

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
ARUSHA REGIONAL DEVELOPMENT DIRECTORATE
THE UNITED REPUBLIC OF TANZANIA

THE FEASIBILITY STUDY
ON
MONDULI TOWN
AND
THE SURROUNDING AREA WATER SUPPLY
IN
ARUSHA REGION

FINAL REPORT
SUMMARY

JICA LIBRARY



J 1127386 (9)

MARCH 1996

SANYU CONSULTANTS INC.
JAPAN ENGINEERING CONSULTANTS CO., LTD.

S S S

UR

96-025

416
61.8
SSS

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
ARUSHA REGIONAL DEVELOPMENT DIRECTORATE
THE UNITED REPUBLIC OF TANZANIA

THE FEASIBILITY STUDY
ON
MONDULI TOWN
AND
THE SURROUNDING AREA WATER SUPPLY
IN
ARUSHA REGION

FINAL REPORT
SUMMARY

MARCH 1996

SANYU CONSULTANTS INC.
JAPAN ENGINEERING CONSULTANTS CO.,LTD.

Foreign Exchange Rate

(as of October 1, 1995)

US \$ 1.00 = Tsh 600 = ¥ 101.25
Tsh 1.00 = ¥ 0.1688

Tsh = Tanzania Shilling



1127386 (9)

PREFACE

In response to a request from the Government of the United Republic of Tanzania, the Government of Japan decided to conduct a feasibility study on Monduli Town and the Surrounding Area Water Supply in Arusha Region and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tanzania a study team headed by Mr. Kunio Ota, Sanyu Consultants Inc., and composed of staff members of Sanyu Consultants Inc. and Japan Engineering Consultants Co., Ltd., three times between November, 1994 and February, 1996.

The team held discussions with the officials concerned of the Government of Tanzania, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the United Republic of Tanzania for their close cooperation extended to the team.



Kimio Fujita
President

Japan International Cooperation Agency

March, 1996

March, 1996

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

Letter of Transmittal

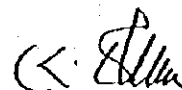
We are pleased to submit to you the feasibility report on the Monduli Town and the Surrounding Area Water Supply in Arusha Region of the United Republic of Tanzania. The report, during the course of the above-mentioned project formulation, has been given due consideration to the advice and suggestions of the authorities concerned of the Government of Japan and your Agency, and to the comments made by the Arusha Regional Development Directorate during technical discussions on the draft final report which were held in Tanzania.

The present production of groundwater could satisfy only 32 percent of the water demand to meet the minimum drinking water of 10 liters per capita per day recommended, for rural water supplies, by WHO. The proposed projects envisage to meet the water demand for domestic use of 30 liters per capit per day, by the construction of boreholes for Monduli town and small-scale dams for the surrounding area where groundwater is not available.

The primary objective of the proposed projects is designed to supply safe and clean water for the rural people, in accordance with the National Water Policy Directive, 1991. The proposed Monduli Water Supply Project should be recognized as urgent and one of the top priority projects. Development of water resources is not only urgent but also crucial to Monduli town, the development center of the District.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs of the Government of Japan. We also wish to express our deep gratitude to the Arusha Regional Development Directorate, the Ministry of Water, Energy and Minerals and other authorities concerned of the Government of the United Republic of Tanzania for the close cooperation and assistance extended to us during our studies.

Very truly yours,



Kunio Ota

Leader of the Study Team

ABSTRACT

1. Background of the Study

The Government of the United Republic of Tanzania (the Government of Tanzania) is making every endeavour to establish water master plans for Regions throughout the country. Preparation of the Arusha Region Water Master Plan is now in the final stages. Monduli district, the second largest district in Arusha region, and its surrounding areas are confronted with serious water shortage problems; the rains in these areas have only a short spell of about four months a year; springs and some boreholes are the only available water sources.

Tanzania's national water policy was formulated in 1991 with the primary objectives of making clean and safe water available to all households, urban and rural. Water management shall be left to the local people themselves, recommending the self sustainability of operation and maintenance of the water supply systems. With the exception of initial investment costs for the water supply project, operation and maintenance costs must be recovered by beneficiaries.

2. Objectives of the Study

The objectives of the study is to identify the potentials of water resources development, placing emphasis on groundwater, in the study area, to estimate future water demand including provision of water for livestock which contribute more to the regional economy, and to formulate priority project(s).

3. Study Area

The study area covers Monduli town, the capital of Monduli district, and its surrounding 18 villages with a total land area of 2,878 square kilometers. The total population in 1994 was 65,428, of which 18,210 lived in Monduli town and 47,218 in the 18 villages. While Monduli town had an average population density of 607 persons per square kilometer, a population density of the 18 villages where the Masai are dominant ethnic group is as low as 17 persons per square kilometers.

The water sources currently used for water supplies are categorized into the following: small-scale dams, boreholes, springs, shallow wells and rainwater storage, total capacities of which are not sufficient to meet the water demands of peoples. Most villagers

need three or more hours to collect water from sources and to carry it to their houses. The average daily water consumption rates are between 8.0 to 9.5 liters per person.

4. The Proposed Project

4-1 Objectives

The main objective of the Project is to provide safe water throughout the year with a target year of 2014. Development proposals for the Project are summarized as follows:

- (1) Construction of water source facilities will be proposed to meet water demands in the target year at daily water consumption rates of 30 liters per capita for domestic use and 25 liters per livestock unit.
- (2) No distribution networks with house connections will be proposed as part of this Project because of the very low population density and the low economic level of the communities.
- (3) The Project has assumed that the number of livestock remains stationary during the planning period owing to water scarcity in the dry season.

The water demand in 2014 will amount to 7,905 cubic meters per day as given below:

Water Demand in 2014					
Items	Domestic	Livestock	Schools/Others	Losses	Total
Monduli Town	1,046	91	78	182	1,397
18 Villages	2,904	2,389	365	850	6,508
Total	3,950	2,480	443	1,032	7,905

4-2 Project Components

The results of exploratory well drilling have revealed less groundwater potential mainly due to complicated geological structures caused by volcanic activities. The proposed water supply projects is composed of two subprojects: Monduli water supply project and village water supply projects serving the 18 villages. The Monduli Water Supply Project has been selected as a top priority project to warrant early implementation. The outlines of the Project are as follows:

Outlines of The Project

Project	Monduli Project	Village Project
Population in 2011	31,851	96,781
Water Demand (ml/day)	1,397	6,508
Main Facilities		
-Boreholes :Construction	3 locations	2 locations
:Rehabilitation	--	2 locations
-Small Dams :Construction	--	28 sites
:Rehabilitation	--	6 sites
-Pipelines :Construction	23 kilometers	--

(US\$ 1.00 = Tsh 600)

5. Project Costs

The Project will be completed in 2001 so as to meet the objectives of the National Water Policy. The estimated total project costs amount to 10,020 million Tanzania Shilling (Tsh) at 1995 price levels as given below:

Project Costs in Million Tsh

Cost Items	Monduli Project	Village Project	Total
Right-of-Way	1.3	33.4	34.7
Construction	2,937.4	4,877.3	7,814.7
Engineering Services	529.0	730.2	1,259.2
Physical Contingencies	316.8	561.1	910.9
Total	3,814.5	6,205.0	10,019.5

6. Project Evaluation

6-1 Economic and Financial Evaluation

While the estimated economic internal rate of return of 12.2 percent for the Monduli Water Supply Project is not so high compared with the social opportunity cost of the country, the project itself has a greater merit on humanitarian grounds.

The water charge is estimated at Tsh 350 per cubic meters of water, or Tsh 1,890 per month per household of six family members to recover the recurrent cost and replacement of equipment. The monthly water charge of Tsh 1,890 per household will place a 6.2 percent

burden per household on monthly household income.

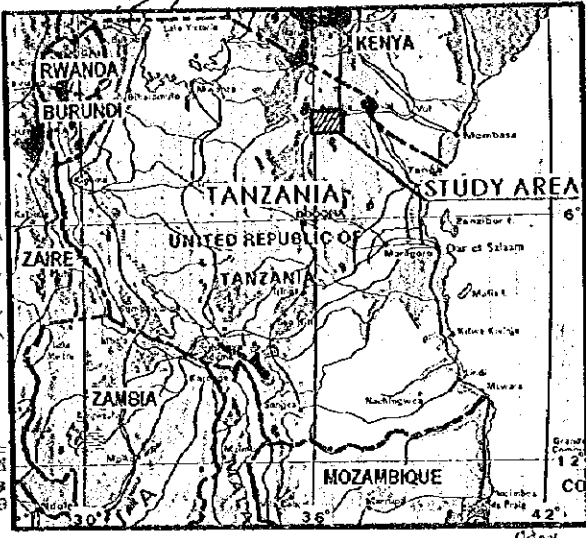
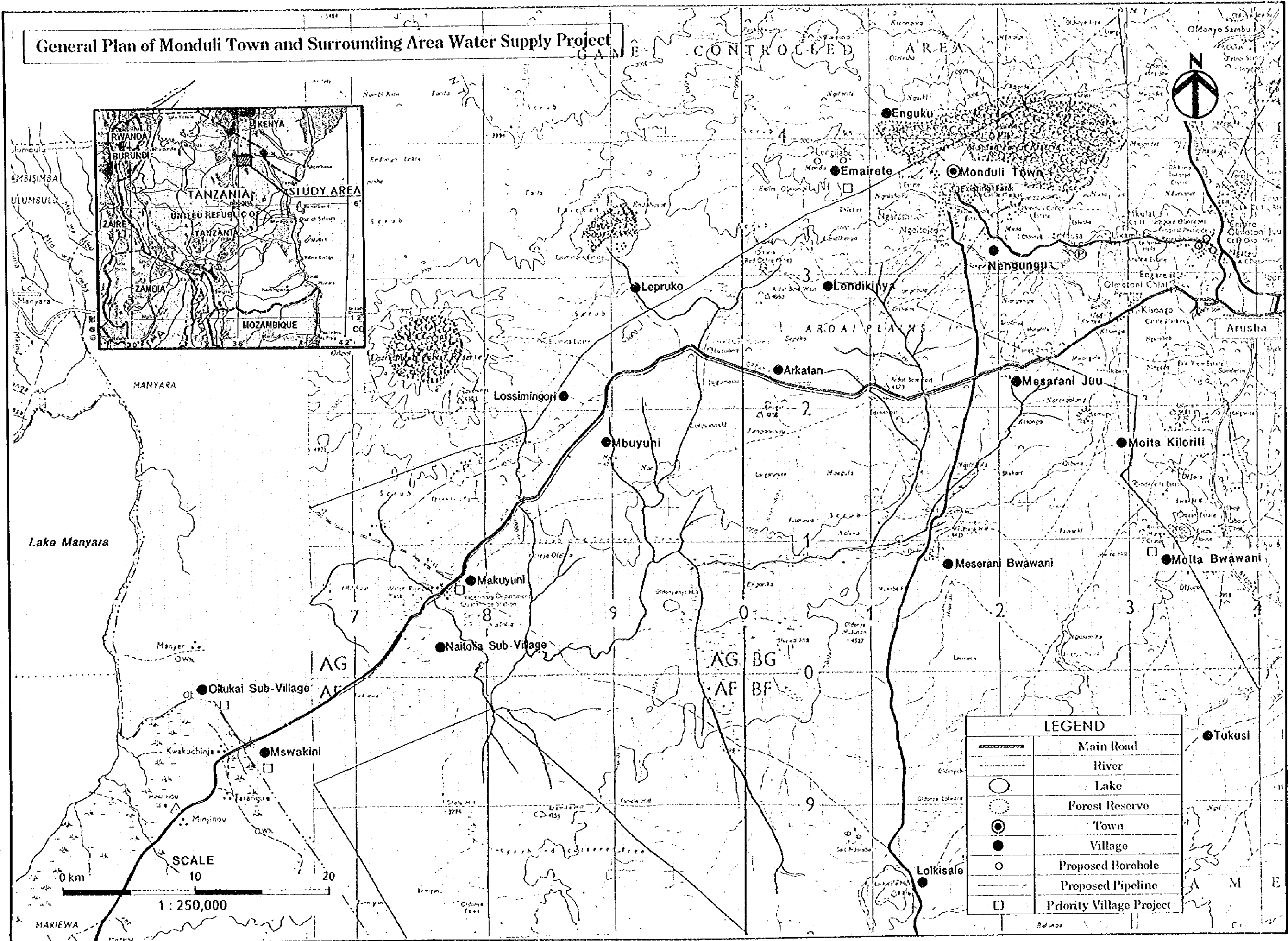
6-2 Environmental Consideration

The severe environmental problems in Monduli district are overgrazing and creeping desertification of large areas in the north and north-eastern parts, and intensive competition for scarce water resources. In implementing the Monduli Water Supply Project which is to provide boreholes and conveyance pipelines, among others careful considerations should be given to compensation of lands, water rights and groundwater pollution.

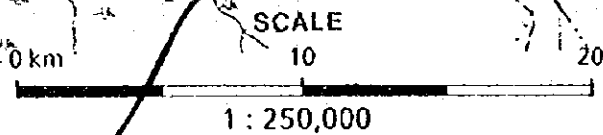
7. Recommendations

- 1) The Project should be implemented as closely as possible to the proposed implementation schedule. The primary objective of the Project is designed to provide safe and clean water supply for the rural people, in accordance with the National Water Policy Directive, 1991.
- 2) The Monduli Water Supply Project should be recognized as urgent and one of the top priority rankings. Development of water sources is not only urgent but also crucial to Monduli town, the development center of the District.
- 3) For successful implementation of the Monduli Water Supply Project, hydrogeological investigation of Engare Olmotoni area should be continued.
- 4) Construction of small traditional-type dams has been proposed for the Village Water Supply Projects. There would be sufficient water to make the year round water supplies available should dams be properly operated and maintained. Arusha Regional Development Directorate should be urged to planning of reservoir operation in due consideration of local hydrological conditions.
- 5) After completion of the Project, the village water committee will be in charge of its operation and management. Arusha Regional Development Directorate together with the Regional Water Department and District Water Department should be encouraged to fully assist newly organized village water committees thus contributing to a successful operations in rural water supplies.

General Plan of Monduli Town and Surrounding Area Water Supply Project



LEGEND	
	Main Road
	River
	Lake
	Forest Reserve
	Town
	Village
	Proposed Borehole
	Proposed Pipeline
	Priority Village Project



CONTENTS

ABSTRACT	I
CONTENTS	VI
1 INTRODUCTION	S-1
1-1 Background of the Study	S-1
1-2 National Water Policy	S-1
1-3 Arusha Regional Water Master Plan	S-1
2 GENERAL DESCRIPTION OF THE STUDY AREA	S-2
2-1 Location	S-2
2-2 Administrative Setup	S-2
2-3 Population	S-3
2-4 Rural Economy	S-3
2-4-1 Economic Activities	S-3
2-4-2 Household Economy	S-4
2-5 Socio-Culture	S-4
2-6 Public Health and Sanitary Education	S-5
2-6-1 Health Services and Diseases	S-5
2-6-2 Sanitary Education	S-5
2-7 Water Supply and Sanitation	S-6
2-7-1 Water Supply	S-6
2-7-2 Sanitation	S-9
2-7-3 Institution and Organization	S-9
2-8 Environment	S-10
2-9 Natural Condition	S-10
2-9-1 Topography and Geol use Geology	S-10
2-9-2 Rainfall and Surface Runoff	S-11
3 GROUNDWATER RESOURCES	S-12
3-1 Hydrogeology	S-12
3-2 Exploratory Well Drilling	S-13
3-3 Evaluation of Potential Well Yield	S-14
3-3-1 Study Area	S-14
3-3-2 Engare Olmotoni Area	S-15

3-4	Water Quality	S-15
3-4-1	Water Quality for Drinking Purposes	S-15
3-4-2	Bacteriological Characteristics	S-16
4	DEVELOPMENT PROPOSAL	S-17
4-1	Needs for Development	S-17
4-2	Objectives and Project Components	S-17
4-3	Projection of Number of Inhabitants and Livestock	S-18
4-3-1	Planning Period	S-18
4-3-2	Population	S-19
4-3-3	Livestock	S-19
4-4	Water Demand	S-19
4-5	Water Resources Development Planning	S-20
4-5-1	Groundwater Development	S-20
4-5-2	Surface Water Development	S-20
5	THE PROPOSED PROJECT	S-22
5-1	Mondull Water Supply Project	S-22
5-1-1	Water Demand	S-22
5-1-2	Water Sources	S-22
5-1-3	Proposed Facilities	S-23
5-1-4	Staged Construction Plan	S-23
5-2	Village Water Supply Project	S-24
5-2-1	Dam Project	S-24
5-2-2	Groundwater Development Projec	S-25
5-3	Priority Project	S-25
6	IMPLEMENTATION AND OPERATION OF THE PROJECT	S-27
6-1	Implementation Program	S-27
6-2	Operation and Maintenance	S-27
7	PROJECT COST	S-28
8	PROJECT EVALUATION	S-29
8-1	Economic Evaluation	S-29
8-2	Financial Evaluation	S-29
	RECOMMENDATIONS	S-30

Table 1 PROPOSED IMPLEMENTATION SCHEDULE S-32
Figure 1 ILLUSTRATION OF
MONDULI WATER SUPPLY PROJECT S-33

1 INTRODUCTION

1-1 Background of the Study

The Government of the United Republic of Tanzania (the Government of Tanzania) is making every endeavor to establish water master plans for regions throughout the country to provide safe drinking water. Monduli district, the second largest district in Arusha region, and its surrounding areas are confronted with serious water shortage problems. The rains in these areas have only a short spell of about four (4) months a year, and springs and the some boreholes are the only available water sources in the dry season.

In accordance with the Scope of Works agreed upon on March 21, 1994 between the Government of Japan represented by Japan International Cooperation Agency (JICA) and the Government of Tanzania represented by Arusha Regional Development Directorate (RDD), JICA commenced the Feasibility Study on Monduli Town and the Surrounding Area Water Supply in Arusha Region (Study) in November, 1994. The feasibility study team (Study Team) is organized by Sanyu Consultants Inc. and Japan Engineering Consultants Co. Ltd.

1-2 National Water Policy

Tanzania's national water policy was formulated in 1991 with the primary objective of making clean and safe water available to all households, urban and rural, within a distance of 400 meters from their households by the year 2002. For rural water supplies, instead of house connection, water will be collected from domestic water points which each serve 200 to 250 people. Water management shall be left to the local people themselves. Cost recovery is emphasized in water management. With the exception of initial cost investment for the water projects, operation and maintenance costs must be recovered.

1-3 Arusha Regional Water Master Plan

Preparation of the Arusha Region Water Master Plan started in 1990 under the United Nations Development Program. The draft report was published in October, 1994. According to the draft report, the study of water resources in Arusha region did not cover all districts completely because some additional surveys, especially for engineering estimates of water supply schemes, are considered necessary.

2 GENERAL DESCRIPTION OF THE STUDY AREA

2-1 Location

The Study Area covers Monduli town, the capital of Monduli district, and its surrounding areas. Monduli district stretches west of Arusha municipality bordering on the Republic of Kenya in the north, Kilimanjaro region in the north east, and Mbulu and Ngorongoro district in the west.

The Study Area with land area of around 2,900 square kilometers occupies about 20 percent of Monduli district which is predominantly inhabited by the Masais who move from one place to another in search of water and pasture land for their animals.

2-2 Administrative Setup

The Study Area administratively consists of Monduli town which is composed of two villages, and 18 villages/Sub-villages in seven (7) wards, as given below:

Villages Selected for the Study

Ward	Village/Sub-Village	Ward	Village/Sub-Village
Engutoto	Monduli Town	Sepeko	Meserani Bwawani
Monduli Juu	Enguik		Lolkisare
	Emairete		Tukusi
Sepeko	Lendikinya	Makuyuni	Makuyuni
	Arkatan		Naitolia Sub-Village
	Lössimingori		Mbuyuni
	Lepruko		Mswakini
	Meserani Juu	Mt wa Mbu	Oltukai Sub-Village
	Moita Kiloriti	Musa	Nengungu
	Moita Bwawani		

Each village has a village council known as the village government comprising of 25 members. Also, there is a village executive officer appointed by the district executive director to carry out the administrative tasks on behalf of the village government.

2-3 Population

The total population in 1992 was 61,096 according to the database for the study of Arusha Region Water Master Plan (ARWMP), based on which the population in 1994 was estimated at 65,428. The mean annual population growth rates on a village basis are calculated for ARWMP based on the 1988 population census and village population in 1992. The mean annual population growth rate is 3.48 percent over the Study Area.

Population			
Item	Monduli Town	18 Villages	Total
Population in 1992	17,067	44,029	61,096
Population in 1994	18,210	47,218	65,428
Annual Growth Rate(%)	3.30	3.56	3.48

The Study Area with the land area of 2,878 square kilometers had a population of 65,428 distributed among 12,489 households in 1994. The village population size ranges from 4,863 in Makuyuni to 1,541 in Tukusi. The settlement pattern of the Study Area where the Masai are a dominant ethnic group is characterized by its low population densities as given below:

Population Density and Average Family Members		
Item	Population Density (person/km)	Average Member of Family
Monduli Town	607	6.4
18 Villages	17	4.9
Overall	23	5.2

2-4 Rural Economy

2-4-1 Economic Activities

The Study Area is predominantly agricultural. Traditionally most of the people are dependent on livestock keeping and agriculture. The livestock sector contributes 66 percent of the regional Gross Domestic Production (GDP) and the agriculture sectors 25 percent.

(Livestock)

More than 86 percent of the population in the District are indigeous Masai pastoralist. Major livestock raised by the people are cattle, goats, sheep and donkeys as follows:

Major Livestock in 1994

Cattle	Goats	Sheep	Donkeys
76,086	74,038	33,223	3,245

The Masai, known as livestock keepers, have been forced to move from good agriculture land to arid or semi-arid areas by the farmers. The harsh climate in semi-arid areas make the Masai are nomadic so that they move from one place to another with their livestock. The animals are overstocked. At present, the Masai are slowly changing toward mixing farming with livestock production.

(Agriculture)

The average farmer cultivates land of between five (5) and ten (10) acres with an average of seven (7) acres, or 2.8 hectares. Main crops are maize, beans, wheat and rice. Agricultural production has steadily increased in recent year; but the productivity in terms of yield per hectare has fluctuated as farming is practiced under rain-fed conditions.

2-4-2 Household Economy

According to the preliminary survey on household income made by the Study Team, the monthly household income ranges from Tanzania Shilling (Tsh) 10,000 to 50,000. The average monthly household income is estimated at Tsh 30,300 in 1995 based on the average rural household income of Tsh 27,482 learnt from the national household economy survey conducted in 1991/1992.

2-5 Socio-Culture

The major ethnic groups in Monduli district are the Masai and Waarusha, who to a large extent are pastoralists though they are now practising agriculture. The major religious groups are Roman Catholic, Lutherans and Pagans. These groups are found almost in every village in the Study Area.

The Masai community has a well-knit hierarchical system which vests power to each group in the society and no group can encroach into another's domain. For example, the junior youths ("Morans") are regarded as the defence squad. They are in charge of all property in the village and in times of war or conflict, they have to be in the frontline. They also take charge of the livestock during seasonal migration. The uncircumcised youths look after calves, goats and sheep. They also herd cattle if they are not taken too far from the homesteads.

Men are overall in charge in the family but the overall responsibility of maintaining the family in terms of food provision, caring for the children and building houses is taken by women (wives). Men and women are supposed to sit together in community meetings although generally those meetings are attended by males only. Women have been designated to an inferior status leaving them helpless in terms of decision-making.

2-6 Public Health and Sanitary Education

2-6-1 Health Services and Diseases

In the Study Area, there are one (1) hospital in Monduli town and 12 dispensaries; three (3) in the Town and nine (9) in the surrounding areas. About 48 percent of villagers go to dispensaries and 24 percent to the Traditional Birth Attendant. Villagers who go to hospitals amount to only one (1) percent. Major diseases are malaria, diarrhoea and dysentery, eye disease, skin disease, worms, sexually transmitted diseases, tuberculosis (TB), typhoid and measles. Life expectancy is 55 years, and infant mortality is 75/1,000. Maternal mortality is as high as 1,345/100,000.

2-6-2 Sanitary Education

The Region has attempted to complement health education and a hygiene training program currently being conducted by introducing other programs such as Health Sanitation and Water, and Child Survival, Protection and Development. The programs operate through networking with other organizations and departments addressing the same related sectors such as health, water and community development. It is only in the recent past that subjects known as health education were introduced in schools. The contents of the subject are designed by the Ministry of Health; but most teaching is done by primary school teachers.

With respect to sanitary education for primary schools, seminars for teachers and education trials for pupils were carried out at the selected three (3) primary schools with the education manuals and learning materials prepared by the Study Team. Teachers were asked to evaluate the teachers' sessions as well as pupils trials. Pupils were requested to give written comments on what they would do next in order to meet the objectives of the trials. The exercise was well done and there are great hopes that the sanitary education program which is being designed will be well received by the schools.

2-7 Water Supply and Sanitation

2-7-1 Water Supply

Water Sources

The water sources presently being used are categorized into the following six (6); small scale dams, boreholes, springs, Tanzania Military Academy (TMA) pipelines, shallow wells and rainwater storage tanks.

Water Source			
Source	Nos. of Sources	Source Capacity	Unit
Small Scale Dams	32	5,012	1,000 m ³
Boreholes	2	210	m ³ /day
Springs	7	337	m ³ /day
TMA Pipeline	1	108	m ³ /day
Shallow Wells	2	0	m ³ /day
Rainwater Tanks	1	0	m ³ /day

(Dams)

This is the commonest type of water source facilities and is the most suitable for the village areas because it can be constructed easily by concerted action from the villagers coupled with appropriate technology to be supplied by the government organizations. Small scale dams are found in Monduli town and 16 villages. However, inflow to the reservoirs is available only for several months during the rainy season reflecting the rainfall pattern prevailing in the area. Furthermore, storage water is easily subject to contamination mainly due to the encroachment of animals on the reservoirs.

(Boreholes)

Groundwater development offers a number of advantages. It is characterized by higher quality; except when extraction is made at shallow depths and in polluted areas. In addition, it is better protected from pollution and evaporation, and the resources do not undergo substantial seasonal and long-term fluctuations, being naturally regulated.

Two boreholes are in operation for village water supplies; one borehole in Makuyuni village with a water yield of 135 cubic meters per day; the other in Mswakini village with a water yield of 75 cubic meters per day, totaling 210 cubic meters per day. The other two

boreholes are not working due to mechanical troubles with pumps and engines.

(Springs)

There are seven (7) springs in use for rural water supplies. This type of water source is found in Monduli town and four (4) villages with the total source capacities of 337 cubic meters per day.

(TMA Pipelines)

TMA pipelines collect water at Emaoi spring located at the foothill of Mt. Meru and convey water to Tanzania Military Academy near to Monduli town. TMA pipelines also distribute water for domestic uses of Monduli town and two (2) villages of Meserani Juu and Nengungu.

(Shallow Wells and Rainwater Tanks)

Four (4) villages each have one shallow dug well for domestic use. These shallow wells yield very limited water, so that the villagers collect water by ladling. Two (2) rainwater storage tanks exist at Arkatan village; however, only one rainwater tank is working at present. The quantity of water available for domestic use is also negligibly small.

Water Supply System

There are only two piped water supply systems; for other areas point sources are provided for domestic use.

(Piped Water Supply System)

Monduli water supply system has two (2) types of water sources; TMA pipelines and two springs. Water from the springs is conveyed to the confluence box by gravity, whereas water from TMA pipelines is conveyed by gravity from TMA storage tank to the booster pump station, and then water is pumped up to the tank near to the Monduli College of Education. The booster pump is not operated as originally planned owing to frequent failures of electric power supplies. The water is distributed in Monduli town through the house connections and domestic water points (DWP) with the service population of 26,000 as summarized below:

Service Population of Monduli Water Supply Project

Service Area	House Connection	Public DWP	Total
Monduli Town	1,000	9,000	10,000
Ngarashi Village	-	12,500	12,500
Rasharasha Village	-	3,500	3,500
Total	1,000	25,000	26,000

Of two (2) boreholes, only one borehole is operated at present at Makuyuni village. Groundwater is pumped up to the elevated storage tank at the village through the pipelines with the length of 4.1 kilometers. Water of 135 cubic meters per day is distributed through three (3) public DWP located in the housing area of the village.

(Point Sources)

For 17 villages, water is provided without water distribution system. The villagers are spending large amounts of time and energy in collecting water for their domestic use.

Present Water Utilization

The survey on water utilization was conducted to establish the water facilities available, how they are utilized, to what extent they can serve the populations, and so on. 550 households were sampled; 100 households for Monduli town and 450 households for 18 villages. Salient features on the current water utilization are summarized as follows:

(Water Consumption Rates)

The average daily water consumption rates are estimated at 9.5 liters per capita for Monduli town and 8.0 liters per capita for the surrounding 18 villages. In case of water shortages, especially in the dry season between July and November, people buy water for drinking. The price is Tsh 1,000 per 200 liters, i.e. Tsh 5.0 per liter.

(Distance to Water Source)

28 percent of the people in Monduli town replied that water sources are available within a distance of 400 meters. The average distances from houses to water sources are around three (3) kilometers for Monduli town whereas most villagers in 18 villages have to walk five (5) to 30 kilometers to collect water.

The number of families involved in collecting adequate water for household use range from one (1) to four (4) persons with an average of 3.3 persons per household. 95 percent of the villagers need three (3) or more hours to collect water from sources and to their carry it to their houses.

(Water Availability and Quality)

15 percent of people said that water was available throughout the year; seven (7) percent for Monduli town; 17 percent for the 18 villages. 18 percent of the people are satisfied with the current water quality.

2-7-2 Sanitation

In Monduli town, 80 percent of households have latrines although they leave much to be desired. Many of the pit latrines have been built by using poles and mud; but thatched with corrugated iron sheets. 20 percent of households have no toilets and have no intention of building toilets.

In the surrounding 18 villages, almost 40 percent of households have toilets. 60 percent of households have no toilets; 55 percent of households defecate anywhere away from the houses; five (5) percent of households go into the bush.

2-7-3 Institution and Organization

The ownership and responsibility for operation and maintenance of rural water supply facilities rest with local government at the village and district level. Monduli District Water Department, one of the functional divisions of Arusha Regional Water Department, is directly responsible for execution of the District Council's water project.

At village level, the water committees are organized with a chairman, a secretary and members of the committee. Most of the village water committees in the Study Area consist of five (5) to eight (8) members. The present responsibility of these committees includes maintenance of water source facilities, control of water quality, petition of rehabilitation works to the government, and collection of funds for operation and maintenance of the facilities.

Monduli water supply project is maintained by Monduli District Water Department that takes charge of providing water and of collecting water revenues. Water is provided through public water taps and house connections as well as commercial connections. Water from public taps is free of charge at this time. Water through house and commercial

connections is charged at a flat monthly rate of Tsh 200 and Tsh 400 respectively. The water revenue collection is low. Water revenue efficiency is 40 percent for domestic users and 70 percent for commercial users.

Basic reasons for low water charge collection efficiencies are; no systematic collection was enforced; and water is not continuously available for 365 days, i.e. non dependability of continuous water supply forced users not to pay the bill.

2-8 Environment

The Government's overall goal of the environmental sector is to achieve sustainable development that maximizes the long-term welfare of both present and future generations of the Tanzanian population. The Ministry of Tourism, Natural Resources and Environment is directly charged with environmental administration. The laws related to environmental conservation are National Parks Ordinance, Forest Ordinance, Grassland and Fire Ordinance, Natural Resources Ordinance and Wildlife Conservation Act.

No officially protected area such as national parks, game reserves, game controlled areas or forest reserves are included in the Study Area. The severe environmental problems in Monduli district are overgrazing and starting desertification of large areas in the north and north-eastern parts, and high competition for scarce water resources among domestic, livestock and irrigation uses.

2-9 Natural Conditions

2-9-1 Topography and Geol use Geology

The Study Area is bordered on the north by three (3) major volcanic mountains of Monduli, Burko and Essimigor, on the east by Arumeru district where a remarkable escarpment extends from a north to south direction, and on the west by Lake Manyara. The physiographic features of Monduli district are mainly related to volcanic activities, and only the southern part of the District is characterized by elevated plateaus of Precambrian rocks.

The plateaus are edged with the tectonic scarps extending in a north to southerly direction. A remarkable fault-scarp from an east to westerly direction exists in the northern edge of the plateaus. A large-scale broad valley was cut at the north of the scarp, that is, the Ardai Basin where a barren land extends between the scarp and the Monduli mountains. The Study Area is underlain with four major geological units; they are the Basement, the Old Extrusives, the Younger Extrusives and the Manyara Lake Beds.

2-9-2 Rainfall and Surface Runoff

The Study Area experiences distinct dry and rainy seasons. The dry season lasts for five (5) months from June to October, and the rainy season for seven (7) months from November to May. Annual rainfall fluctuates considerably between 350 millimeters and 1,600 millimeters with mean annual rainfall of 810 to 860 millimeters. The short rainy period extends from November to December, and the long rainy period lasts for three (3) months from March to May with the peak rainfall in April.

Small rivers and many streams flow southward through the Study Area, all of which are seasonal flowing. No river gauging station is established in the Study Area. River discharge data of two (2) rivers at Mto wa Mbu were evaluated to take a general view of surface water runoff in and around the Study Area. The mean annual river yields are 143 millimeters and 114 millimeters for Simba river at the station with a catchment area of 190 square kilometers and Mto wa Mbu river at the station with the catchment area of 148 square kilometers, respectively.

3 GROUNDWATER RESOURCES

3-1 Hydrogeology

(Monduli Town and Monduli Juu)

Being located in the foothills of Mt. Monduli, Monduli town is underlaid by Colluvial Deposits derived from the Older Extrusive of the Monduli mountain. Unconsolidated colluvial beds of about 40 meters thickness cover fractured volcanic rocks. The former acts as part of the aquifer, but does not have good potential, and the latter contains pressure gas in caverned volcanic rocks. An interpretation of aerial photographs reveals that the depth to the extrusive was thickened abruptly in the south of Monduli mountain due to east-westerly faulting.

The geology of Monduli Juu is characterized by two (2) calderas; inner and outer caldera. In the inner caldera, the upper part consists of the Colluvial Deposits of clayey beds with a thickness of about 70 meters, with the lower part consisting of medium to coarse sand with a thickness of more than 30 meters which acts as an aquifer. In the outer caldera, thick unconsolidated beds of clay with gravels and clayey fragments underlie.

(Surrounding Villages)

Oltukai subvillage is located several kilometers east of Lake Manyara, and is underlain by the Lake Manyara Beds with a thickness of more than 100 meters. The groundwater potential of the Lake Manyara Beds seems excellent; but the water has a high concentration of dissolved solids.

Being located east of Oltukai subvillage, Mswakini village is underlaid by the Lake Manyara Beds. The village is bordered on the east and southeast by the Tarangire National Park and Lolkisare Game Controlled Area which act as a part of recharge areas. Groundwater quality in the Lake Manyara Beds in the southern and eastern parts of the village has been improved with freshwater flowing from the forest-covered land.

Naitolia subvillage is located in the eastern end of the old Lake Manyara depositional plain and is underlaid by the Lake Manyara Beds in the lowland. Major aquifers in the lowland are of sandy materials from the Lake Manyara Beds and water quality of the aquifers is considered as having a high concentration of total dissolved solids.

(Ardai Basin)

The Ardai Basin, which is located south of Monduli town, covers a moderately

sloping alluvial surface and wide valley floor with a total area of about 130 square kilometers. All rivers and streams rising in Monduli and Lendikinya mountain ranges run southwards through the Ardai Basin. Part of the runoff is lost in the Ardai Basin which is bounded on the south by the uplifted lava plateau. There are only two (2) outlets to drain surface runoff from the basin.

Groundwater may be recharged in the basin, transmitted and released in the Colluvial Beds and heavily fractured volcanic rock aquifers in the zone of saturated subsurface.

3-2 Exploratory Well Drilling

Exploratory well drilling has been carried out to obtain the hydrogeological data, more particularly, to set up hydrogeological units, to obtain vertical/horizontal extent of aquifers, to grasp characteristics and potential of aquifers, and to test groundwater quality. 11 drilling sites were selected over the Study Area after consideration of the results of hydrogeological surveys and resistivity prospecting. After completion of the drilling works, fiberglass reinforced pipe (FRP) casing of 150 millimeters diameter and horizontal slotted screens of FRP with 12 percent openings were installed in the boreholes. The results of test drilling are shown below:

Well No.	Location	Drilled Depth(m)	Groundwater Level (mbgs)	Water Yield (l/min.)	Remarks
EX-1	Naitolia	76	65	neglig. small	
EX-2	Mbuyuni	64	58	dry	
EX-3	Tukusi	98	55	1.0	
EX-4	Monduli Town	154	129	neglig. small	
EX-5	Lashaine	198	.	dry	gas
EX-6	Lendikinya	250	.	dry	
EX-7	Monduli Juu	102	72	20.7	
EX-8	Monduli Town	126	.	dry	gas
EX-9	Arkatan West	48	.	dry	gas
EX-10	Arkatan East	152	.	dry	gas
EX-11	Monduli Town	150	.	neglig. small	

Of 11 exploratory wells, only two (2) wells have yielded a countable amount of groundwater; EX-3 well and EX-7 well. EX-3 well at Tukusi was drilled in the weathered

gneiss of the Basement Rocks and EX-7 well at Monduli Juu was drilled in the Colluvial Beds in Monduli Juu caldera. The most striking feature of the subsurface of the Ardai Basin is the presence of pressure gas in the cavern volcanic rocks instead of groundwater.

3-3 Evaluation of Potential Well Yield

Based on the specific capacities obtained through the examination of exploratory well drilling and data on the existing wells, the optimum well yields for respective hydrogeological units have been assessed. In the assessment, depths of proposed wells are determined based on the borehole loggings. The optimum well yields are determined on condition that screens of minimum 20 meters be installed, minimum drawdown is 10 meters and pumping is operated for 10 hours a day.

3-3-1 Study Area

(Lake Manyara Beds)

The Lake Manyara Beds overlying the Basement occur in the southern part of the Study Area. Four (4) villages of Oltukai, Mswakini, Naitolia and Makuyuni are situated on the Lake Manyara Beds, of which two (2) villages of Naitolia and Oltukai have no groundwater development potentiality because of a low water yield together with inferior water quality due to high electrical conductivity. The possible well yield for one (1) production well is 135 cubic meters per day for Makuyuni village and 144 cubic meters per day for Mswakini village.

(Colluvial Beds)

Large scale Colluvial Beds underlie the Monduli Juu caldera. The possible groundwater yield of one (1) production well is 36 cubic meters per day. Relatively small quantity of well yield is due to small scale of the recharge area.

(Young Extrusive)

Three (3) major mountains are underlaid by the Younger Extrusive. Test well drilling encountered pressure gas in the cavern lava. There is no potentiality of groundwater development for rural water supplies.

(Plateau Lava)

Most test wells for water development for Monduli water supplies were located to identify aquifers in the Plateau Lava. From the existing data 20 cubic meters per day of water

can be expected; One of the major problems with respect to rural water supplies is deeper static water levels in excess of 100 meters below the ground surface.

(Basement Rocks)

The Basement aquifers extend widely over the southwestern part of the Study Area. ARWMP investigation indicates that the average well yield is 80 cubic meters per day with the average static water level of around 30 meters below the ground surface; however, in the Study Area the potential well yield is as low as 12 cubic meters per day at Naitolia village.

3-3-2 Engare Olmotoni Area

The Engare Olmotoni area extending north of the Arusha Air Field is underlain by Meru volcanic lava and covered by volcanic debris with high potentiality for groundwater development. RDD has made preliminary investigation on groundwater development in Engare Olmotoni area in order to identify water sources for Monduli water supply project. No exploratory well drilling was made in this Study; however, the average well yield of 630 cubic meters per day could be expected, being learnt from the analysis of the existing data on seven (7) test wells. The static water levels are within 30 to 45 meters below the ground surface.

3-4 Water Quality

Water quality analyses have been conducted by means of in-situ tests for 29 samples and laboratory tests for 30 samples including both the surface water and groundwater with the objectives of interpreting hydrochemical evaluation of groundwater, and evaluating surface and groundwater sources for water supply planning. The in-situ test covers the parameters of electrical conductance, pH, water temperature and bacteriological examination, and the laboratory test covers 25 physical and chemical parameters.

3-4-1 Water Quality for Drinking Purposes

The water samples were assessed for drinking purposes based on a maximum permissible level of WHO Drinking Water Standards. The results of tests are summarized as follows:

- Apart from the water sample from Lake Manyara with the pH value of 10.3, all water samples are of pH values within the permissible limit of between 6.5 and 9.2.*
- High turbidity values were recorded mostly from water of river surface flows, reservoirs and lakes; however, turbidity is highly susceptible to variations in*

rainfall intensity apart in Lake Manyara.

- Four (4) water samples have higher Electric Conductivity which exceeds the limitation of 1,200 μ S/cm, including Tukusi spring, Lake Manyara, Mswakini borehole and Burko BH-14 borehole.*

3-4-2 Bacteriological Characteristics

All water samples from boreholes were safe from the bacteriological contamination. Other water samples were bacteriologically contaminated. This may be due to contamination from animals and human beings. Most sources are open, i.e. not fenced in therefore access of either people or animals to water sources might be the major cause of pollution.

4 DEVELOPMENT PROPOSAL

4-1 Needs for Development

The existing water supply sources covering about 65,000 residents in the Study Area range from traditional hand dug wells to modern boreholes. Water supplies for the surrounding 18 villages rely mainly on the stored water in small-scale dams. The present production of groundwater is 210 cubic meters per day. This covers only 32 percent of the water demand to meet the minimum drinking water of 10 liters per capita per day recommended for rural water supplies by WHO. The present daily water consumption level is less than the minimum requirement: 9.5 liters per capita per day for Monduli town and 8.0 liters per capita per day for the surrounding area. Water resources development is essential in order to meet the minimum water requirement both for the time being and later to meet the increasing water demand in the near future.

In many villages where water supplies rely on small scale dams, water is not available in the dry season since proper reservoir operation is not put in practice. As a result of unreliable water sources, the villagers have to walk long distances in search of water. 95 percent of the households spend three (3) hours a day in collecting water for their families. Women and children undertake the responsibility of water collection, laborious works. For reduction in carrying distance, water source development needs to be distributed throughout the Study Area.

The groundwater development potential in the Study Area is not adequate to fulfill the estimated water demand. The results of exploratory well drilling have revealed less groundwater potential mainly due to complicated geological structures caused by volcanic activities. Accordingly, efforts shall be made to develop surface water resources by means of construction of small dams with well designed water control structures. For stable water supplies throughout the year, water management shall be introduced in operating reservoirs. In conformity with the national water policy, rural water supplies shall be operated and maintained by the villagers and they shall make water charge collections. To this end, the functions of the village water committees shall be strengthened.

4-2 Objectives and Project Components

The main objective of the Project is to provide safe water throughout the year in adequate quantities for drinking, food preparation, and personal hygiene with a target year of 2014. Furthermore, with due consideration of the importance of livestock to the villagers in the Study Area together with contribution of the livestock sector to the regional economy,

water provision for livestock has been proposed as far as water resources are available.

The project proposes to develop water resources including provision of water source facilities and public stand pipes; however, distribution systems with house connections have not been planned with this Project because of the very low population density of around 17 persons per square kilometer in the surrounding villages and economic consideration in keeping with the low economic level of the communities.

To accomplish the above objective, the Project proposes to implement the following projects with the lowest investment cost for serving all villages:

Groundwater Development

1) Monduli Water Supply Project

- Construction of boreholes with power pumps in Engare Olmotoni area, north of the Arusha air field.
- Construction of transmission pipelines with booster pumps from the proposed boreholes to the existing water tank in Monduli town.

2) Existing Village Water Supply Project

- Rehabilitation of Makuyuni water supply project.
- Rehabilitation of Mswakini water supply project.
- Construction of boreholes at Emairete village

Surface Water Development

1) New Construction of Small Scale Dams

- 29 dams in Monduli town and 15 villages.

2) Rehabilitation of Small Scale Dams

- Six (6) dams in Lossimngori and four (4) other villages.

4-3 Projection of Number of Inhabitants and Livestock

4-3-1 Planning Period

The planning period has been fixed at 20 years extending from 1995 to 2014 according to the planning criteria established by the Ministry of Water, Energy and Minerals. The number of inhabitants and livestock will be projected for this planning period.

4-3-2 Population

Projection of population is based on the population in 1994 and the mean annual population growth rates on a village basis. The total population will increase from 65,428 in 1994 to 131,635 in 2014, about double the present population, as given below:

Items	1994	2004	2014
Monduli Town	18,210	25,203	34,854
18 Villages	47,218	67,300	96,781
Total	65,428	92,503	131,635

4-3-3 Livestock

While livestock contributes more to the regional economy, there are many bottlenecks for improving livestock production. The number of livestock should be reduced and the quality of livestock should be improved. This is the basic position held by the Planning Commission of Monduli district. Under this situation, the Project assumes that the number of livestock will remain stationary during the planning period owing to scarcity of water and pasture in the dry season. The number of livestock unit is 99,166. One (1) livestock unit is equivalent to one (1) head of cattle, or five (5) goats, or five (5) sheep, or two (2) donkeys.

4-4 Water Demand

The first step in the water supply plan is to provide the people with minimum water of 10 liters per capita per day. Water consumption levels will be increased as water resources are made available and the living standards of the villagers are improved. The Project has estimated that daily water demand for domestic use will increase to 30 liters per capita during the planning period. The water demand for livestock of 25 liters per day per livestock unit has been employed. In the estimate of water demand, 15 percent of loss water is added. The water demand in the planning year of 2014 will amount to 7,905 cubic meters a day.

Water Demand Forecast in 2014 (m³/day)

Items	Domestic	Livestock	Schools/Others	Losses	Total
Monduli Town	1,046	91	78	182	1,397
18 Villages	2,904	2,389	365	850	6,508
Total	3,950	2,480	443	1,032	7,905

4-5 Water Resources Development Planning

4-5-1 Groundwater Development

Groundwater is a most suitable water resources for rural water supplies for its stable water yield and water quality. Development of groundwater resources will be planned according to the following guidelines:

- Facilities for groundwater development consist of boreholes, pumping equipment with drainage facilities to protect wells from surface water infiltration, and storage tanks; distribution systems are not provided.*
- Pumping systems are of manual operation when static water levels are less than 30 meters below the ground surface; otherwise power generating systems will be provided.*
- Although the daily water consumption of 30 liters per capita is proposed as the target, the consumption level will be modified so as to meet the minimum water requirement only during the initial stage of the Project depending on the capacity of well yields.*
- Boreholes will be located within a reasonable distance from the village centers as far as possible.*
- Water quality shall be tested to confirm if it meets the requirements of the Drinking Water Standard of the Government.*
- Locations of boreholes will be selected within public land, as a rule, such as schools, village offices, dispensaries and others.*

4-5-2 Surface Water Development

The water yields of the existing 32 dams expressed in terms of millimeters as the rates of total reservoir capacities to their catchment area averaged to 4.8 millimeters, compared to a mean annual rainfall of 800 millimeters. Topography of the Study Area allows small-scale dams to be built. Development of surface water where groundwater is not available will be planned according to the following guidelines:

- The live storage capacities of dams will be enough to meet water demands during drought conditions with a return period of 10 years.*
- The intake facilities and spillways shall be properly located with respect to topographic conditions.*
- Where water treatment is necessary, simple processes will be employed to permit village operation of the facilities.*

- *Selected materials shall be used for the embankment to cross river channels, and embankment shall be well compacted. Foundation treatment shall be done for the river crossings; failures of the existing dams have mainly taken place at the river crossings.*
- *Reservoir operation rules shall be prepared through an examination of water balance so as to make water available all the year round.*

5 THE PROPOSED PROJECT

5-1 Monduli Water Supply Project

5-1-1 Water Demand

The daily water demand in 2014 will amount to 1,397 cubic meters based on the population projected and water consumption level of 30 liters per capita per day for domestic use and the like.

Daily Water Demand (m³/day)

Item	Water Demand	Remarks
Domestic Water	1,046	34,854 persons
Schools	6	645 pupils
Hospitals	74	840 beds
Public Facilities	4	382 persons
Commercial Use	27	386 persons
Others	58	5 percent
Losses	182	15 percent
Total	1,397	

5-1-2 Water Sources

To meet the estimated water demand in 2014, development of new water resources with a capacity of 1,222 cubic meters is proposed by drilling boreholes in Engare Olmotoni area.

Proposed Water Sources (m³/day)

Water Source	Capacity	Remarks
Existing Sources		
- Kilimani spring	130	
- TMA pipeline	45	actual supply
New Sources		
- Boreholes	1,222	3 boreholes
Total	1,397	

As mentioned earlier, there are fewer potentialities of developing groundwater in the

Study Area. Alternative sources of water are springs in Mfereji village and groundwater in Engare Olmotoni area; however, according to the preliminary investigation, the surplus water of the spring is estimated at only 60 cubic meters a day, far less than the water demand. Therefore, it is proposed to construct boreholes in Engare Olmotoni area, north of the Arusha air field. The potential well yield is around 40 cubic meters per hour. Construction of three (3) boreholes is planned.

5-1-3 Proposed Facilities

The Project proposes to provide the following water resources facilities and conveyance pipelines with pumping stations:

1) Boreholes

- Wells : 3 locations
- Pumping equipment : 3 pumps
3 generators

2) Conveyance Pipelines

- Connection pipelines : 2 km, FRP pipe, ϕ 150 mm
- Pipelines : 23 km, Ductile pipe, ϕ 150 mm
- Pumping stations : 2 stations with a relay station
 - 2 pumps each
 - 1 generator each

5-1-4 Staged Construction Plan

The proposed Monduli Water Supply Project will begin with a detailed design in 1996 and provide three (3) boreholes and the conveyance pipelines with a length of 23 kilometers to connect the boreholes with the existing water tank in Monduli town. In view of increasing water demands toward the planning year of 2014, two boreholes will be drilled in 1997 and one borehole in 2005 in conformity with the increasing water demand.

Further consideration is given to installation of pipelines which need large amounts of capital investment in the initial stage of the project with lower water demand, thus the following two (2) alternative construction plans are selected: case 1 deals with installation of pipelines in 1997-1998, and case 2 deals with transportation of water by water tank trucks for five (5) years and then installation of conveyance pipelines in 2001-2002.

Two (2) cases are compared by means of Economic Internal Rate of Return (EIRR). As a result, the EIRR of case 1 turned out to be 9.9 percent, and case 2 indicated that the EIRR increased to 12.2 percent. Therefore, the Project proposes to implement the case 2 from

the viewpoint of national economy.

Two Alternative Cases

Particulars	Case 1	Case 2
Boreholes: 2 locations	in 1997	in 1997
: 1 location	in 2005	in 2005
Water Tank Truck: (4)	.	in 1997
Pipeline :23 km	in 1997-98	in 2001-02
Cost (Tsh Million)	3,369	3,814
EIRR (%)	9.9	12.2

5-2 Village Water Supply Project

Main sources of water for village water supplies is surface water. Preliminary water balance studies on a monthly basis were made in order to determine the reservoir capacities required for year-round water supplies for domestic and livestock uses. Parameters involved in the studies are inflow converted from minimum monthly rainfall with the return period of 10 years, evaporation losses from the reservoir surface, sedimentation in the reservoirs and water demand. Topographic conditions are based on the topographic maps with a scale of 1:50,000.

5-2-1 Dam Project

Rehabilitation of the following six (6) dams is proposed; they are not now in use due to embankment failures.

- Lossimingori village : Rasharahsa dam
- Meserani Bwawani Village : Meserani dam
- Makuyuni village : JKT No. 3 dam
- Mswakini village : Mswakini No.1 and No.2 dams

New construction of 28 small-scale dams with the combined storage capacities of 3.75 million cubic meters is proposed for village water supplies of 15 villages excluding villages of Arkatan, Meserani Bwawani and Oltukai. Dam heights range from four (4) meters to six (6) meters.

5-2-2 Groundwater Development Project

The project includes rehabilitation of two (2) existing boreholes and new construction of boreholes in Emairere village where groundwater resources are available, as given below:

- Makuyuni village : 1 location, 130 m³/day
replacement of 1 pump and 1 engine
replacement of GS pipe, ϕ 4", 4.1 km
construction of water tank, 91 m³
- Mswakini village : 2 locations, 2 x 7.5 m³/hour
replacement of 2 pumps and 2 engines
replacement of GS pipe, ϕ 3", 4.5 km
construction of 2 water tanks, 91 m³
- Emairere village : 2 locations, 10 (A)/hours each
installation of 2 pumps and 2 engines
installation of GS pipe, ϕ 3", 2.0 km
construction of 2 water tanks, 91 m³

5-3 Priority Project

Six (6) projects have been selected as priority projects to warrant early implementation; they are the Monduli Water Supply Project and five (5) Village Water Supply Projects.

1) Monduli Water Supply Project

The existing Monduli water supply system covers Monduli town, the development center of the District, with the distribution network and public taps. With provision of additional water resources and conveyance pipelines, quick returns from the project investment will be generated.

2) Village Water Supply Project

Among village water supply projects, the first priority will be given to groundwater development projects and second priority to dam projects for Moita Bwawani village and Oltukai village where there are no alternative sources of water.

Groundwater Development Project

- *Rehabilitation of Makuyuni village water supply project*
- *Rehabilitation of Mswakini village water supply project*
- *Construction of Emairere village water supply project*

Dam Project

- *Moita Bwawani village water supply project*
 - *construction of 3 dams with the combined storage of 1.17 million m³*
- *Oltukai village water supply project*
 - *rehabilitation of Oltukai dam with a storage capacity of 141,000 m³*

6 IMPLEMENTATION AND OPERATION OF THE PROJECT

6-1 Implementation Program

The Regional Water Department of Arusha will be the executing agency responsible for implementing the Monduli Water Supply Project with the assistance and cooperation of the Monduli District Water Department and the village governments concerned in their respective fields. The Monduli District Water Department will be responsible for implementing the Village Water Supply Projects.

The Monduli Water Supply Project will be implemented in two (2) stages as summarized below (Figure 1 and Table 1):

Stage 1: 1996 - detail design

1997 - construction of 2 boreholes

- procurement of 4 water tank trucks of 10 m³ each

1998 - commencement of water services by trucks

Stage 2: 2001 - commencement of conveyance pipelines works

2002 - completion of conveyance pipelines works

2003 - commencement of water services by pipelines

2005 - construction of 1 borehole

The Village Water Supply Projects will be started in 1996 and are due for completion in 2001 so as to begin water services in 2002 as envisaged in the national water policy.

6-2 Operation and Maintenance

In accordance with the provision of the national water policy, the Monduli Water Department will be responsible for looking after the Monduli Water Supply Project, the large water supply project, and the village government will be responsible for the security and protection of water supply points within their villages through establishment of the village water committees.

The proposed Village Water Supply Projects will be operated and maintained by the communities after the completion of project facilities through the establishment of the village water committees.

7 PROJECT COST

The construction works will be implemented on a contract basis under the supervision of the Arusha Regional Water Department for the Monduli Water Supply Project, and Monduli District Water Department for Village Water Supply Projects.

The construction costs include the costs for engineering services of detailed design and supervision of construction works, construction of engineering facilities, procurement of water tank trucks, and right-of-way. 10 percent of physical contingencies are added. Price escalation contingencies are calculated at rates of two (2) percent per year for the foreign currency components and 14.7 percent per year for the local currency components. Foreign exchange rates of US\$ 1.00 = Tsh 600 = Japanese Yen 101.25 are applied.

The construction costs amount to Tsh 4,320 million for the Monduli Water Supply Project and Tsh 7,791 million for Village Water Supply Projects, totaling Tsh 12,111 million as summarized as follows:

Total Project Costs			
Cost Items	-Unit: Tsh Million-		
	Monduli Project	Village Projects	Total
Right-of-Way	1.3	33.4	31.7
Construction	2,532.5	4,877.3	7,409.8
Water Tank Trucks	401.9	-	401.9
Engineering Services	529.0	730.2	1,259.2
Physical Contingencies	346.7	564.0	910.7
Base Cost	3,814.4	6,201.9	10,019.3
Price Contingencies	505.3	1,586.5	2,091.8
Total Cost	4,319.7	7,791.4	12,111.1

The operation and maintenance costs of the Monduli Water Supply Project cover the three (3) components: the existing intake facilities from the existing springs, pumping water diversion from TMA pipelines and water supplies from the proposed three (3) boreholes in Emairete Olmotoni area. Annual recurrent costs for operation and maintenance are; Tsh 2.6 million for the existing water intake and distribution facilities, Tsh 0.9 million for diversion from TMA pipelines, water supplies from the proposed boreholes, and Tsh 29.3 million for water transportation by four (4) water tank trucks.

8 PROJECT EVALUATION

8-1 Economic Evaluation

The contribution of the Monduli Water Supply Project to the national economy is evaluated in terms of the EIRR for the project lifespan of 20 years. The resultant EIRR is 12.2 percent, in which economic benefits are derived from the villagers' willingness to pay Tsh 5,000 a month per household of six family members. While the EIRR is not high as the social opportunity cost is around 15 to 20 percent, the project itself has great merit on humanitarian grounds. Water is indispensable for survival and without it, no social and economic development will be made feasible. Furthermore, provision of water is in accordance with the national water policy in 1991.

8-2 Financial Evaluation

The water charge is estimated at Tsh 350 per cubic meters of water, or Tsh 1,890 per household of six to recover the recurrent costs and replacement of pumps, generators and other equipment needed during the project life of 20 years. The water charge of Tsh 1,890 per household will place a 6.2 percent burden per household of monthly household income. The FIRR of net cash flow becomes 33.1 percent with a bill collection efficiency of 100 percent. The figure would be appropriate since the interest rate charged by city banks range between 29 and 30 percent.

Financial environment will be subject to change over time. Factors affecting financial conditions are revenue and cost. Water revenue collection efficiency of 100 percent cannot be maintained over time. Four (4) scenarios to test sensitivity of project finance are examined as follows:

Sensitivity Test

Base condition	: EIRR of 33.1 %
Water revenue 10 % down	: EIRR of 28.1 %
O&M cost 10% up	: EIRR of 28.6 %
2 year delay in construction	: EIRR of 32.9 %
Water revenue 20 % down	: EIRR of 22.7 %

RECOMMENDATIONS

1. *It is recommended that the proposed Monduli Water Supply Project and Village Water Supply Projects should be implemented as closely as possible to the proposed implementation schedule. The primary objective of the proposed project is designed to provide safe and clean water supply for the rural people, in accordance with the National Water Policy Directive, 1991.*

2. *The Monduli Water Supply Project should be recognized as urgent and one of the top priority rankings in terms of national policy objectives. The Project is formulated with the aim of solving the current inability to supply adequate water. Development of water sources is not only urgent but also crucially vital to the functioning of Monduli town, the development center of the District.*

The economic internal rate of return of 11.2 percent is not necessarily higher than the social opportunity cost in Tanzania. Nevertheless, the project should be interpreted as being of highest priority on humanitarian grounds. The project could be maintained by the beneficiaries after the completion of the construction works. Water tariff of 350 Tsh/m³, or Tsh 1,890 a month per household is proposed. This rate would satisfy financial self sustainability in covering O&M costs and some financial risk on one hand, and for water user groups in terms of affordability. Tsh 350/m³ or Tsh 1,890 a month would represent a 6.2 percent burden on household income.

3. *The water source capacities of the Monduli can be improved by securing groundwater in the area of Engare Olmotoni. Three (3) boreholes are proposed to meet the water demand in 2014 for the Monduli Water Supply Project. The implementation stages of the project are proposed from the viewpoint of national economy: the first stage is to provide two (2) boreholes and four water tank trucks in 1997, and the second stage is to construct water conveyance pipeline system in 2001 - 2002 and one (1) additional borehole in 2005.*

For successful implementation of the project, hydrogeological investigation of Engare Olmotoni area should be continued with the emphasis on evaluation of groundwater potential and an inventory survey of water rights.

4. *Water supplies for the villages have the problem of groundwater development. Therefore, construction of small traditional-type dams, has been proposed for the Village Water Supply Project. At present a number of small dams have been utilized*

in the villages. However, many of those dams dry up during the dry season, and several dams are not used. The preliminary study on reservoir operation indicates that there would be sufficient water to make the year round water supplies available for people and livestock should dams be properly operated and maintained.

Arusha Regional Development Directorate should be urged to planning of reservoir operation in due consideration of local hydrological conditions.

- 5. After completion of the Project, the village water committee will be in charge of its management and operation, and be legally, organizationally, managerially and financially as well as technically independent. This vision is consistent with the national water policy.*

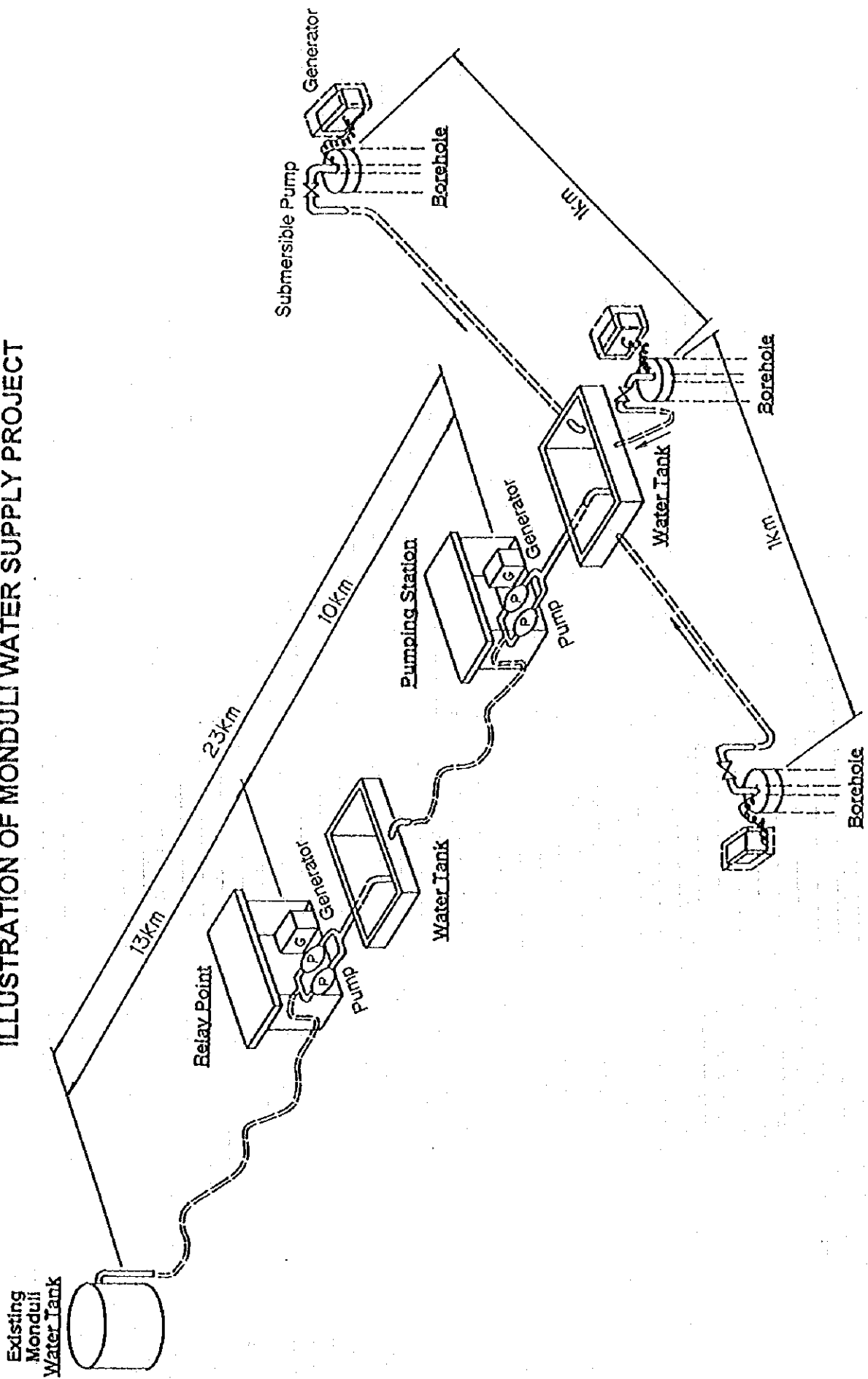
Arusha Regional Development Directorate together with the Regional Water Department and District Water Department should be encouraged to fully assist newly organized village water committees thus contributing to a successful operations in rural water supply.

Table 1 PROPOSED IMPLEMENTATION SCHEDULE

Project	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1. Monduli Water Supply project										
(1) Survey and Detail Design	█								█	
(2) Right-of-Way	█	█							█	
(3) Construction of Boreholes		█								
- Two Boreholes		█								
- One Borehole		█								
(4) Procurement of Four Water Trucks	█	█								
(5) Construction of Pipelines (23 km)					█	█				
(6) Supervision		█			█	█				
2. Village Water Supply Projects										
(1) 5 Priority Village Water Supply Projects										
- Makuyuni Village Project	█	█								
- Mswakuni Village Project	█	█								
- Oitukai Village Project	█	█								
- Emarete Village Project	█	█								
- Moita Bwawani Village Project	█	█								
(2) 13 Village Water Supply Projects										

Figure 1 ILLUSTRATION OF MONDULI WATER SUPPLY PROJECT

ILLUSTRATION OF MONDULI WATER SUPPLY PROJECT



JICA