EC_{25} mS/m	pH	Ca^{2+} mg/l	Mg^{2+} mg/l	TH ppm $CaCO_3$	Fe mg/l	Mn mg/l	F^- mg/l	Cl^- mg/l	HCO_3^- mg/l	NO_3^- mg/l	SO_4^{2-} mg/l	CO_2 mg/l	O_2 mg/l	E. Coli MPN/100 ml	General Appearance
Berega	781024	23010111	140	8.0				0.03	-	0.8			3.1					F
	790225	23011111	20	6.7						0.2							~	P
Bonye	781103	76011111	14.5	7.7						0.3			3.0				~	F
Bwakira Chini	781103	75015111	30	7.6						0.7			1.8				0	G
Chakwale	781025	22010111	300	7.8	230	70	860	0.06	0.1	0.7	500	490						G
	790223	22015111	7	6.5				0.2	-	0.1			3.2	3			6	G
Changarawe (Mla)	790306	55035111	5.5	6.9	4	5	30	0.02	0.4	0.1	8	73	1.8	2			70	G
Dakawa	781103	75032111	125	7.2	76	51	400	0.03		0.6	115	570	2.7	88			~	P
Dakawa Wami	781113	35011111	20	7.1						0.2							200	P
	781019	35019121*	22	8.1				0.14	0.1	0.2			1.8					G
	790313	35019122	32	6.8	22	15	115	3.4	0.4	0.4	18	110	0.4	7	52	0	0	G
	790418	35014131	55	7.3	20	17	120	0.1	0.2	0.1	25	100	110	45			2	G
Dibamba	781028	34019111*	40	7.5	24	24	110	0.4	0.8	0.4	15	200	2.7	5			0	G
	790313	34019112	35	6.8	28	12	120	2.4	0.5	0.4	12	130	0.9	5	6.4	0	0	G
Diguzi	781124	57010111	70	7.1				5.0		0.3			3.1				~	P
Dihinda	781027	25039111	13	7.0						0.2			2.7				150	P
	781027	25039221	11	6.8						0.2							50	P
	781114	25031131	10	7.0						0.1							0	F
Dihombo	781027	35021111	5	7.2						0.1							~	F
	781113	35021112	6	6.8						0.1							10	F
Doma	790306	63014111	75	7.1	62	34	200	0.03	0.5	0.4	75	49	0.9	4			5	G
Fulwe	781122	56032111	20	7.0						0.3							600	P
	781122	56030121	17	6.2						0.1							260	P
	781122	56030231	10.5	6.7						0.2							240	P
	781122	56030241	15	6.7						0.1							0	P
	781122	56032251	135	7.5	52	47	320	0.36		1.0	190	550	2.7	9			90	P
	781122	56039161	25	6.4						0.2							0	P
Gairo	790223	22025111	7	6.5				0.2	-	0.1			2.2	3			20	G
Gomero	781103	75040111	100	7.1				0.02		0.2			2.7				6	P
Hembeti	781027	35031111	4	7.0						0.1			4.5				52	G
	781027	35030121	110	8.1				0.07	0.3	0.5			22				10	F
Ibindo	781117	23020111	90	7.3						0.8			3.0					F
Ibido	781023	23030111	70	7.8				0.23	1.8	0.4			0.4					F
Ilakala	781115	62010111	55	7.2				0.23		0.2			3.5				40	P
	781115	62010221	4	6.4						< 0.1							~	P
Ilonga	781114	53021111	19	7.5						0.1							~	F
Iwemba	780228	82021111	10	7.2				0.23	0.5	0.2			3.5	3			50	P
Kauzeni	790306	55055111	8	7.6	6	2.4	25	0.04	0.6	0.2	7.5	290	0.4	2			> 1000	F
Kibedya	790223	22055111	7	6.6				0.2		0.1			2.0	3			20	G
Kichangani	781113	25235111	5.5	7.0						< 0.1							50	G
Kidudwe	781027	25052111	40	7.8						0.3			31				10	G
	781027	25052221	110	7.9				0.05	1.2	0.4			270				6	P
	781027	25052331	40	7.8						0.4			4.5				0	P

Table BD 1-1 (continued)

Village	Date	Lab.No.	EC_{25} mS/m	pH	Ca^{2+} mg/l	Mg^{2+} mg/l	TH ppm $CaCO_3$	Fe mg/l	Mn mg/l	F^- mg/l	Cl^- mg/l	HCO_3^- mg/l	NO_3^- mg/l	SO_4^{2-} mg/l	CO_2 mg/l	O_2 mg/l	E. Coli MPN/100 ml	General Appearance
Kidudwe/ Ujamaa	781027	25062111	170	7.8				0.07	1.8	0.2			4				0	P
	781027	25062221	60	8.0						0.1			3.1				6	P
Kifinga	790228	82031111	11.8	8.1				0.16	0.3	0.2			1.8	1			120	P
Kigugu	781113	25075111	6.5	6.8						< 0.1							0	G
Kihonda	790418	55074111	225	7.5	44	32	240	0.4	0.5	0.5	115	370	27	12			0	F
Kikundi	781124	56087111	30	6.8						0.2							10	F
Kilimanjaro	781113	25085111	5.5	7.0						< 0.1							50	G
Kinyolisi	781025	23070111	60	8.0				0.04	0.3	0.5			2.0					G
Kiroka	781103	56091111	20	7.7						0.4							0	G
	781103	56091121	20	7.5						0.3							5	G
Kisala	781113	25090111	17	6.7						< 0.1							0	P
	781113	25090221	17.5	6.7						< 0.1							6	P
	781113	25090331	13	6.2						0.2							4	P
Kitete/ Msindazi	790228	83024111	22.5	6.5	24	7	90	2.6	1.2	0.3	10	135	1.3	2			0	G
	790228	83022121	25	6.7	26	6	90	1.8	1.0	0.3	12	150	1.3	4			14	F
Kondoa	781025	53050111	52	7.1				0.04	0.1	0.8			4.9				2	P
	781025	53052121	37	6.8						0.4			1.2				0	F
	781025	53052231	42	7.0						0.8							70	G
	781025	53052341	45	6.9				0.12		0.5			3.1				10	F
	790329	53059151*	45	7.1	52	18	200	0.07	1.4	0.5	15	190	3	37				G
Kunke	781027	25102111	250	7.6				0.07	1.3	0.4			10				0	P
	781027	25102221	130	8.1				0.03	0.1	0.6			3.1				6	G
Kwamtonga	781027	25111111	3	7.2						0.2			2.2				0	G
Lubungo (Nge)	781122	46010111	5	6.3						< 0.1							0	P
	781122	46012121	300	6.8	32	29	200	0.23		0.3	310	330	7.5	100			20	P
Lukenge (Tur)	781027	25131111	5	7.6						0.1			2.7				0	P
Lumango	790228	83031111	12.5	7.4				0.09	0.3	0.2			1.8	4			20	F
Mabula	781023	23080111	160	8.3				0.03		0.6			3.0					P
	781023	23080221	140	7.8				0.04		0.8			3.1					G
Madege	781024	23100111	190	7.7				0.07	2.5	0.4			6.6					P
Madizini (Tur)	781027	25142111	140	7.8				0.04	0.2	0.2			310				0	P
	781027	25142221	30	7.8						0.2			9				0	P
Madoto	790223	43024111	325	7.2	40	34	240	0.04	-	0.2	180	370	58	30				G
	790216	43029121*	133	7.5	96	73	540	0.21	0.5	0.5	80	560	2.7	170				G
Madudu	781019	34062111	70	6.9				0.07		0.6			1.8				20	G
	781019	34062221	65	6.7				0.02		0.4			58				4	G
	781019	34062331	40	6.8				0.14	0.1	0.4			3.5				700	P
Magera	781023	23110111	75	8.1				0.04	0.1	0.3			2.7					F
	781023	23110221	110	8.1				0.05	-	0.7			2.9					P
Magole	790313	34079111	88					0.25	-								1	G
Majawanga	790222	22095111	7	6.5				0.2	-	0.1			2.0	3			12	G
Makuyu (Tur)	781019	34082111	33	6.6				0.03		0.4			31				6	G
	781019	34082221	130	7.4				0.04		0.9			11				12	F
	781019	34082331	68	6.8				0.04		0.3			9				15	F
	781120	34082441	80	6.9				0.15		0.5			3.5				160	G

Table BD 1-1 (continued)

Village	Date	Lab.No.	EC_{25} mS/m	pH	Ca^{2+} mg/l	Mg^{2+} mg/l	TH ppm $CaCO_3$	Fe mg/l	Mn mg/l	F^- mg/l	Cl^- mg/l	HCO_3^- mg/l	NO_3^- mg/l	SO_4^{2-} mg/l	CO_2 mg/l	O_2 mg/l	E. Coli MPN/100 ml	General Appearance
	781123	34089151*	29	7.7	18	11	90	0.33		0.5	27	128	6.2	4				G
Malangali	781025	53060111	82	6.8				0.06	0.1	0.4			2.2				0	P
	781025	53060221	76	6.7						0.3							10	P
	781025	53062131	122	6.9				0.04	0.2	0.5			16.4				8	G
	781025	53062241	230	7.1				0.03	0.1	0.5			2.7				0	G
	781025	53062351	197	6.9				0.06	0.1	0.5			1.2				~	G
	781025	53062461	90	7.3				0.24		0.8			2.7				0	G
	781025	53062571	96	7.4						0.4							0	G
	781025	53062681	38	7.0				0.03	0.1	0.6			2.7				40	G
Malui	781026	53070111	66	7.0						0.6							0	P
	781026	53072121	99	6.8				0.03	0.7	0.5			2.7				8	G
	781026	53072231	65	6.9						0.6							160	G
	781026	53072341	81	7.0						0.5			2.8				0	G
	781026	53072451	61	7.0				0.03	0.3	0.6							0	G
	781026	53071161	24	7.5						0.3							10	G
Mamoyo	781025	53082111	81	7.2						0.7			2.2				4	G
	781025	53082221	70	7.1						0.6							0	G
	781025	53082331	70	7.1				0.24		0.7			3.1				15	P
	781025	53080141	58	7.0				0.04	0.1	0.6			3.0				~	P
	781025	53082451	60	7.1						0.6							0	G
	781025	53082561	63	7.0				0.03	0.1	0.5			2.7				0	G
	781025	53082671	57	7.3				0.03	0.2	0.6			2.2				0	G
	781025	53082781	50	7.0						0.6							12	F
Mandela	781019	34092111	190	7.3				0.06	0.1	1.0			16				200	P
	781019	34090121	58	6.7				0.02		0.5			1.8				6	P
	781114	34092231	45	6.8				0.04		0.3			3.5					G
	781110	34099141*	50	7.5	44	19	190	0.06		0.3	55	200	3.5	19				G
	790313	34099142	55	6.5	40	20	190	0.3	0.5	0.5	45	200	0.4	10	112	0	0	G
Mangae	790306	54014111	140	7.1	76	88	380	0.02	0.05	0.7	160	480	10	4			2	G
	790306	54010121	160	7.9	52	63	280	0.01	0.3	3.1	120	440	40	3			30	G
Manyinga	781027	25162111	20	7.9						0.2			5.6				0	G
	781027	25162221	80	7.7				0.03	0.2	0.2		110					0	F
Maseyu	781124	46020111	2	6.4						< 0.1							20	G
	781124	46020221	9	6.5						0.2							400	P
	781124	46022131	400	8.2	48	53	340	0.18		0.2	1000	390	2	8			6	F
Matuli	781124	57071111	25	6.8						0.2							20	P
	781124	57070121	35	6.7				0.4		0.1								P
Mbili	781117	23140111	325	7.5	88	95	610	0.9		0.7	730	590	12.4	68				F
Mbwade (Bwa)	781103	76031111	14.5	7.7						0.3			3.1				~	F
Mbwade (Mas)	781025	53092111	166	6.9				0.05	0.2	0.6			3.1				10	F
	790130	53099121*	65	8.5	64	29	280	0.04	0.5	0.4	18	300	13	90				
Melela	790306	54027111	90	6.9	96	44	350	0.02	0.3	0.4	90	220	31	4			0	G
Mfulu	781019	34112111	110	7.4				0.03		0.6			84				200	P
Mikese	781122	56162111	115	7.0	48	29	240	0.2		0.4	165	370	6.7	38			300	F
	781124	56164121	120	6.6	72	39	340	2.4		0.2	190	230	2	120			0	F

Table BD 1-1 (continued)

Village	Date	Lab.No.	EC_{25} mS/m	pH	Ca^{2+} mg/l	Mg^{2+} mg/l	TH ppm $CaCO_3$	Fe mg/l	Mn mg/l	F^- mg/l	Cl^- mg/l	HCO_3^- mg/l	NO_3^- mg/l	SO_4^{2-} mg/l	CO_2 mg/l	O_2 mg/l	E. Coli MPN/100 ml	General Appearance
Mileng-welenge	781103	75072111	60	7.3						0.9			6.7				0	G
Mirama	781019	34122111	95	7.2				0.03		0.5			17				2	G
	781019	34122221	98	7.0				0.03		0.7			11.5				150	G
	781019	34122331	25	6.6				0.2		0.5			7				8	P
Mkambarani	781122	56170111	14.5	6.6						0.2							400	P
	781122	56170221	60	6.8						0.4			2.0				50	P
Mkindo	781113	25191111	4.5	6.8						< 0.1							100	G
Mkundi	781019	34131111	14	7.4				0.09		0.2			1.3				> 1000	P
Mkuyuni	781103	56183111	70	7.0						0.5			2.7				20	G
Mlali	790306	55185111	20	8.0	16	11	85	0.4	0.1	0.4	7.5	190	1.3	2			200	G
Mngazi	781103	75091111	8	7.7						0.2			3.1				300	F
Msonge	781103	66183111	86	7.5						0.6							0	G
	781103	66183221	90	7.6						0.6							> 1000	G
	781103	66181131	60	7.6						0.5							15	G
	781103	66181241	45	8.4						0.6			2.2				0	G
Mscwero (Mas)	781026	43041111	10	7.4				0.04	0.3	0.2			2.7				0	G
Msowero (Mik)	790228	83041111	6	7.1				0.5	0.6	0.1			1.3	3			3	P
Msufini	781027	34142111	110	8.2				0.03	0.1	0.8			2.2				> 1000	F
Mtamba	781103	66196111	55	6.9						0.7			3.5				0	G
Mugudeni	781019	34150111	195	7.5	56	54	360	0.04	0.25	1.3	260	700	2.2	85			800	P
	781019	34152121	175	7.6				0.03	0.2	1.1			6.2				4	P
	781019	34150231	530	7.5	96	88	600	0.08	0.25	0.8	1125	1000	2.2	320			35	P
	781019	34150341	130	7.3				0.03		0.8			2.2				> 1000	P
Muhenda	781115	62031111	25	7.9				0.64		0.3			3.1				100	F
	781115	62033121	14.5	6.5				1.8		0.2			2.7				0	G
Muhungamkol	781124	56190111	80	6.9				0.4		0.2			2.2				200	P
	781124	56190221	17	6.7				0.1									60	P
Mvomero	781113	34162111	175	6.6				0.04		0.2			90				70	G
Mvuha	781103	66211111	9	7.4						0.1							50	F
Mvumi	781114	43055121	8	7.3						0.1							140	G
Mwandi	781117	23150111	110	7.2				0.3		0.8			3.1					P
Ndogomi	781024	23160111	175	7.8				0.2	0.8	0.3			6.2					F
Ngerengere	781124	57095111	90	7.1				0.8		0.3			16				0	F
Ngerengere Dar.	781124	47021111	20	7.1						0.2							500	P
Nguyami	781024	23170111	225	7.8				2.2	2.8	0.7			5.3					F
Peapea	781012	43067111	83	7.0						0.3							0	G
	781012	43062121	85	7.2						0.2							10	G
	781012	43062231	80	7.1						0.2							20	G
Rubeho	790222	32115111	7	6.5				0.2		0.1			2.2	3			1	G
Rudewa Batini	781012	43072111	35	6.7						0.3			8.9				0	G
	781012	43072221	105	6.6						0.5							20	P
	781012	43072331	42	6.6						0.4							0	P
	781012	43072441	42	6.5						0.4							200	F
	790227	43079151*	22.5	6.9	18	8.5	80	0.8	0.7	0.3	8	95	2.2	0.5				G
Rudewa Gongoni	781012	43085111	7	7.3						0.1							400	F
	781114	43081211	7.5	7.2						0.1							420	F

Table BD 1-1 (continued)

Village	Date	Lab.No.	EC_{25} mS/m	pH	Ca^{2+} mg/l	Mg^{2+} mg/l	TH ppm $CaCO_3$	Fe mg/l	Mn mg/l	F^- mg/l	Cl^- mg/l	HCO_3^- mg/l	NO_3^- mg/l	SO_4^{2-} mg/l	CO_2 mg/l	O_2 mg/l	E. Coli MPN/100 ml	General Appearance
Rudewa																		
Mbuyuni	781026	43090111	35	8.0				0.05	0.2	0.5			3				120	P
	781026	43092121	40	8.2				0.04	0.1	0.5			1.4				0	F
Ruhembe	790228	83051111	22.5	7.8				1.0	0.9	0.3			1.3	14			20	P
Rusanga	781113	25225111	5.5	6.7						< 0.1							0	G
Tangeni	790306	55231111	6	7.2	4	6	25	0.01	0.4	0.1	7.5	60	2.7	3			> 1000	G
Tindiga	781026	53112111	62	6.8						0.5							50	G
	781026	53112221	70	6.9						0.4							24	G
	781026	53112331	87	7.0						0.6							0	P
	781026	53114141	89	7.1				0.03	0.1	0.5			3.1				0	G
Tundu	790228	82051111	9.5	8.5	10	2.4	35	0.2	0.2	0.2	5	50	2.7	2			60	F
Ukwamani	790222	22165111	7	6.5				0.2	0	0.1			2.2	3			2	G
Ulaya Kibaoni	781115	62051111	11.5	7.6						0.1							18	G
Vigolegole	781103	75141111	8	7.7						0.2				3.1			300	F

Rivers/ Springs	Date	Lab.No.	EC_{25} mS/m	pH	Ca^{2+} mg/l	Mg^{2+} mg/l	TH ppm $CaCO_3$	Fe mg/l	Mn mg/l	F^- mg/l	Cl^- mg/l	HCO_3^- mg/l	NO_3^- mg/l	SO_4^{2-} mg/l	CO_2 mg/l	O_2 mg/l	E. Coli MPN/100 ml	General Appearance
Lusonge R.	781113	Dihinda	10	7.0						0.1							0	F
Kidodi R.	790228	Tundu	10															
Kisungusi R.	781114	(Mfuluni)	20	6.8				0.12		0.1			4.1				0	G
Mgeta R.	781104	Sesenga	18	8						0.3			2.7				20	F
Milindo T.	790222	Point No 9	6	6.5						< 0.1							0	G
	"	10B	6	6.5						< 0.1							0	G
	"	10E	6	6.5						< 0.1							0	G
	"	10F	6	6.5						< 0.1							0	G
	"	10G	6	6.5						< 0.1							0	G
	"	4	6	6.5						< 0.1							15	G
Mkalazi	781103	Kalundwa	9	7.0						0.2							> 1000	F
Mkondoa	781115	Kilosa	20	7.5						0.2							280	F
Mzuazi	781103	Kalundwa	7	7.2						0.1			2.7				> 1000	G
Msengere	781114	Kwantonga	7	6.9						0.1							100	F
Mvaji	781114	Kwamtonga	7	7.4						0.1							10	G
Ruvu	781103	Kibungo															0	G

Other rivers/springs:

Berega R.	: see Berega village	Ilonga R.	: see Ilonga	Mjonga R.	: see Rusanga	Msowero R.	: see Msowero (Mik)
Bwakira R.	: see Bwakine Chini	Iwemba R.	: see Iwemba	Mkindo R.	: see Mkindo	Mtamba S.	: see Mtamba
Chazi R.	: see Kigugu	Kifinga R.	: see Kifinga	Mkundi R.	: see Mkundi	Mvuha R.	: see Mvuha
Dihombo R.	: see Dihombo	Kiroka R.	: see Kiroka	Mkunyuni S.	: see Mkuyuni	Ruhembe R.	: see Ruhembe
Divue R.	: see Kwamtonga	Kisangate R.	: see Mvumi	Mlali R.	: see Mlali	Ngerengere R.	: see Tangeni, Ngerengere
Diwale R.	: see Turiani, Lukenge	Lumango R.	: see Lumango	Mngazi R.	: see Mngazi	Tami R.	: see Msowero (Mas)
Dutumi R.	: see Mbwade (Bwa)	Miyombo R.	: see Ulaya Kibaoni	Msonge R.	: see Msonge	Wami R.	: see Dakawa, Rudewa Gongoni

Coding of Lab. No.: e.g. 53082451, explanation:

53 = codenumber for sheet No. where village is located
08 = number of village on that sheet in accordance with alphabetical order
2 = type of water supply facility of which the sample was taken (see below)
4 = sequence number for that particular type of facility (in this case the fourth facility of this type)
5 = sequence number for the total amount of facilities surveyed in the village
1 = sequence number for the number of laboratory analyses carried out for this facility.

Code numbers for the various types of water supply facilities (the fifth figure in the laboratory code numbers):

0 = handdug hole (on village ground or in river bed)
1 = river as water source
2 = lined shallow well as water source
3 = spring (not developed)
4 = lined shallow well with handpump
5 = river intake with piped supply (either pumped or gravity diversion)
6 = spring with piped supply
7 = shallow well with mechanically driven pump and piped supply
8 = borehole with mechanically driven pump and piped supply
9 = miscellaneous (e.g. new MDWSP boreholes).

Table BD 2-1 Health statistics of rural health centres and dispensaries in the survey area (1978)

	TOTAL FIRST ATTENDANCES												FAECAL-ORAL DISEASES (%)											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Morogoro District																								
Dakawa Wami						471	759		798		790	504						23	24		27		27	26
Doma	878		936	824	776	550	478	688	713	935	691		21		31	18	20	9	8	9	13	10	11	
Kanga	1697	1888	230	370	560		626	748			1105	1071	27	17	16	13	21		25	24			17	14
Kibanile				588		654	514	617	428	459	561	874				16		19	16	16	13	16	16	12
Kibati	1452		1076	925	1270	1424	1030	1374	1441	1423	836	1293	25		32	29	31	26	28	25	23	24	19	19
Kikundi	750	908	707	811		1400	1800	1440			1561	1392	12	9	12	14		13	11	14			17	16
Kinda	1694						2218	660	719	1614	1399	1290	19						11	14	15	20	16	17
Kiroka	1794		1510	1607	1362	1639	1427	1469	1642	1720	1721	1179	6		9	7	8	6	8	8	11	11	9	13
Kisaki			1468	1214	1574		1586	1188	758			708			25	22	25	18	28		16			25
Konga			1394	1517	1537	1360	1368	1240	964	995					14	20	22	22	18	32	19	16		
Maharaka			610	310	429		411	284	330	550	560	431			12	16	18		6	8	5	6	6	9
Maskati	1100	183	239			273	151	173			164		30	42	25			24	46	25			25	
Melela			1120	1263	1322	1105	1045	1192	1252	1316	1105	1100			13	10	9	11	14	12	18	17	16	14
Mkata		487			412	1048	1178			450	1073	621		24			26	33	29			27	31	32
Mngazi				1892			3453		2545		2947	3208				29			26		30		30	29
Mtombozi						1419	1541	1283	559	48	1425	1516						21	17	19	18	21	20	16
Mvomero	2820	2626	2722	2678	3233	3018	2492	2830	2382		2478	2629	16	12	12	15	14	13	15	10	9		12	14
Mvuha						3028	2561	2340		2861	1436	2658						38	32	27		26	30	19
Mziha		860	882	740	827	992	1054	884			834	810		14	10	10	13	12	15	15			22	16
Ndole				720		773	771	720	612	740	801	781				16		12	12	18	17	20	18	24
Turiani		2318	1983		2533	2720	2549	2374	2130	2264	1430	1874		12	13		8	4	12	9	15	17	14	10
Visaraka				511	582	626	467		137							12	11	10	6		27			
Kilosa District																								
Gairo			1913	1471	1212	1314	1704	1193	1216	1341					3	5	5	5	5	7	5	3		
Idibo				1037		936		1381	1343	1036	1201					23		20		17	21	24	18	
Iyogwe	2626		1781	4467		3115	4599	4924	4029	5147	6505		27		17	31		19	26	22	33	25	33	
Kidete		1149			573	944	914		782	951	827			12			6	16	5		6	5	20	
Kilangali	1601	1506			1092			1297	1128		1061		33	34			39			19	25		19	
Kimamba	2382	2136			2074	2131	1941	1686	1672				12	13			9	4	4	5	10			
Kisanga			763	815	599	713	640	562	509						14	15	22	17	7	21	20			
Kivungu	682	847		596	570	363		510	493				18	24		9	5	10		16	18			
Lumuma	2236	2031	2156	1296	1177	1088	1296						24	31	18	22	23	24	22					
Madege	469	281			672	445		520	462	608			26	13			25	21		23	16	13		
Magole	872	2156	2455	2345	717	2800		2638		4040			23	7	7	8	37	10		7		4		
Malangali	1570	1276				552	1152	870					11	19				13	11	18				
Malolo	1666		1304	1468	1403						1395		14		18	20	17						17	
Mamboya	1064		518	636					716	1161	546		21		22	16					20	12	10	
Mbamba	933	1329	1261	861	904	877	587	814		818			17	39	39	18	11	10	8	13		13		
Msimba		922	1006	745	936	787								9	8	11	14	14						
Msowero	1798	1746	1560	1575	1666		1870	1540		1690			16	16	15	15	14		13	14		13		
Muhenda	1624	1222	1861	1998		1346	2100	1861					18	22	14	18		14	34	14				
Mwasa			983	•	1160	1053			1190	1149					6		14	31			27	14		
Rudewa			1496	1269	1665			947		1225	739				3	2	2			4		3	1	
Uleling'ombe		621	638	652	587	583		591						23	21	22	23	27		28				

WATER-WASHED DISEASES (%)												WATER BASED DISEASES (%)												WATER-RELATED INSECT VECTORS (%)											
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
					3	5		5		8	3						10	5		5		5	5						24	16		19		20	24
8		6	7	10	10	9	8	10	8	4		8		9	16	12	5	1	2	2	3	2		9		10	5	10	16	15	9	11	10	8	
3	8	12	15	12		7	6			7	6	10	17	4	16	2		0	0			9	15	35	21	14	12	13		27	23			20	23
			10		6	9	10	10	8	12	6				< 1		< 1	< 1	< 1	-	< 1	< 1	< 1				18		24	14	21	24	20	20	26
6		6	7	8	8	5	8	6	7	4	8	9		7	5	8	8	7	8	9	8	12	9	8		6	10	10	9	10	9	10	2	4	9
10	15	9	12		16	12	16			14	16	11	6	7	9		5	4	8			7	6	16	16	14	14		27	30	26			25	25
12						4	3	2	12	8	9	1						3	8	2	6	4	4	12						32	< 1	25	10	10	11
4		17	21	10	9	7	7	15	15	7	22	2		1	2	2	2	2	2	2	2	1	2	8		7	8	10	9	9	10	7	7	6	9
		5	6	6		5	5	5			8			6	8	9		6	13	7			10			12	12	12		8	15	16			13
		4	4	3	4	5	5	9	9					19	14	4	11	14	14	6	6					29	26	22	37	30	16	15	17		
		9	16	11		7	12	10	7	6	7			12	2	-		16	14	12	13	13	16			11	21	2		12	12	10	7	7	8
9	7	8			7	4	12			10		-	17	7			10	23	24			17		1	13	4			4	3	-			16	
		7	10	6	7	6	5	7	3					1	2	2	3	3	1	5	3	4	3			13	13	19	21	17	12	16	13	13	16
	3			8	8	7			7	9	3		18			4	10	11			7	10	2		14			25	12	13			23	12	10
			5			6		5		4	5				3			5		5		2	1				15			12		14		11	16
					5	8	8	6	2	1	7						4	3	2	13	2	4	3						14	15	13	13	23	14	15
9	9	10	8	10	8	12	8	9		14	14	5	6	5	5	5	6	6	6	2		5	6	20	19	20	20	16	17	19	17	13		15	20
					10	8	9		8	14	4						13	6	6		2	4	4						9	19	18		21	21	25
	7	4	4	5	3	4	5			4	2		11	15	11	10	9	10	8			12	5		10	8	10	8	9	12	8			13	4
	19	14		15	15	13	14	13	14	12	14		2	3		2	4	3	1	2	2	2	2		29	28		37	32	34	28	30	32	36	35
			13	10	7	16		11							< 1	< 1	< 1	< 1		< 1							8	16	16	13		9			
			12		6	6	4	7	5	12	6				2		2	2	1	1	1	1	3				12		24	18	20	13	16	10	14
		14	11	16	14	15	12	3	11					1	1	1	2	2	1	1	2					18	9	10	4	12	7	6	12		
			20		18		12	15	22	20					7		6		4	7	8	6					8		5		4	2	5	6	
22		14	26		18	24	31	22	25	20		5		2	3		4	< 1	< 1	1	< 1	< 1		11		4	16		17	17	17	19	17	15	
	15			6	26	9		29	25	29			1			4	3	3		3	3	4			7			13	14	15		14	14	16	
31	27			14			37	31		44		-	-			-			-	-		-		25	26			31			13	26		23	
12	6			8	6	6	8	6				2	1			3	4	3	1	1				20	32			34	35	42	43	39			
		17	20	18	30	40	23	32						7	3	6	< 1	5	13	8						5	10	14	1	12	2	4			
14	9		26	18	24		24	19				5	7		6	5	-		2	-				16	15		20	28	19		17	15			
9	10	6	9	11	13	9						1	< 1	< 1	-	-	-	-						17	24	17	25	21	22	25					
12	15			24	15		19	21	10			2	2			2	4		2	1	9			4	5			4	4		5	4	4		
7	< 1	1	< 1	3	< 1		1		1			4	3	2	3	11	2		4		1			40	40	34	36	32	47		34		26		
6	10				18	8	5					4	6				6	5	6					28	18				13	18	17				
12		17	15	16						14		1		1	1	1						1		14		20	16	16						15	
19		25	21					21	11	32		4		4	8					4	2	6		9		12	12					7	4	1	
5	4	4	8	11	6	6	6		5			3	2	3	3	6	3	1	6		12			11	10	11	13	12	17	13	10		10		
	10	8	21	21	22								1	1	1	2	3								25	6	22	25	10						
13	13	15	15	15		14	21		28			7	9	6	13	12		13	14		14			19	20	18	19	20		20	16		10		
21	15	18	13		13	9	18					7	12	38	35		21	20	38					18	18	12	11		19	12	12				
		16		17	16			12	7					5		6	13			5	4					6		6	11			15	9		
		18	19	21			20		17	20				1	1	1			1		< 1	< 1				-	7	20			10		5	3	
	18	20	15	16	16		16						6	7	2	4	5		7						14	13	26	22	18		15				

Table BD 3-1 Water demand estimates for villages in the survey area

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Amini	Mat		1116	0.53	0.67	0.80	1.07	-								
Baga	Mat		1276	0.61	0.76	0.92	1.23									
Bagiro	Mat		1471	0.70	0.88	1.06	1.41									
Balani	Bwa		771	0.37	0.46	0.56	0.74									
Berega	Mam		2890	1.37	1.72	2.08	2.78	929	0.32	0.36	0.40	0.48	1.69	2.09	2.49	3.26
Bigwa	Nge		1063	0.50	0.63	0.77	1.02									
Bonye	Bwa		2205	1.05	1.32	1.59	2.12	16	0.01	0.01	0.01	0.01	1.05	1.32	1.60	2.13
Bumu	Mge		1383	0.66	0.83	1.00	1.33									
Bunduki	Mge	DP	1501	0.79	1.01	1.23	1.63									
Bungu	Bwa		1183	0.56	0.71	0.85	1.14									
Bwakira/ Chini	Bwa		1379	0.65	0.82	0.99	1.32	40	0.01	0.02	0.02	0.02	0.67	0.84	1.01	1.35
Bwakira Juu	Bwa	DP	2020	1.03	1.32	1.61	2.13									
Bwila	Bwa		2331	1.11	1.39	1.68	2.24									
Chabi- Mgogozi	Mik		1623	0.77	0.97	1.17	1.56	709	0.25	0.28	0.31	0.37	1.02	1.25	1.48	1.93
Chabima	Mas		458	0.22	0.27	0.33	0.44									
Chagongwe	Non		1451	0.69	0.87	1.05	1.39	1626	0.56	0.64	0.71	0.85	1.25	1.50	1.75	2.24
Chakwale	Gai	DP	4416	2.17	2.75	3.33	4.43	2648	0.92	1.03	1.15	1.38	3.09	3.78	4.48	5.81
Changa	Mat		1274	0.60	0.76	0.92	1.22									
Changarawe	Mas		1590	0.75	0.95	1.15	1.53									
Changarawe	Mla		1305	0.62	0.78	0.94	1.25	617	0.21	0.24	0.27	0.32	0.83	1.02	1.21	1.58
Chanjale	Non	DP	1856	0.96	1.22	1.49	1.97									
Chanyumbu	Nge		2272	1.08	1.36	1.64	2.18									
Chanzuru	Mas		2297	1.09	1.37	1.65	2.21	47	0.02	0.02	0.02	0.02	1.11	1.39	1.68	2.23
Chogowale	Gai		1430	0.68	0.85	1.03	1.37	5743	1.99	2.24	2.49	2.99	2.67	3.10	3.52	4.36
Chonwe	Mik		1611	0.76	0.96	1.16	1.55	43	0.01	0.02	0.02	0.02	0.78	0.98	1.18	1.57
Dakawa	Bwa		1871	0.89	1.12	1.35	1.80	26	0.01	0.01	0.01	0.01	0.90	1.13	1.36	1.81
Dakawa Wami	Tur	DP	1774	0.92	1.17	1.43	1.90									
Dibamba	Tur		801	0.38	0.48	0.58	0.77									
Diburuma	Tur		879	0.42	0.52	0.63	0.84	4933	1.71	1.93	2.14	2.57	2.13	2.45	2.77	3.41
Difinga	Tur		461	0.22	0.28	0.33	0.44									
Digalama	Tur		549	0.26	0.33	0.40	0.53									
Digoma	Tur		2190	1.04	1.31	1.58	2.10									
Diguzi	Nge		868	0.41	0.52	0.63	0.83									
Dihinda	Tur		1267	0.60	0.76	0.91	1.22	6	0.01	0.01	0.01	0.01	0.60	0.76	0.92	1.22
Dihombo	Tur		984	0.47	0.59	0.71	0.95									
Dimiro	Mat		1020	0.48	0.61	0.73	0.98									
Dodoma	Mas		650	0.31	0.39	0.47	0.62									
Doma	Mla	DP	2801	1.41	1.79	2.17	2.88	30	0.01	0.01	0.01	0.02	1.42	1.80	2.18	2.90
Dumila	Mam		2606	1.24	1.56	1.88	2.50	250	0.09	0.10	0.11	0.13	1.32	1.65	1.99	2.63

Table BD 3-1 (continued)

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Fulwe	Nge		2212	1.05	1.32	1.59	2.12									
Gairo	Gai	RHC	5008	2.46	3.12	3.78	5.02	843	0.29	0.33	0.37	0.44	2.76	3.45	4.15	5.46
Gomero	Bwa		2842	1.35	1.70	2.05	2.73	39	0.01	0.02	0.02	0.02	1.36	1.71	2.06	2.75
Gozo	Mat		1797	0.85	1.07	1.29	1.73									
Hembeti	Tur		1827	0.87	1.09	1.32	1.76									
Hewe	Mat		789	0.37	0.47	0.57	0.76									
Homboza	Mla		1827	0.87	1.09	1.32	1.76									
Hoza	Tur		1542	0.73	0.92	1.11	1.48	4145	1.44	1.62	1.80	2.16	2.17	2.54	2.91	3.64
Ibindo	Mam		1558	0.74	0.93	1.12	1.50	1262	0.44	0.49	0.55	0.66	1.18	1.42	1.67	2.15
Ibingu	Ula		601	0.29	0.36	0.43	0.58	137	0.05	0.05	0.06	0.07	0.33	0.41	0.49	0.65
Ibuti	Gai		1245	0.59	0.74	0.90	1.20	61	0.02	0.02	0.03	0.03	0.61	0.77	0.92	1.23
Ibido	Gai	DP	2715	1.36	1.74	2.11	2.80	3985	1.38	1.56	1.73	2.08	2.75	3.29	3.84	4.87
Ihenje	Gai		1483	0.70	0.89	1.07	1.42	340	0.12	0.13	0.15	0.18	0.82	1.02	1.22	1.60
Ikwamba	Non		2594	1.23	1.55	1.87	2.49	3210	1.11	1.25	1.39	1.67	2.35	2.80	3.26	4.16
Ilakala	Ula		1502	0.71	0.90	1.08	1.44	25	0.01	0.01	0.01	0.01	0.72	0.91	1.09	1.46
Ilonga	Mas	DP	1881	0.97	1.24	1.51	2.00									
Italagwe	Gai		2214*	1.05	1.32	1.60	2.13	2774	0.96	1.08	1.20	1.44	2.01	2.40	2.80	3.57
Iwemba	Mik		1425	0.68	0.85	1.03	1.37	2	0.01	0.01	0.01	0.01	0.68	0.85	1.03	1.37
Iyogwe	Gai	DP	2856	1.43	1.82	2.21	2.93	926	0.32	0.36	0.40	0.48	1.75	2.18	2.61	3.42
Kalundwa	Mat		1754	0.83	1.05	1.26	1.68									
Kambala	Tur		1009	0.48	0.60	0.73	0.97	9126	3.17	3.56	3.96	4.75	3.65	4.17	4.69	5.72
Kanga	Tur	DP	1166	0.63	0.81	0.99	1.31	39	0.01	0.02	0.02	0.02	0.64	0.83	1.01	1.33
Kasanga	Bwa		1428	0.68	0.85	1.03	1.37									
Kauzeni	Mla		781	0.37	0.47	0.56	0.75	52	0.02	0.02	0.02	0.03	0.39	0.49	0.59	0.78
Kibaoni	Mge		979	0.46	0.58	0.71	0.94									
Kibagile	Mat		1162	0.55	0.69	0.84	1.12	32	0.01	0.01	0.01	0.02	0.56	0.71	0.85	1.13
Kibati	Tur	RHC	2783	1.41	1.79	2.18	2.89	4627	1.61	1.81	2.01	2.41	3.01	3.60	4.18	5.30
Kibedya	Gai		3271	1.55	1.95	2.36	3.14	4496	1.56	1.76	1.95	2.34	3.11	3.71	4.31	5.48
Kibigiri	Mge		1978	0.94	1.18	1.43	1.90									
Kibogwa	Mat	DP	1718	0.89	1.14	1.39	1.84									
Kibuko	Mat	DP	1482	0.78	1.00	1.22	1.61									
Kibuko	Mge		942	0.45	0.56	0.68	0.90									
Kibungo (Kib)	Mat	DP	1053	0.58	0.74	0.91	1.20									
Kibungo (Kir)	Mat		1135	0.54	0.68	0.82	1.09									
Kibwaya	Mat		1406	0.67	0.84	1.01	1.35									
Kibwege	Mat		1006	0.48	0.60	0.72	0.97									
Kichangani	Tur	DP	3593	1.78	2.26	2.74	3.64	27	0.01	0.01	0.01	0.01	1.79	2.27	2.75	3.66
Kidete (st.)	Ula	DP	1382	0.73	0.94	1.15	1.52	672	0.23	0.26	0.29	0.35	0.97	1.20	1.44	1.87
Kidogobasi	Mik		3424	1.62	2.04	2.47	3.29	5	0.01	0.01	0.01	0.01	1.63	2.05	2.47	3.29
Kidudwe	Tur		2183	1.04	1.30	1.57	2.10	94	0.03	0.04	0.04	0.05	1.07	1.34	1.61	2.15
Kidudwe Ujamaa	Tur		649	0.31	0.39	0.47	0.62									
Kidugallo	Nge		2133	1.01	1.27	1.54	2.05									
Kiduhi	Mas		452	0.21	0.27	0.33	0.43	17430	6.05	6.81	7.57	9.08	6.27	7.08	7.89	9.51

Table BD 3-1 (continued)

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Kidunda	Nge		1402	0.67	0.84	1.01	1.35									
Kiegea	Mam		1217	0.58	0.73	0.88	1.17	1468	0.51	0.57	0.64	0.76	1.09	1.30	1.51	1.93
Kifindike	Mat		1287	0.61	0.77	0.93	1.24									
Kifinga	Mik		1958	0.93	1.17	1.41	1.88	6	0.01	0.01	0.01	0.01	0.93	1.17	1.41	1.88
Kifuru	Mat		806	0.38	0.48	0.58	0.77									
Kiganila	Bwa		829	0.39	0.49	0.60	0.80									
Kigugu	Tur		1530	0.73	0.91	1.10	1.47									
Kihonda	Nge		1707	0.81	1.02	1.23	1.64									
Kikeo	Mge	DP	1435	0.76	0.97	1.19	1.57									
Kikundi	Mat	DP	1489	0.78	1.00	1.23	1.62	2	0.01	0.01	0.01	0.01	0.78	1.00	1.23	1.62
Kikunga	Ula		771	0.37	0.46	0.56	0.74	12	0.01	0.01	0.01	0.01	0.37	0.46	0.56	0.75
Kilama	Gai		800*	0.38	0.48	0.58	0.77	2684	0.93	1.05	1.16	1.40	1.31	1.53	1.74	2.17
Kilangali	Mas	DP	2357	1.19	1.52	1.85	2.46	5094	1.77	1.99	2.21	2.65	2.96	3.51	4.06	5.11
Kilimanjaro	Tur		2235	1.06	1.33	1.61	2.15	7	0.01	0.01	0.01	0.01	1.06	1.34	1.61	2.15
Kilosa		DH														
Kimamba		DP														
Kinda	Tur		1397	0.66	1.01	1.34										
Kinonko	Nge		651	0.31	0.39	0.47	0.63									
Kinyolisi	Gai		800*	0.38	0.48	0.58	0.77	875	0.30	0.34	0.38	0.46	0.68	0.82	0.96	1.22
Kipera	Mla		2289	1.09	1.37	1.65	2.20	163	0.06	0.06	0.07	0.08	1.14	1.43	1.72	2.28
Kiroka	Mat	DP	3327	1.66	2.10	2.51	3.39									
Kirunga	Mat		1215	0.58	0.73	0.88	1.17									
Kisaki-Kituoni	Bwa	DP	2015	1.03	1.32	1.60	2.13									
Kisala	Tur		1340	0.64	0.80	0.97	1.29									
Kisanga	Mik	DP	2464	1.25	1.59	1.93	2.56	550	0.19	0.21	0.24	0.29	1.44	1.80	2.17	2.84
Kisanga-stand	Nge		1099	0.52	0.66	0.79	1.06									
Kisemu	Nge		966	0.46	0.58	0.70	0.93									
Kisimagulu	Tur		1180	0.56	0.70	0.85	1.13									
Kisinga	Nge		938	0.45	0.56	0.68	0.90									
Kisitwi	Gai		2130	1.01	1.27	1.53	2.05	2290	0.80	0.89	0.99	1.19	1.81	2.17	2.53	3.24
Kisongwe	Mas		1508	0.72	0.90	1.09	1.45	149	0.05	0.06	0.06	0.08	0.77	0.96	1.15	1.53
Kiswira	Mat		1230	0.58	0.73	0.89	1.18									
Kitaita	Gai		624	0.30	0.37	0.45	0.60	931	0.32	0.36	0.40	0.48	0.62	0.74	0.85	1.08
Kitange I	Mam		1151	0.55	0.69	0.83	1.11	1146	0.40	0.45	0.50	0.60	0.94	1.13	1.33	1.70
Kitange II	Mam	DP	2113	1.08	1.38	1.68	2.22	2253	0.78	0.88	0.98	1.17	1.86	2.26	2.65	3.39
Kitete	Mam		1171	0.56	0.70	0.84	1.12	48	0.02	0.02	0.02	0.03	0.57	0.72	0.86	1.15
Kitete/Msindazi	Mik		1542	0.73	0.92	1.11	1.48	11	0.01	0.01	0.01	0.01	0.74	0.92	1.12	1.49
Kitonga	Bwa		1011	0.48	0.60	0.73	0.97									
Kitungwa	Nge		2211	1.05	1.32	1.59	2.12									
Kitungwa	Mat		1192	0.57	0.71	0.86	1.15									
Kivungu	Mas	DP	2265	1.15	1.47	1.78	2.37	19	0.01	0.01	0.01	0.01	1.16	1.47	1.79	2.38

Table BD 3-1 (continued)

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Kiwege	Nge		937	0.44	0.56	0.68	0.90									
Kizagira	Bwa		628	0.30	0.37	0.45	0.60									
Kiziwa	Mat		2210	1.05	1.32	1.59	2.12	60	0.02	0.02	0.03	0.03	1.07	1.34	1.62	2.15
Kododo	Mge		2134	1.01	1.27	1.54	2.05									
Kolero	Bwa	DP	1540	0.81	1.03	1.26	1.48									
Koloni	Bwa		1485	0.70	0.89	1.07	1.43									
Konde	Mat		1231	0.58	0.73	0.89	1.18	78	0.03	0.03	0.03	0.04	0.61	0.77	0.92	1.22
Kondoa	Mas		1021	0.48	0.61	0.74	0.98	227	0.08	0.09	0.10	0.12	0.56	0.70	0.83	1.10
Konga-Vikenge	Mla	DP	1449	0.76	0.98	1.20	1.58									
Kongwa	Bwa		1157	0.55	0.69	0.83	1.11	1857	0.64	0.73	0.81	0.97	1.19	1.42	1.64	2.08
Kumba	Bwa		961	0.46	0.57	0.69	0.92									
Kumbulu	Non		1255	0.60	0.75	0.90	1.21									
Kunke	Tur		1326	0.63	0.79	0.96	1.27	20	0.01	0.01	0.01	0.01	0.64	0.80	0.96	1.28
Kwaba	Nge		718	0.34	0.43	0.52	0.69									
Kwambe	Mam		-					16898	5.87	6.60	7.33	8.80				
Kwamtonga	Tur		1109	0.53	0.66	0.80	1.07									
Kwelikwiji	Tur		1464	0.69	0.87	1.05	1.41	18	0.01	0.01	0.01	0.01	0.70	0.88	1.06	1.42
Kwipipa	Gai		1273	0.60	0.76	0.92	1.22	1569	0.54	0.61	0.68	0.82	1.15	1.37	1.60	2.04
Langali	Mge	RHC	2201	1.13	1.44	1.76	2.33									
Lanzi	Mat		1010	0.48	0.60	0.73	0.97									
Legezamwendo	Nge		1373	0.65	0.82	0.99	1.32									
Leshata	Gai		2285	1.08	1.36	1.65	2.20	6143	2.13	2.40	2.67	3.20	3.22	3.76	4.31	5.39
Logo	Mat		871	0.41	0.52	0.63	0.84									
Longwe	Bwa		635	0.30	0.38	0.46	0.61									
Luale	Mge	DP	2303	1.17	1.49	1.81	2.40									
Lubasazi	Bwa		861	0.41	0.51	0.62	0.83									
Lubumu	Nge		372	0.18	0.22	0.27	0.36									
Lubungo	Mla		1095	0.52	0.65	0.79	1.05									
Lubungo	Nge		967	0.46	0.58	0.70	0.93									
Lufukiri	Non		1004	0.48	0.60	0.72	0.96	1619	0.56	0.63	0.70	0.84	1.04	1.23	1.43	1.81
Lugeni	Mat		707	0.34	0.42	0.51	0.68									
Luhembe	Mik		303	0.14	0.18	0.32	0.29									
Luhindo	Tur		812	0.39	0.48	0.59	0.78									
Luholole	Mat		1645	0.78	0.98	1.19	1.58									
Luhwaji	Gai		879	0.42	0.52	0.63	0.84	774	0.27	0.30	0.34	0.40	0.69	0.83	0.97	1.25
Lukange	Bwa		1841	0.87	1.10	1.33	1.77									
Lukenge	Mat		1103	0.52	0.66	0.79	1.06									
Lukenge	Tur		864	0.41	0.52	0.62	0.83	13	0.01	0.01	0.01	0.01	0.41	0.52	0.63	0.84
Lukobe	Nge		1380	0.65	0.82	0.99	1.33									
Lukulunge	Bwa		636	0.30	0.38	0.46	0.61									
Lukunguni	Mge		1694	0.80	1.01	1.22	1.63									
Lukuyu	Mge		791	0.38	0.47	0.57	0.76									
Lulongwe	Nge		883	0.42	0.53	0.64	0.85									

Table BD 3-1 (continued)

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Lumango	Mik		835	0.40	0.50	0.60	0.80	13	0.01	0.01	0.01	0.01	0.40	0.50	0.61	0.81
Lumba Chini	Bwa		2154	1.02	1.29	1.55	2.07									
Lumba Juu	Bwa		860	0.41	0.51	0.62	0.83									
Lumbiji	Mon		1861	0.88	1.11	1.34	1.79									
Lumuma-Idole	Ula	DP	1729	0.90	1.15	1.40	1.85									
Lundi	Mat	DP	2006	1.03	1.31	1.60	2.12									
Lusanga	Mat		1237	0.59	0.74	0.89	1.19									
Lusungi	Mge		1214	0.58	0.72	0.87	1.17									
Lutindi-Twatwatwa	Mas		1032	0.49	0.62	0.74	0.99	24,584	8.54	9.60	10.67	12.80	9.03	10.22	11.41	13.80
Luwemba	Ula		1181	0.56	0.70	0.85	1.13	777	0.27	0.30	0.34	0.40	0.83	1.01	1.19	1.54
Mabana	Mam		1050	0.50	0.63	0.76	1.01	11	0.01	0.01	0.01	0.01	0.50	0.63	0.76	1.01
Mabula	Mam		1069	0.51	0.64	0.77	1.03	834	0.29	0.33	0.36	0.43	0.80	0.96	1.13	1.46
Machatu	Mam		829	0.39	0.49	0.60	0.80									
Madege	Gai	DP	2050*	1.05	1.34	1.63	2.16	2648	0.92	1.03	1.15	1.38	1.97	2.37	2.78	3.54
Madizini	Tur		2443	1.16	1.46	1.76	2.35	33	0.01	0.01	0.01	0.02	1.17	1.47	1.77	2.36
Madizini	Mik		862	0.41	0.51	0.62	0.83	300	0.10	0.12	0.13	0.16	0.51	0.63	0.75	0.98
Madoto	Mas		1731	0.82	1.03	1.25	1.66	51	0.02	0.02	0.02	0.03	0.84	1.05	1.27	1.69
Madudu	Mam		1296	0.62	0.77	0.93	1.25	818	0.28	0.32	0.36	0.43	0.90	1.09	1.29	1.67
Madudumizi	Ula		1414	0.67	0.84	1.02	1.36	11	0.01	0.01	0.01	0.01	0.67	0.85	1.02	1.36
Mafuta	Tur		809	0.38	0.49	0.58	0.78	5	0.01	0.01	0.01	0.01	0.39	0.48	0.59	0.78
Magali	Mla		647	0.31	0.39	0.47	0.62	89	0.03	0.03	0.04	0.05	0.34	0.42	0.50	0.67
Magela	Nge		460	0.22	0.27	0.33	0.44									
Magera	Mam		1567	0.74	0.94	1.13	1.51	581	0.20	0.23	0.25	0.30	0.95	1.16	1.38	1.81
Magogoni	Bwa		786	0.45	0.58	0.72	0.95									
Magole	Mam	DP	3752	1.86	2.35	2.86	3.80	24	0.01	0.01	0.01	0.01	1.86	2.36	2.87	3.81
Magomeni	Mas		5400	2.56	3.22	3.89	5.19									
Magubike	Mam	RHC	2919	1.47	1.87	2.27	3.02	4323	1.50	1.69	1.88	2.25	2.97	3.56	4.15	5.27
Maguha	Mam		1827	0.87	1.09	1.32	1.76	1417	0.49	0.55	0.62	0.74	1.36	1.64	1.93	2.49
Magunga	Tur		546	0.26	0.33	0.39	0.52									
Maguruwe	Mge		1541	0.73	0.92	1.11	1.48									
Maharaka	Mla	DP	1840	0.95	1.21	1.48	1.96	33	0.01	0.01	0.01	0.02	0.96	1.23	1.49	1.98
Majawanga	Gai		955	0.45	0.57	0.69	0.92	155	0.05	0.06	0.07	0.08	0.51	0.63	0.76	1.00
Makuyu	Tur		2342	1.11	1.40	1.69	2.25	6177	2.14	2.41	2.68	3.22	3.26	3.81	4.37	5.47
Makuyu	Gai		2089	0.99	1.25	1.51	2.01	2453	0.85	0.96	1.06	1.28	1.84	2.20	2.57	3.28
Makwambe	Mam		1153	0.55	0.69	0.83	1.11	600	0.21	0.23	0.26	0.31	0.76	0.92	1.09	1.42
Malangali	Mas	DP	3126	1.56	1.98	2.41	3.19	192	0.07	0.08	0.08	0.10	1.63	2.06	2.49	3.29
Malani	Bwa		815	0.39	0.49	0.59	0.78									
Malolo	Mik	DP	2612	1.32	1.67	2.03	2.70	813	0.28	0.32	0.35	0.42	1.60	1.99	2.39	3.12
Malui	Mas		2977	1.41	1.78	2.14	2.86	2468	0.86	0.96	1.07	1.29	2.27	2.74	3.22	4.15
Mambani	Mat		1512	0.72	0.90	1.09	1.45									
Mamboya	Mam	DP	956	0.53	0.69	0.84	1.11	4512	1.57	1.76	1.96	2.35	2.10	2.45	2.80	3.46
Mamoyo	Mas		4509	2.14	2.69	3.25	4.33	20	0.01	0.01	0.01	0.01	2.15	2.70	3.26	4.34
Mandela	Mam		1643	0.78	0.98	1.18	1.58	115	0.04	0.04	0.05	0.06	0.82	1.03	1.23	1.64

Table BD 3-1 (continued)

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Mangae	Mla		952	0.45	0.57	0.69	0.91	54	0.02	0.02	0.02	0.03	0.47	0.59	0.71	0.94
Manyinga	Tur		2156	1.02	1.29	1.55	2.07	53	0.02	0.02	0.02	0.03	1.04	1.31	1.58	2.10
Manza	Mla		580	0.28	0.35	0.42	0.56	40	0.01	0.02	0.02	0.02	0.29	0.36	0.44	0.58
Masalawe	Mge		989	0.47	0.59	0.71	0.95									
Masenge	Gai		1592	0.76	0.95	1.15	1.53	687	0.24	0.27	0.30	0.36	0.99	1.22	1.45	1.89
Maseyu	Mge		1216	0.58	0.73	0.88	1.17									
Maskati	Tur	DP	2631	1.32	1.68	2.05	2.72									
Matale	Tur		1185	0.56	0.71	0.85	1.14	1658	0.58	0.65	0.72	0.86	1.14	1.35	1.57	2.00
Matuli	Nge	DP	2061	1.05	1.34	1.64	2.17									
Mazimba	Tur		908	0.43	0.54	0.65	0.87									
Mbamba	Ula	DP	1505	0.79	1.01	1.24	1.64	25	0.01	0.01	0.01	0.01	0.80	1.02	1.25	1.65
Mbigili	Mam		2555	1.21	1.52	1.84	2.45	10	0.01	0.01	0.01	0.01	1.22	1.53	1.85	2.46
Mbili	Mam		821	0.39	0.49	0.59	0.79	344	0.12	0.13	0.15	0.18	0.51	0.62	0.74	0.97
Mbogo	Tur		2423	1.15	1.45	1.75	2.33									
Mbwade	Bwa	RHC	2289	1.17	1.49	1.82	2.41	1640	0.57	0.64	0.71	0.85	1.74	2.13	2.53	3.27
Mbwade	Mas		1004	0.48	0.60	0.72	0.96	11	0.01	0.01	0.01	0.01	0.48	0.60	0.73	0.97
Melela	Mla	DP	3489	1.73	2.20	2.67	3.54	97	0.03	0.04	0.04	0.05	1.77	2.24	2.71	3.59
Meshugi	Gai		1240	0.59	0.74	0.89	1.19	1000	0.35	0.39	0.43	0.52	0.94	1.13	1.33	1.71
Mfulu	Mam		1016	0.48	0.61	0.73	0.98	29	0.01	0.01	0.01	0.02	0.49	0.62	0.74	0.99
Mfuluni	Mas		1093	0.52	0.65	0.79	1.05	6	0.01	0.01	0.01	0.01	0.52	0.65	0.79	1.05
Mfumbwe	Mat		1661	0.79	0.99	1.20	1.60									
Mgata	Bwa		1580	0.75	0.94	1.14	1.52									
Mhale	Mge		1207	0.57	0.72	0.87	1.16									
Mhonda	Tur		2011	0.95	1.20	1.45	1.93	6	0.01	0.01	0.01	0.01	0.96	1.20	1.45	1.93
Mifulu	Mat		1924	0.91	1.15	1.39	1.85									
Mikese	Nge	DP	2081	1.06	1.36	1.65	2.19									
Mikumi		DP	(4274)													
Milawilila	Mat		809	0.38	0.48	0.58	0.78									
Mileng-welengwe	Bwa		889	0.42	0.53	0.64	0.85									
Mindu	Nge		2162	1.03	1.29	1.56	2.08									
Mirama	Tur		1248	0.59	0.74	0.90	1.20	109	0.04	0.04	0.05	0.06	0.63	0.79	0.95	1.26
Misongeni	Nge		1428	0.68	0.85	1.03	1.37									
Mkalama	Gai		1436	0.68	0.86	1.03	1.38	1510	0.52	0.59	0.66	0.79	1.21	1.45	1.69	2.17
Mkambarani	Nge		564	0.27	0.34	0.41	0.54									
Mkata Ranch	Mla		400*	0.19	0.24	0.29	0.38									
Mkata-Ujamaa	Mla	DP	388	0.26	0.35	0.43	0.56									
Mkindo	Tur		2336	1.11	1.39	1.68	2.24									
Mkobwe	Non		1183	0.56	0.71	0.85	1.14	979	0.34	0.38	0.42	0.51	0.90	1.09	1.28	1.65
Mkololo	Bwa		438	0.21	0.38	0.38	0.47	0.61								
Mkonowamara	Nge		623	0.30	0.37	0.45	0.60									
Mkulazi	Nge		602	0.29	0.36	0.43	0.58									
Mkundi	Mam		814	0.39	0.49	0.59	0.78	189	0.07	0.07	0.08	0.10	0.45	0.56	0.67	0.88

Table BD 3-1 (continued)

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Mkundi	Nge		685	0.33	0.41	0.49	0.66									
Mkunghulu	Ula		1155	0.55	0.69	0.83	1.11	1264	0.44	0.49	0.55	0.66	0.99	1.18	1.38	1.77
Mkuyuni	Mat	DP	1983	1.02	1.30	1.58	2.10									
Mlaguzi	Tur		667	0.32	0.40	0.48	0.64									
Mlali	Mla	DP	2196	1.12	1.43	1.74	2.30	226	0.08	0.09	0.10	0.12	1.20	1.51	1.83	2.42
Mlilingwa	Nge		474	0.22	0.28	0.34	0.46									
Mlono	Mat		1505	0.71	0.90	1.08	1.45									
Mngazi	Bwa	DP	1344	0.71	0.92	1.12	1.48	21	0.01	0.01	0.01	0.01	0.72	0.93	1.13	1.49
Mnyanza	Mla		1931	0.92	1.15	1.39	1.86									
Morogoro		RH														
Msimba	Mik	DP	1301	0.69	0.89	1.09	1.44	77	0.03	0.03	0.03	0.04	0.72	0.92	1.12	1.48
Msingise	Gai		1582	0.75	0.94	1.14	1.52	2893	1.00	1.13	1.26	1.51	1.76	2.07	2.40	3.03
Msolokelo	Tur		513	0.24	0.31	0.37	0.49									
Msolwa	Mik		1204	0.57	0.72	0.87	1.16	360	0.13	0.14	0.16	0.19	0.70	0.86	1.02	1.34
Msonge	Bwa		1085	0.51	0.65	0.78	1.04	47	0.02	0.02	0.02	0.02	0.53	0.67	0.80	1.07
Msongozi	Mla		1423	0.68	0.85	1.03	1.37	49	0.02	0.02	0.02	0.03	0.69	0.87	1.05	1.39
Msowero	Mik		1220	0.58	0.73	0.88	1.17	10	0.01	0.01	0.01	0.01	0.58	0.73	0.88	1.18
Msowero	Ula		1450	0.69	0.87	1.04	1.39	877	0.30	0.34	0.38	0.46	0.99	1.21	1.43	1.85
Msowero	Mam	DP	4845	2.38	3.01	3.64	4.85	2399	0.83	0.94	1.04	1.25	3.21	3.94	4.68	6.09
Msufini	Tur		733	0.35	0.44	0.53	0.70									
Mtamba	Mat		3160	1.50	1.89	2.28	3.04	61	0.02	0.02	0.03	0.03	1.52	1.91	2.30	3.07
Mtega	Non		1688	0.80	1.01	1.22	1.62	2199	0.76	0.86	0.95	1.15	1.56	1.87	2.17	2.77
Mtombozi	Mat	DP	1007	0.55	0.72	0.88	1.16									
Mtumbatu	Mam		1588	0.75	0.95	1.14	1.53	1673	0.58	0.65	0.73	0.87	1.33	1.60	1.87	2.40
Mugudeni	Tur		1187	0.56	0.71	0.86	1.14	176	0.06	0.07	0.08	0.09	0.62	0.78	0.93	1.23
Muhenda	Ula	DP	1978	1.01	1.30	1.58	2.09	35	0.01	0.01	0.02	0.02	1.03	1.31	1.59	2.11
Muhungamkola	Nge		474	0.22	0.28	0.34	0.46									
Mulunga	Mik		755	0.36	0.45	0.54	0.73	444	0.15	0.17	0.19	0.23	0.51	0.62	0.74	0.96
Munisagara	Mas		1042	0.49	0.62	0.75	1.00									
Mvomero	Tur	DP	3458	1.72	2.18	2.64	3.51	138	0.05	0.05	0.06	0.07	1.76	2.23	2.70	3.58
Mvuha	Bwa	DP	2539	1.28	1.63	1.98	2.63	53	0.02	0.02	0.02	0.03	1.30	1.65	2.01	2.66
Mvumi	Mam	DP	3406	1.69	2.15	2.61	3.46	2281	0.79	0.89	0.99	1.19	2.48	3.04	3.60	4.65
Mwalazi	Mge		1420	0.67	0.85	1.02	1.36									
Mwandi	Mam		2558	1.21	1.53	1.84	2.46									
Mwarazi	Mat		1016	0.48	0.61	0.73	0.98									
Mwasa	Ula	DP	1117	0.61	0.78	0.96	1.26									
Mzaganza St.	Ula		835	0.40	0.50	0.60	0.80	150	0.05	0.06	0.07	0.08	0.45	0.56	0.67	0.88
Mziha	Tur	DP	1916	0.99	1.26	1.53	2.03	23	0.01	0.01	0.01	0.01	0.99	1.27	1.54	2.04
Ndogomi	Gai		1434	0.68	0.86	1.03	1.38	2161	0.75	0.84	0.94	1.13	1.43	1.70	1.97	2.50
Ndole	Tur	DP	726	0.42	0.55	0.68	0.89									
Ngerengere	Nge	RHC	3753	1.87	2.37	2.86	3.82									
Ngerengere Dar.	Nge		1384	0.66	0.83	1.00	1.33									
Ngiloli	Gai		1000*	0.47	0.60	0.72	0.96									

Table BD 3-1 (continued)

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Ngong'oro	Mat		1605	0.76	0.96	1.16	1.54									
Ngungulu	Mge		1028	0.49	0.61	0.74	0.99									
Nguyami	Gai		1792*	0.85	1.07	1.29	1.72	1503	0.52	0.59	0.65	0.78	1.37	1.66	1.94	2.50
Ng'weme	Mat		624	0.30	0.37	0.45	0.60									
Njungwa	Mam		1628	0.77	0.97	1.17	1.56	306	0.11	0.12	0.13	0.16	0.88	1.09	1.31	1.72
Nongwe	Non	DP	1338	0.71	0.91	1.12	1.48	538	0.19	0.21	0.23	0.28	0.90	1.12	1.35	1.76
Ntala	Bwa		1066	0.51	0.64	0.77	1.02									
Nyachiro	Mat		2363	1.12	1.41	1.70	2.27									
Nyali	Ula		1142	0.54	0.68	0.82	1.10	41	0.01	0.02	0.02	0.02	0.56	0.70	0.84	1.12
Nyameni	Ula		1490	0.71	0.89	1.07	1.43	25	0.01	0.01	0.01	0.01	0.72	0.90	1.08	1.44
Nyamigadu-A	Bwa		942	0.45	0.56	0.68	0.90									
Nyamigadu-B	Bwa		823	0.39	0.49	0.59	0.79									
Nyandira	Mge		2065	0.98	1.23	1.49	1.98									
Nyangala	Mam		558	0.26	0.33	0.40	0.54	127	0.04	0.05	0.06	0.07	0.31	0.38	0.46	0.60
Nyarutanga	Bwa		1685	0.80	1.01	1.21	1.62									
Nyingwa	Mat		1696	0.80	1.01	1.22	1.63									
Pandambili	Tur		925	0.44	0.55	0.67	0.89	330	0.11	0.13	0.14	0.17	0.55	0.68	0.81	1.06
Pangawe	Nge		886	0.42	0.53	0.64	0.85									
Peapea	Mas		842	0.40	0.50	0.61	0.81									
Peko-Misegese	Mla		2667	1.27	1.59	1.92	2.56									
Pemba	Tur	DP	2275	1.16	1.47	1.79	2.38	227	0.08	0.09	0.10	0.12	1.23	1.56	1.89	2.49
Pinde	Mge		897	0.43	0.54	0.65	0.86									
Ruaha	Mik		7369	3.50	4.40	5.31	7.08	14	0.01	0.01	0.01	0.01	3.50	4.40	5.32	7.09
Rubeho	Gai		2872	1.36	1.71	2.07	2.76	3377	1.17	1.32	1.47	1.76	2.54	3.03	3.53	4.52
Rudewa	Mat		2576	1.22	1.54	1.86	2.47									
Rudewa Batini	Mas	DP	2693	1.35	1.72	2.09	2.78	46	0.02	0.02	0.02	0.02	1.37	1.74	2.11	2.80
Rudewa Gongoni	Mas		1764	0.84	1.05	1.27	1.69	69	0.02	0.03	0.03	0.04	0.86	1.08	1.30	1.73
Rudewa Mbuyuni	Mas		1682	0.80	1.00	1.21	1.62	64	0.02	0.03	0.03	0.03	0.82	1.03	1.24	1.65
Ruhembe	Mik		2399	1.14	1.43	1.73	2.30	3	0.01	0.01	0.01	0.01	1.14	1.43	1.73	2.31
Rusanga	Tur		2897	1.37	1.73	2.09	2.78	5	0.01	0.01	0.01	0.01	1.38	1.73	2.09	2.79
Sagasaga	Nge		887	0.42	0.53	0.64	0.85									
Sangasanga	Mla		766	0.36	0.46	0.55	0.74									
Semwali	Tur		858	0.41	0.51	0.62	0.82									
Seregete-A	Nge		380	0.18	0.23	0.27	0.37									
Seregete-B	Nge		683	0.32	0.41	0.49	0.66									
Sesenga	Bwa		1046	0.50	0.62	0.75	1.00									
Singisa	Bwa		1410	0.67	0.84	1.02	1.35									
Senyaulime	Nge		832	0.39	0.50	0.60	0.80									
Tabu Hotel	Gai		1200*	0.57	0.72	0.86	1.15	354	0.12	0.14	0.15	0.18	0.69	0.85	1.02	1.34
Tambuu	Mat		3335	1.58	1.99	2.40	3.20									
Tandai	Mat	DP	2827	1.42	1.80	2.19	2.91	93	0.03	0.04	0.04	0.05	1.45	1.84	2.23	2.96
Tandari	Mge		1097	0.52	0.65	0.79	1.05									

Table BD 3-1 (concluded)

Village		DP RHC	Population 1978	Population Demand 1978 (l/s)	Population Demand 1983 (l/s)	Population Demand 1988 (l/s)	Population Demand 1998 (l/s)	Livestock Units 1978	Livestock Demand 1978 (l/s)	Livestock Demand 1983 (l/s)	Livestock Demand 1988 (l/s)	Livestock Demand 1998 (l/s)	Total Demand 1978 (l/s)	Total Demand 1983 (l/s)	Total Demand 1988 (l/s)	Total Demand 1998 (l/s)
Tandari	Mat		1626	0.77	0.97	1.17	1.56									
Tangeni	Mla		1776	0.84	1.06	1.28	1.71									
Tawa	Mat	RHC	3036	1.53	1.94	2.36	3.13									
Tchenzema	Mge		1645	0.78	0.98	1.19	1.58									
Tegetero	Mat		1250	0.59	0.75	0.90	1.20									
Temekero	Bwa		728	0.35	0.43	0.52	0.70									
Tindiga	Mas		3941	1.87	2.35	2.84	3.79	39,394	13.68	15.39	17.10	20.52	15.55	17.74	19.94	24.30
Tulo	Bwa		825	0.39	0.49	0.59	0.79									
Tundu	Mik		2112	1.00	1.26	1.52	2.03	12	0.01	0.01	0.01	0.01	1.01	1.27	1.53	2.04
Tungi	Nge		2318	1.10	1.38	1.67	2.23									
Tununguo	Nge	DP	1510	0.72	0.90	1.09	1.45	4973	1.73	1.94	2.16	2.59	2.44	2.84	3.25	4.04
Ubili	Tur		725	0.34	0.43	0.52	0.70									
Udung'hu	Mik		2456	1.17	1.47	1.77	2.36									
Ukwama	Bwa		1265	0.60	0.75	0.91	1.22									
Ukwamani	Gai		1609	0.76	0.96	1.16	1.55	2274	0.79	0.89	0.99	1.18	1.55	1.85	2.15	2.73
Ulaya-Kibaoni	Ula	DP	2010	1.03	1.31	1.60	2.12	35	0.01	0.01	0.02	0.02	1.04	1.33	1.62	2.14
Ulaya-Mbuyuni	Ula		659	0.31	0.39	0.47	0.63	20	0.01	0.01	0.01	0.01	0.32	0.40	0.48	0.64
Uleling'ombe	Mik		1281	0.68	0.88	1.08	1.42	852	0.30	0.33	0.37	0.44	0.98	1.21	1.45	1.87
Unone	Mas	DP	999	0.55	0.71	0.87	1.15	84	0.03	0.03	0.04	0.04	0.58	0.74	0.91	1.19
Uponda Chini	Mat		1547	0.73	0.92	1.11	1.49									
Uponela	Mam		1526	0.72	0.91	1.10	1.47	874	0.30	0.34	0.38	0.46	1.03	1.25	1.48	1.92
Usungura	Nge		538	0.26	0.32	0.39	0.52									
Vidunda	Mik		1595	0.76	0.95	1.15	1.53	37	0.01	0.01	0.02	0.02	0.77	0.97	1.17	1.55
Vigolegole	Bwa		2181	1.03	1.30	1.57	2.10									
Vihengele	Mat		943	0.45	0.56	0.68	0.91									
Vinile	Mge		795	0.38	0.47	0.57	0.76									
Visaraka	Nge	DP	1112	0.60	0.78	0.95	1.26									
Zombo-Lumbo	Ula	DP	1683	0.87	1.12	1.37	1.81	28	0.01	0.01	0.01	0.01	0.88	1.13	1.38	1.82

LEGEND: DP = dispensary; RHC = rural health centre; DH = district hospital; RH = regional hospital.

DATA BD 4

Table B.D4-1 Assessment of water supply conditions for villages in the survey area

Village	Div.	Scores for assessment criteria						
		A	S	D	R	C	P	Total
Amini	Mat	1	2	1	1	1	2	8
Baga	Mat	1	2	1	1	1	2	8
Bagiro	Mat	1	2	1	1	1	2	8
Balani	Bwa	1	2	1	1	1	1	7
Berega	Mam	1	2	1	3	1	3	11
Bigwa	Nge	2	1	1	3	1	2	10
Bonye	Bwa	2	2	1	2	1	3	11
Bumu	Mge	1	1	1	1	1	2	7
Bunduki	Mge	1	1	1	1	1	2	7
Bungu	Bwa	1	2	1	1	1	2	8
Bwakira Chini	Bwa	1	1	1	2	1	2	8
Bwakira Juu	Bwa	2	3	1	2	1	3	12
Bwila	Bwa	1	3	1	1	1	3	10
Chabi-Mgogozi	Mik	1	2	1	1	1	2	8
Chabima	Mas	1	2	1	1	1	1	7
Chagongwe	Non	1	2	1	1	1	2	8
Chakwale	Gai	3	1	1	3	1	3	12
Changa	Mat	1	2	1	1	1	2	8
Changarawe	Mas	1	2	2	1	1	2	9
Changarawe	Mla	1	2	1	2	1	2	9
Chanjale	Non	1	2	1	1	1	2	8
Chanyumbu	Nge	1	3	3	1	1	3	12
Chanzuru	Mas	2	2	1	2	2	3	12
Chogowale	Gai	1	2	1	2	1	2	9
Chonwe	Mik	1	2	1	1	1	2	8
Dakawa	Bwa	1	3	3	2	1	2	12
Dakawa Wami	Tur	1	3	2	1	1	2	10
Dibamba	Tur	2	2	2	2	1	1	10
Diburuma	Tur	1	3	1	1	1	1	8
Difinga	Tur	2	3	3	2	1	1	12
Digalama	Tur	1	1	1	1	1	1	6
Digoma	Tur	1	1	1	1	1	3	8
Diguzi	Nge	2	3	3	2	1	1	12
Dihinda	Tur	3	3	2	3	1	2	14
Dihombo	Tur	2	2	1	3	1	1	10
Dimiro	Mat	1	2	1	1	1	2	8
Dodoma	Mas	2	2	1	2	1	1	9
Doma	Mla	2	1	2	2	1	3	11
Dumila	Mam	2	3	2	2	1	3	12
Fulwe	Nge	2	2	2	2	2	3	13
Gairo	Gai	3	1	1	3	1	3	12
Gomero	Bwa	2	3	1	3	2	3	14
Gozo	Mat	1	2	1	1	1	2	8
Hembeti	Tur	1	2	2	1	1	2	9
Hewe	Mat	1	2	1	1	1	1	7
Homboza	Mla	1	2	1	1	1	2	8
Hoza	Tur	1	3	1	1	1	3	10
Ibindo	Mam	2	3	1	2	2	2	12
Ibingu	Ula	2	1	1	2	1	1	8
Ibuti	Gai	3	1	2	3	1	2	12
Idibo	Gai	2	3	1	2	1	3	12
Ihenje	Gai	2	2	2	2	2	2	14
Ikwamba	Non	1	2	1	1	1	3	9
Ilakala	Ula	3	3	2	3	1	2	14
Ilonga	Mas	1	3	1	1	1	2	9
Italagwe	Gai	2	2	1	2	1	3	11
Iwemba	Mik	1	2	2	1	1	2	9
Iyogwe	Gai	2	3	1	2	1	3	12
Kalundwa	Mat	1	2	1	1	1	2	8
Kambala	Tur	2	1	1	3	3	2	12
Kanga	Tur	2	2	1	2	1	2	10
Kasanga	Bwa	1	2	1	1	1	2	8
Kauzeni	Mla	1	2	1	1	1	1	7
Kibaoni	Mge	1	1	1	1	1	1	6
Kibangile	Mat	1	3	1	1	1	2	9
Kibati	Tur	1	3	1	1	1	3	10
Kibedya	Gai	3	1	1	3	1	3	12
Kibigiri	Mge	1	1	1	1	1	2	7
Kibogwa	Mat	1	2	1	1	1	2	8
Kibuko	Mat	2	2	1	2	1	2	10
Kibuko	Mge	1	1	1	1	1	1	6
Kibungo (kib)	Mat	1	2	1	1	1	2	8
Kibungo(kir)	Mat	2	3	1	2	1	2	11
Kibwaya	Mat	2	2	1	3	1	2	11
Kibwege	Mat	1	2	1	2	1	2	9
Kichangani	Tur	1	2	1	2	1	3	10
Kidete St.	Ula	1	3	1	1	1	2	9
Kidogobasi	Mik	2	2	1	2	2	3	12
Kidudwe	Tur	2	3	1	2	1	3	12
Kidudwe-Ujamaa	Tur	2	2	2	2	2	1	11
Kidugallo	Nge	2	1	1	3	2	2	11
Kiduhi	Mas	1	2	1	2	1	1	8
Kidunda	Nge	1	2	1	1	1	2	8
Kiegea	Mam	2	3	1	2	2	2	12
Kifindike	Mat	1	2	1	1	1	2	8
Kifinga	Mik	1	2	1	1	1	2	8
Kifuru	Mat	1	2	1	1	1	1	7
Kiganila	Bwa	1	3	1	1	1	1	8
Kigugu	Tur	1	2	2	1	1	2	9

Table BD 4-1 (continued)

Village	Div.	Scores for assessment criteria						
		A	S	D	R	C	P	Total
Kihonda	Nge	2	3	1	3	2	2	13
Kikeo	Mge	1	1	1	1	1	2	7
Kikundi	Mat	1	1	1	2	1	3	9
Kikunga	Ula	1	2	1	1	1	1	7
Kilama	Gai	2	3	3	3	1	1	13
Kilangali	Mas	1	2	1	1	1	3	9
Kilimanjaro	Tur	1	2	1	2	1	3	10
Kilosa								
Kimamba								
Kinda	Tur	1	1	1	1	1	2	7
Kinonko	Nge	2	2	2	3	2	1	12
Kinyolisi	Gai	2	3	1	3	1	1	11
Kipera	Mla	2	2	1	2	1	3	11
Kiroka	Mat	3	2	1	3	1	3	13
Kirunga	Mat	1	2	1	1	1	2	8
Kisaki Kituoni	Bwa	1	1	2	2	1	3	10
Kisala	Tur	2	3	1	2	1	2	11
Kisanga	Mik	1	2	1	1	1	3	9
Kisanga Stand	Nge	1	3	1	1	1	2	9
Kisemu	Nge	2	2	3	2	2	1	12
Kisimagulu	Tur	1	1	1	1	1	2	7
Kisinga	Nge	2	1	1	2	1	1	8
Kisitwi	Gai	1	1	1	1	1	3	8
Kisongwe	Mas	1	2	1	1	1	2	8
Kiswira	Mat	1	2	1	2	1	2	9
Kitaita	Gai	2	3	3	3	1	1	13
Kitange I	Mam	1	2	1	1	1	2	8
Kitange II	Mam	1	2	1	1	1	3	9
Kitete	Mam	3	2	1	3	1	2	12
Kitete-Msindazi	Mik	1	2	2	1	1	2	9
Kitonga	Bwa	1	2	1	1	1	2	8
Kitungwa	Nge	2	1	1	2	1	3	10
Kitungwa	Mat	1	2	2	1	1	2	9
Kivungu	Mas	1	2	2	1	1	3	10
Kiwege	Nge	2	3	3	3	2	1	14
Kizagira	Bwa	1	2	1	1	1	1	7
Kiziwa	Mat	3	2	1	3	1	3	13
Kododo	Mge	1	1	1	1	1	3	8
Kolero	Bwa	1	2	1	1	1	2	8
Koloni	Bwa	1	2	1	1	1	2	8
Konde	Mat	1	2	1	2	1	2	9
Kondoa	Mas	2	3	1	3	1	2	12
Konga-Vikenge	Mla	1	2	2	1	1	2	9
Kongwa	Bwa	1	2	1	2	1	2	9
Kumba	Bwa	1	2	1	1	1	1	7
Kumbulu	Non	1	2	1	2	1	2	9
Kunke	Tur	2	2	1	3	2	2	12

Village	Div.	Scores for assessment criteria						
		A	S	D	R	C	P	Total
Kwaba	Nge	2	3	1	2	1	1	10
Kwambe	Mam	1	1	1	2	1	1	7
Kwamtonga	Tur	1	1	2	1	1	2	8
Kwelikwiji	Tur	1	1	1	1	1	2	7
Kwipipa	Gai	2	1	1	3	1	2	10
Langali	Mge	1	1	1	1	1	3	8
Lanzi	Mat	1	2	1	1	1	2	8
Legezamwendo	Nge	2	1	1	2	1	2	9
Leshata	Gai	2	3	1	3	1	3	13
Logo	Mat	1	2	1	1	1	1	7
Longwe	Bwa	1	2	1	1	1	1	7
Luale	Mge	1	1	1	1	1	3	8
Lubasazi	Bwa	1	2	1	2	1	1	8
Lubumu	Nge	2	3	1	2	1	1	10
Lubungo	Mla	2	2	1	2	1	2	10
Lubungo	Nge	3	2	2	3	3	1	14
Lufukiri	Non	1	2	1	1	1	2	8
Lugeni	Mat	1	2	1	1	1	1	7
Luhembe	Mik	1	2	1	1	1	1	7
Luhindo	Tur	1	3	3	1	1	1	10
Luholole	Mat	2	2	1	2	1	2	10
Luhwaji	Gai	3	1	2	3	1	1	11
Lukange	Bwa	1	2	1	2	1	2	9
Lukenge	Mat	1	2	1	1	1	2	8
Lukenge	Tur	1	3	2	1	1	2	10
Lukobe	Nge	3	1	1	3	3	2	13
Lukulunge	Bwa	1	2	1	2	1	1	8
Lukunguni	Mge	1	1	1	1	1	2	7
Lukuyu	Mge	1	1	1	1	1	1	6
Lulongwe	Nge	2	3	1	3	1	1	11
Lumango	Mik	1	2	2	2	1	1	9
Lumba Chini	Bwa	1	2	1	1	1	3	9
Lumba Juu	Bwa	1	2	1	1	1	1	7
Lumbiji	Non	1	2	1	1	1	2	8
Lumuma Idole	Ula	1	3	1	1	1	2	9
Lundi	Mat	2	3	1	2	1	2	11
Lusanga	Mat	1	2	1	1	1	2	8
Lusungi	Mge	1	1	1	1	1	2	7
Lutindi-Twatwatwa	Mas	1	3	1	1	1	2	8
Luwemba	Ula	1	2	1	1	1	2	8
Mabana	Mam	2	2	1	3	1	2	11
Mabula	Mam	2	3	1	2	2	2	12
Machatu	Mam	2	3	3	2	3	1	14
Madege	Gai	2	3	2	3	3	3	16
Madizini	Tur	3	1	1	3	2	3	13
Madizini	Mik	1	2	1	1	1	1	7
Madoto	Mas	2	1	1	2	2	2	10

Table BD 4-1 (continued)

Village	Div.	Scores for assessment criteria						
		A	S	D	R	C	P	Total
Madudu	Mam	3	2	1	3	1	2	12
Madudumizi	Ula	1	2	1	1	1	2	8
Mafuta	Tur	1	1	1	1	1	1	6
Magali	Mla	2	2	1	2	2	1	10
Magela	Nge	2	3	1	2	1	1	10
Magera	Mam	2	3	1	2	1	2	11
Magogoni	Bwa	1	3	1	1	1	1	8
Magole	Mam	1	1	2	2	1	3	10
Magomeni	Mas	1	2	2	1	1	3	10
Magubike	Mam	2	3	1	2	3	3	14
Maguha	Mam	1	2	1	2	1	2	9
Magunga	Tur	1	1	1	1	1	1	6
Maguruwe	Mge	1	1	1	1	1	2	7
Maharaka	Mla	2	3	1	3	2	2	13
Majawanga	Gai	3	1	1	3	1	1	10
Makuyu	Tur	2	1	1	3	1	3	11
Makuyu	Gai	2	3	1	2	1	3	12
Makwambe	Mam	1	2	1	1	1	2	8
Malangali	Mas	1	3	2	1	1	3	11
Malani	Bwa	1	2	1	1	1	1	7
Malolo	Mik	1	2	1	1	1	3	9
Malui	Mas	2	2	1	2	1	3	11
Mambani	Mat	1	2	1	1	1	2	8
Mamboya	Mam	1	3	1	2	1	1	9
Mamoyo	Mas	2	2	1	2	1	3	11
Mandela	Mam	2	2	2	3	1	2	12
Mangae	Mla	2	2	2	2	2	1	11
Manyinya	Tur	2	1	1	2	1	3	10
Manza	Mla	3	2	1	3	2	1	12
Masalawe	Mge	1	1	1	1	1	1	6
Masenge	Gai	1	2	1	1	1	2	8
Maseyu	Mge	2	2	3	2	2	2	13
Maskati	Tur	1	1	1	1	1	3	8
Matale	Tur	1	2	1	2	1	2	9
Matuli	Nge	2	3	1	2	1	3	12
Mazimba	Tur	2	2	2	2	2	1	11
Mbamba	Ula	2	3	1	2	1	2	11
Mbigili	Mam	2	2	1	3	1	3	12
Mbili	Mam	2	3	1	3	2	1	12
Mbogo	Tur	1	1	1	1	1	3	8
Mbwade	Bwa	2	2	1	2	1	3	11
Mbwade	Mas	2	2	1	2	2	2	11
Melela	Mla	1	1	1	2	1	3	9
Meshugi	Gai	3	1	3	3	1	2	13
Mfulu	Mam	2	2	1	3	2	2	12
Mfuluni	Mas	1	2	1	1	1	2	8
Mfumbwe	Mat	1	2	1	1	1	2	8
Mgata	Bwa	1	2	1	1	1	2	8

Village	Div.	Scores for assessment criteria						
		A	S	D	R	C	P	Total
Mhale	Mge	1	1	1	1	1	2	7
Mhonda	Tur	1	1	1	2	1	3	9
Mifulu	Mat	1	2	1	1	1	2	8
Mikese	Nge	2	1	1	2	2	2	10
Mikumi								
Milawilila	Mat	1	2	1	1	1	1	7
Milengwe-lengwe	Bwa	3	2	1	3	1	1	11
Mindu	Nge	1	2	2	1	1	3	10
Mirama	Tur	2	2	2	2	2	2	12
Misongeni	Nge	2	1	2	2	1	2	10
Mkalama	Gai	3	1	3	3	1	2	13
Mkambarani	Nge	2	2	3	2	2	1	12
Mkata Ranch	Mla	1	2	1	1	1	1	7
Mkata Ujamaa	Mla	1	2	1	1	1	1	7
Mkindo	Tur	1	2	1	1	1	3	9
Mkobwe	Non	1	2	1	1	1	2	8
Mkololo	Bwa	1	2	1	1	1	1	7
Mkonowamara	Nge	2	3	1	3	3	1	13
Mkulazi	Nge	1	3	3	1	1	1	10
Mkundi	Mam	2	3	2	3	1	1	12
Mkundi	Nge	2	2	3	2	2	1	12
Mkunghulu	Ula	1	3	1	1	1	2	9
Mkuyuni	Mat	2	2	1	3	1	2	11
Mlaguzi	Tur	1	1	1	1	1	1	6
Mlali	Mla	1	2	1	2	1	3	10
Mlilingwa	Ngw	2	2	3	2	1	1	11
Mlono	Mat	1	2	1	1	1	2	8
Mngazi	Bwa	1	2	1	1	1	2	8
Mnyanza	Mla	1	2	2	1	1	2	9
Morogoro								
Msimba	Mik	1	2	1	1	1	2	8
Msingise	Gai	2	1	1	3	1	2	10
Msolokelo	Tur	1	1	1	1	1	1	6
Msolwa	Mik	1	2	2	1	1	2	9
Msonge	Bwa	1	2	3	1	1	2	10
Msongozi	Mla	2	2	1	2	2	2	11
Msowero	Mik	1	2	1	1	1	2	8
Msowero	Ula	1	3	1	1	1	2	9
Msowero	Mam	1	2	1	2	1	3	10
Msufini	Tur	2	2	1	3	2	1	11
Mtamba	Mat	3	1	1	3	1	3	12
Mtega	Non	1	2	1	1	1	2	8
Mtombozi	Mat	1	2	1	1	1	2	8
Mtumbatu	Mam	2	3	3	2	1	2	13
Mugudeni	Tur	2	2	1	3	3	2	13
Muhenda	Ula	3	3	3	3	1	2	15
Muhungamkola	Nge	3	2	1	3	1	1	11

Table BD 4-1 (concluded)

Village	Div.	A	S	D	R	C	P	Total
		Scores for assessment criteria						
Mulunga	Mik	1	2	2	1	1	1	8
Munisagara	Mas	1	2	2	1	1	2	9
Mvomero	Tur	2	1	1	3	1	3	11
Mvuha	Bwa	1	2	1	1	1	3	9
Mvumi	Mam	1	2	1	2	1	3	10
Mwalazi	Mge	1	1	1	1	1	2	7
Mwandi	Mam	2	3	1	2	1	3	12
Mwarazi	Mat	2	2	1	3	1	2	11
Mwasa	Ula	1	2	1	1	1	2	8
Mzaganza St.	Ula	1	2	1	1	1	1	7
Mziha	Tur	2	2	1	3	1	2	11
Ndogomi	Gai	2	3	1	2	1	2	11
Ndole	Tur	1	1	1	1	1	1	6
Ngerengere	Nge	2	2	1	2	2	3	12
Ngerengere Dar	Nge	2	3	1	2	2	2	12
Ngiloli	Gai	2	1	3	3	1	1	11
Ngong'oro	Mat	3	2	1	2	1	2	11
Ngungulu	Mge	1	1	1	1	1	2	7
Nguyami	Gai	2	3	1	2	3	3	14
Ng'weme	Mat	1	2	1	1	1	1	7
Njungwa	Mam	1	2	1	1	1	2	8
Nongwe	Non	1	2	1	1	1	2	8
Ntala	Bwa	1	2	1	1	1	2	8
Nyachiro	Mat	1	2	1	1	1	3	9
Nyali	Ula	1	2	2	1	1	2	9
Nyameni	Ula	1	2	1	1	1	2	8
Nyamigadu-A	Bwa	1	2	1	1	1	1	7
Nyamigadu-B	Bwa	1	2	1	1	1	1	7
Nyandira	Nge	1	1	1	1	1	3	8
Nyangala	Mam	1	2	1	1	1	1	7
Nyarutanga	Bwa	2	3	1	3	2	2	13
Nyingwa	Mat	1	2	1	1	1	2	8
Pandambili	Tur	1	1	1	1	1	1	6
Pangawe	Nge	2	1	1	2	1	1	8
Peapea	Mas	2	2	1	3	1	1	10
Peko-Misegese	Mla	1	2	1	1	1	3	9
Pemba	Tur	2	2	1	1	1	3	10
Pinde	Mge	1	1	1	1	1	1	6
Ruaha	Mik	1	2	2	1	1	3	10
Rubeho	Gai	1	1	1	2	1	3	9
Rudewa	Mat	1	2	1	1	1	3	9
Rudewa Batini	Mas	2	2	1	3	1	3	12
Rudewa Gongoni	Mas	1	3	2	1	1	2	10
Rudewa Mbuyuni	Mas	2	2	1	3	1	2	11
Ruhembe	Mik	1	2	1	2	1	3	10
Rusanga	Tur	3	1	1	3	1	3	12
Sagasaga	Nge	2	2	3	2	2	1	12
Sangasanga	Mla	3	2	2	3	1	1	12

Village	Div.	A	S	D	R	C	P	Total
		Scores for assessment criteria						
Semwali	Tur	1	1	1	1	1	1	6
Seregete-A	Nge	2	3	3	3	1	1	13
Seregete-B	Nge	2	3	2	3	1	1	12
Sesenga	Bwa	1	2	1	1	1	2	8
Singisa	Bwa	1	2	1	1	1	2	8
Senyaulime	Nge	2	2	2	2	2	1	11
Tabu Hotel	Gai	2	2	3	3	1	2	13
Tambuu	Mat	1	1	2	1	1	3	9
Tandai	Mat	1	2	1	1	1	3	9
Tandari	Nge	1	1	1	1	1	2	7
Tandari	Mat	1	2	2	1	1	2	9
Tangeni	Mla	1	2	1	1	1	2	8
Tawa	Mat	1	2	1	1	1	3	9
Tchenzema	Mge	1	1	1	1	1	2	7
Tegetero	Mat	1	2	1	1	1	2	8
Temekero	Bwa	1	2	1	1	1	1	7
Tindiga	Mas	2	2	2	3	1	3	13
Tulo	Bwa	1	2	1	2	1	1	8
Tundu	Mik	1	2	1	1	1	3	9
Tungi	Nge	3	2	1	3	2	3	14
Tununguo	Nge	1	3	1	1	1	2	9
Ubili	Tur	1	1	1	1	1	1	6
Udung'hu	Mik	1	2	1	1	1	3	9
Ukwama	Bwa	1	2	1	1	1	2	8
Ukwamani	Gai	3	1	2	3	1	2	12
Ulaya Kibaoni	Ula	1	2	1	1	1	3	9
Ulaya Mbuyuni	Ula	1	2	1	1	1	1	7
Uleling'ombe	Mik	1	1	1	1	1	2	7
Unone	Mas	1	2	1	1	1	1	7
Uponda Chini	Mat	1	2	1	1	1	2	8
Uponela	Mam	1	2	1	1	1	2	8
Usungura	Nge	1	2	2	1	1	1	8
Vidunda	Mik	1	2	1	1	1	2	8
Vigolegole	Bwa	1	2	1	1	1	3	9
Vihengele	Mat	1	2	1	1	1	1	7
Vinile	Mge	1	1	1	1	1	1	6
Visaraka	Nge	2	3	1	2	1	2	11
Zombo-Lumbo	Ula	1	2	1	1	1	2	8

LEGEND (See also Table B2.3-1):
A = availability criterion
S = quality of source criterion
D = distance to source criterion
R = reliability criterion
C = electrical conductivity criterion
P = population criterion
Total = total assessment score