No. 1

# BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE AFFECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA

JULY 1996



JAPAN INTERNATIONAL COOPERATION AGENCY
KOKUSAI KOGYO CO.,LTD.



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# PREFACE

In response to a request from the Government of the United Republic of Tanzania, the Government of Japan decided to conduct a basic design study on the project for improvement of water supply and medical services in refugee affected areas of Kagera region in the United Republic of Tanzania and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tanzania a study team from January 30 to March 29, 1996.

The team held discussions with the officials concerned of the Government of Tanzania, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Tanzania in order to discuss a draft basic design, and as this result, the present report was finalized.

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 teams.

July 1996

Kimio Fujita
President
Japan International Cooperation Agency

July, 1996

Letter of Transmittal

We are pleased to submit to you the basic design study report on the project for improvement of water supply and medical services in refugee affected areas of Kagera region in the United Republic of Tanzania.

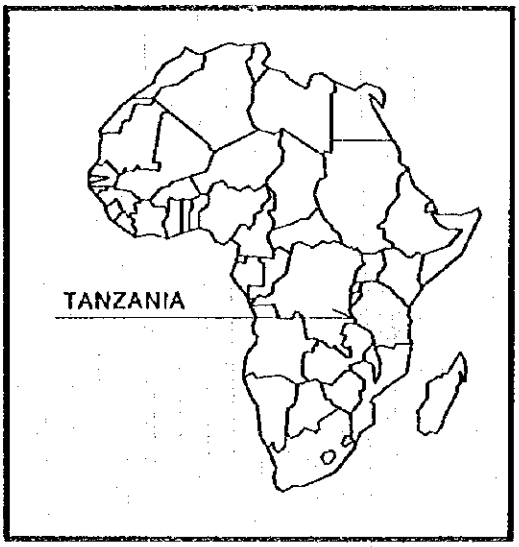
This study was conducted by Kokusai Kogyo Co., Ltd., under a contract to JICA, during the period from January 23 to August 9, 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tanzania and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

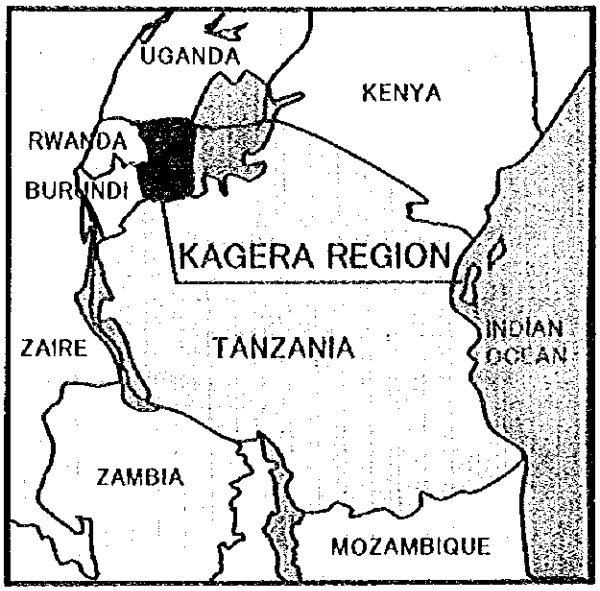
Finally, we hope that this report will contribute to further promotion of the project.

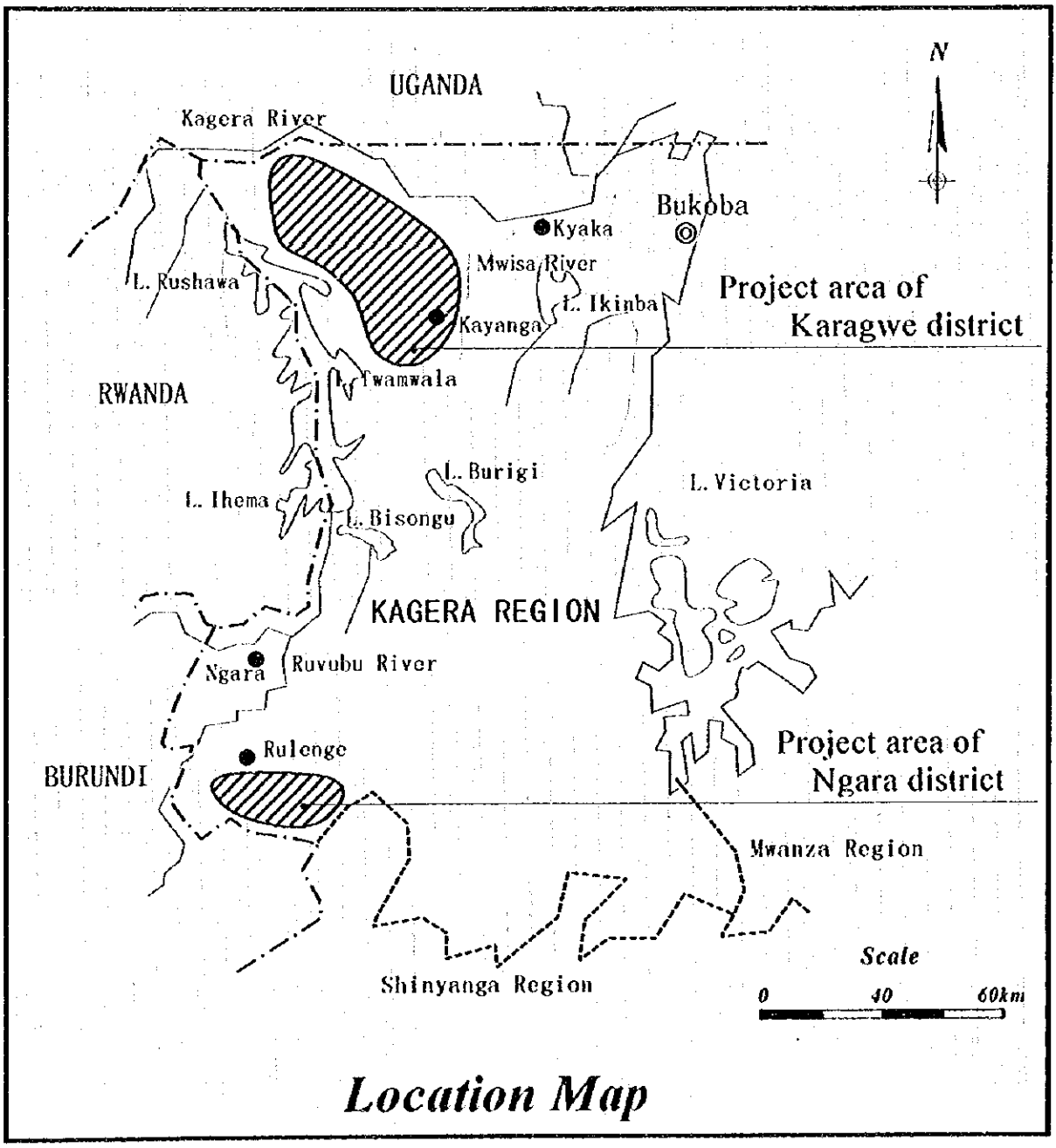
Very truly yours,

鎌田 彰

Akira Kamata
Project manager,
Basic design study team on
project for improvement of water supply
and medical services in refugee affected
areas of Kagera region in the United
Republic of Tanzania
Kokusai Kogyo Co., Ltd

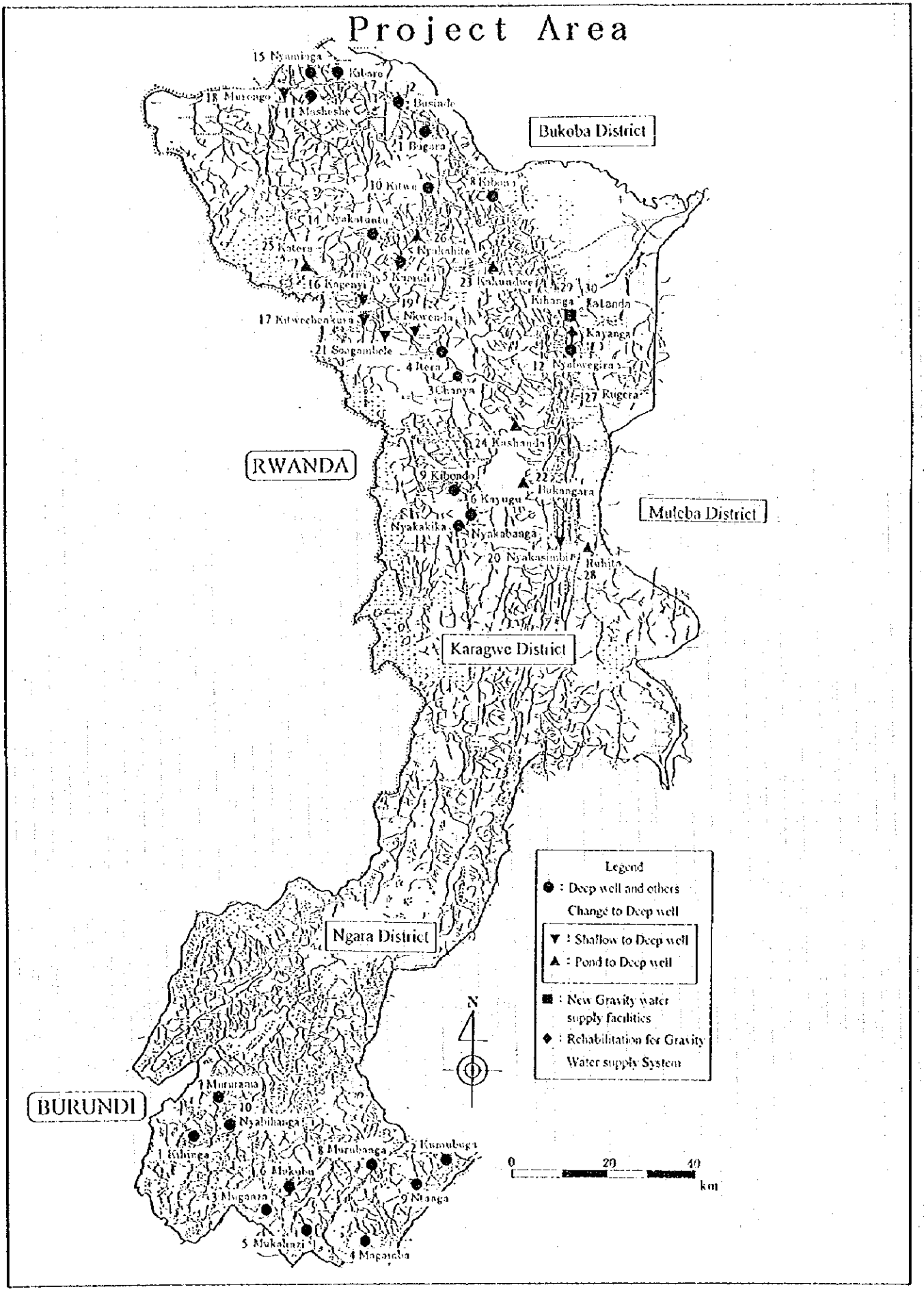


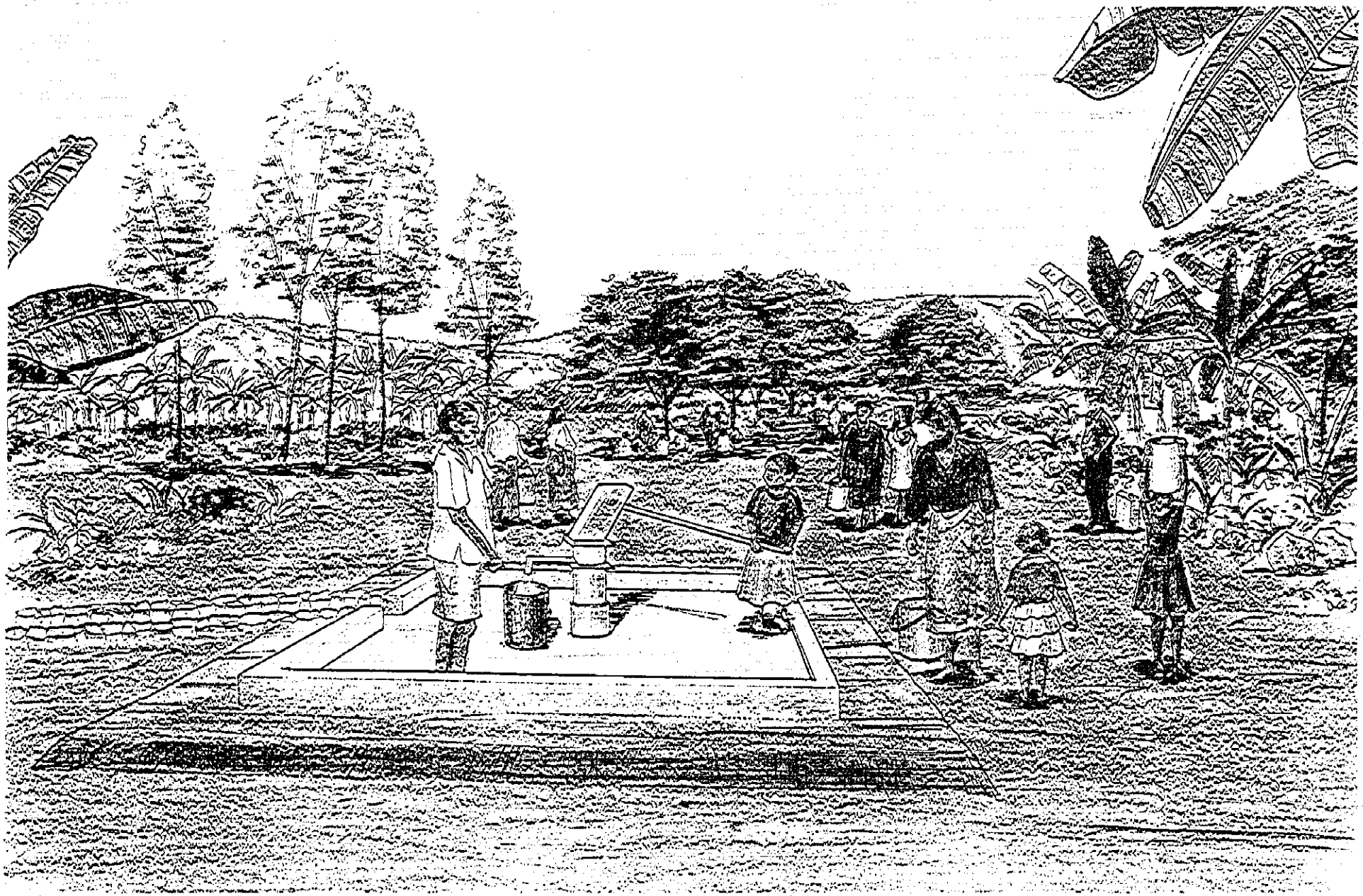



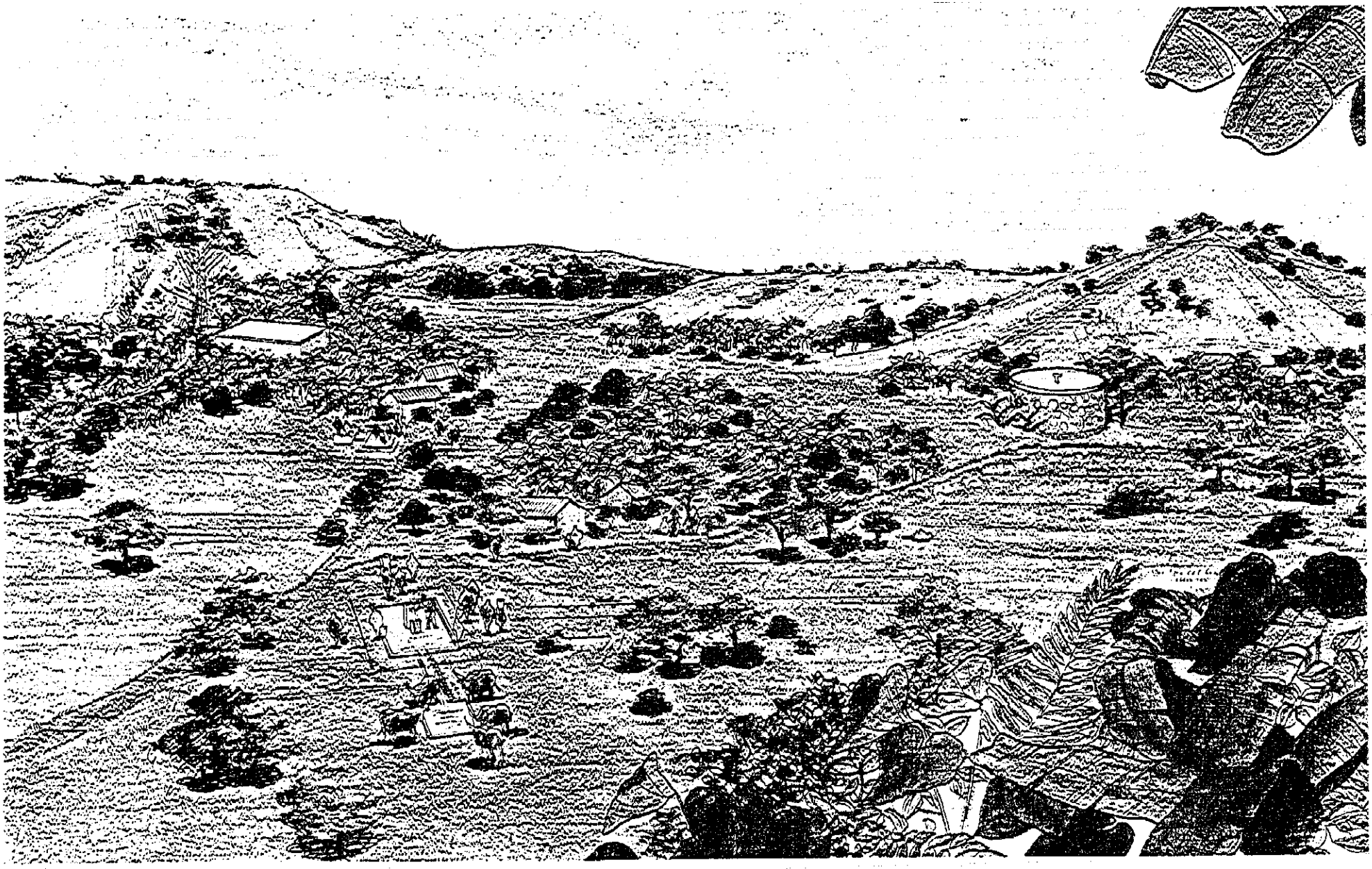

***Location Map***

# Project Area





PERSPECTIVE FOR DEEP WELL FACILITY



PERSPECTIVE FOR GRAVITY WATER SUPPLY FACILITY

## List of Abbreviations

| | |
|---|---|
| DWE | District Water Engineer |
| JICA | Japan International Cooperation Agency |
| MOW | Ministry of Water |
| PMO | Prime Minister's Office |
| RWE | Regional Water Engineer |
| TCRS | Tanganyika Christian Refugee Service |
| UNDP | United Nations Development Program |
| UNHCR | United Nations High Commissioner for Refugees |
| UNICEF | United Nations Children's Fund |

## SUMMARY

The United Republic of Tanzania is an agricultural country lying between the Indian Ocean to the east and the Central African Highlands to the west. It covers an area of 945,000 km² (2.5 times as large as Japan) and has a population of 25,160,000 (1991 estimate).

Tanzania was under a Socialist regime until 1985 when it implemented an Economic Reconstruction Plan (ERP Phase I from 1986-1989, Phase II from 1989-1992) to establish a free market economic system. A sluggish economic growth, however, due to inert agricultural production, decrease in international prices, and inflation, reduced the per capita GNP to US $110 (1990) and compelled the Government to adopt a curtailment policy.

Given these conditions, the Government decided to promote a 20 year Rural Water Supply Program (1971-1991) as an important aspect of rural development. In 1991, the Government also implemented a new plan to accelerate rural water supply development, in line with the National Water Policy. Nevertheless, the rural service ratio still remains at 46%, and the majority of the rural population still resorts to the traditional use of shallow dug wells, contaminated rivers and ponds for their domestic water needs. Consequently, these areas have a high incidence of water borne diseases.

The project area is located in the frontier of Tanzania that comprises the Ngara and Karagwe districts in the Kagera Region. It is more than 1,500 km from the city of Dar Es Salaam, which is the center of all political and economic activities in the country. The water supply conditions in the project area is underdeveloped.

The project area is bordered by Rwanda and Burundi to the west and Uganda to the north. The inter-tribal genocide in neighboring countries resulted in the huge influx of refugees to the project area. In 1994, the rate exceeded 600,000, thereby significantly affecting the infrastructure (land, water, food, roads, hospitals and schools) of the project area.

To cope with the needs of the refugees, shallow wells and deep wells were drilled in the refugee camps. The villages where these refugee camps are established have no such facilities -- a condition that has significantly affected the surrounding environment and intensified the dissatisfaction of the residents regarding biased public services.

Although organizations such as the UNHCR, UNICEF, and other non-governmental organizations have extended assistance for the construction and improvement of water supply facilities in these villages, their efforts have been insufficient. The adequate

treatment of numerous patients affected with water borne diseases has also been hampered by the absence of necessary medical facilities.

In consideration of the aforementioned conditions, UNDP and the Government of Tanzania held a donor conference to conclude the support policy to be implemented for the refugee affected areas. In accordance with this policy, the Government of Tanzania requested grant aid from the Government of Japan for the improvement of the water supply conditions and sanitary environment of these areas.

In response to the request, the Japan International Cooperation Agency (JICA) dispatched a Preliminary Study Team to the site for 30 days from October 8, 1995. The Preliminary Study Team held a meeting with the Prime Minister's Office and the Ministry of Water -- the executing agency of the project -- to discuss the details of the request and determine the extent of assistance to be carried out. Subsequently, the study team conducted field surveys in the area.

Considering the results of the field surveys, JICA dispatched the Basic Design Study team to the site for 60 days from January 30, 1996. This study team discussed the appropriateness of the implementation plan with the Government of Tanzania, conducted relevant technical studies, and data gathering and analysis.

After returning to Japan, the Basic Design Study Team formulated the basic design of the study after analyzing the various data and information obtained from Tanzania, including the results of the discussion with the counterpart agency. The details of the basic design are summarized in the Basic Design Summary Report, the contents of which were explained to the counterpart agency from May 27 to June 7, 1996.

The districts of Ngara and Karagwe, the project area, are situated in highlands elevated to about 1300 - 1800 meters. The villages to be covered by the project are located on the ridge. With the exclusion of Katanda for which the rehabilitation of gravity water supply facilities is requested, these villages rely on springs, shallow wells, and reservoir ponds for their water supply. This region is not blessed with abundant water reserves and water resources are often depleted in the dry season. Further, most of these water resources are contaminated by livestock and are extremely insanitary. However, hydrogeological and geophysical surveys indicate the possibility of exploiting groundwater reserves in the weathered zone and the fissures and cracks in quartzite, granite and phyllite rocks in the project area through deep well construction for the supply of stable and clean drinking water.

The expansion of medical services was also carried through the supply of medical equipment and deployment of personnel for rural development. Yet, the treatment of

various diseases in regional hospitals, public health centers and clinics is impeded by the constant shortage in medical supplies and equipment due to financial stringency and massive refugee influx.

The facilities requested in this project consist of the construction of deep wells (25 villages), shallow wells (6 villages), small dams (7 villages), and the construction and rehabilitation of gravity water supply facilities (1 village each). However, In consideration of the hydrogeological findings stating that groundwater from shallow geological strata is of poor quality and quantity, deep wells will be constructed instead of shallow wells. Deep wells will also replace the small dams requested for 7 villages due to the absence of suitable dam sites.

However, deep well construction would still be difficult in view of the accessibility of some villages for the transport of drilling machinery. Accordingly, the following will be carried out in these villages: ① installation of protection devices for existing springs, ② rehabilitation of collection ditches and existing wells, ③ stabilization of water quality and quantity, and ④ increase the volume of water supply.

On the other hand, the rehabilitation and construction of gravity water supply facilities will be carried out as requested as studies indicate the possibility of securing stable flow, and because such facilities can cover a wide service area and are easy to operate and maintain.

The equipment requested in this project consist of the drilling machineries for construction of deep wells, the equipment and materials required for the operation and maintenance program of the water facilities in the target villages and basic first aid medical instruments for clinics and public health centers in both districts.

The drilling machineries owned by the drilling unit of the Ministry of Water are found to be antiquated and significantly inoperative. Therefore, to enable the construction of large and deep wells, new machinery will be procured and training programs will be conducted to upgrade the technical capabilities of local drilling experts. Further, to help the Government of Tanzania promote rural water supply development after the conduct of this project, these machinery shall be easy to operate and maintain, and shall have easily obtainable spare parts.

The equipment and materials required for the operation and maintenance program are mainly for hand pump installation and repair, and training in the use of the equipment and facilities. Studies were carried out to determine the vehicles and tools that may be required for such occasions. The operation and maintenance of the water supply facilities to be constructed in this project will be the responsibility of the water committee

of each village. With these equipment and materials, the District Water Engineer's Office will also be able to supervise, guide, and assist the water committees in their operation and maintenance responsibilities.

The district of Karagwe has 1 hospital, a public health center, and 16 clinics, while Ngara has a public health center and 19 clinics. These areas shall be provided with basic first aid medical instruments and supplies. The medical instruments basically considered for this request were manually operated medical instruments. Medical instruments provided in the Expanded Immunization Program (EPI) established by UNICEF and other assistance by other donors shall not be included in the request.

The details of the request made by the Government of Tanzania and the outline of the plan based on the basic design study are as follows:

Facility Construction

| Item | Request | | Basic Design Outline | |
|---|---|---|---|---|
| A. Deep wells | Ngara District | | Ngara District | |
| | 10 villages | 70 wells | 10 villages | 40 wells |
| | Karagwe District | | Karagwe District | |
| | 15 villages | 133 wells | 13 villages | 44 wells |
| | Total | 207 wells | Total | 84 wells |
| B. Shallow wells | Karagwe District | | Change to deep wells | |
| | 6 villages | 55 wells | 6 villages | 26 wells |
| C. Small dams | Karagwe District | | Change to deep wells | |
| | 7 villages | 7 places | 6 villages | 20 wells |
| D. Rehabilitation of collection ditches | | | 1 village | 1 place |
| E. Installation of protection devices for existing spring | | | 25 villages | 36 places |
| F. Rehabilitation of existing wells | | | 2 villages | 2 places |
| G. Rehabilitation of gravity water supply system | Karagwe District Kihanga village | 1 place | Karagwe District Kihanga village | 1 place |
| H. Construction of gravity water supply system | Karagwe District Katanda village | 1 place | Karagwe District Katanda village | 1 place |

Equipment Procurement

| Item | Request | | Basic Design Outline | |
|---|---|---|---|---|
| A. Drilling rig & accessories (Supporting equipment materials) | Top drive type | 1 | Top drive type | 1 |
| | Standard accessories | 1 set | Standard accessories | 1 set |
| | Compressor | 1 | Compressor | 1 |
| | Large truck | 1 | | |
| | Medium size truck | 1 | Medium size truck with crane | 2 |
| | Water tank lorry | 1 | Water tank lorry | 1 |
| | Fuel tank truck | 1 | Fuel tank truck | 1 |
| | Pick-up truck | 3 | | |
| | Concrete mixer | 3 | | |
| | Electric logging equipment | 2 | Electric logging equipment | 1 |
| | Submersible motor pump | 2 | Submersible motor pump | 2 |
| | Welder | 1 | Welder | 1 |
| | Generator | 2 | Generator | 1 |
| | Bentonite | 1 set | Bentonite | 1 set |
| | CMC | 1 set | CMC etc. | 1 set |
| | Hand pump | 250 | Hand pump | 145 |
| | PVC casing | 3125 | PVC casing | 1712 |
| B. Maintenance & education | Screen | 1563 | Screen | 466 |
| | Well service car | 2 | Pick-up truck | 2 |
| | Motorcycles | 6 | Motorcycles | 4 |
| | Wireless communication system | 2 sets | Wireless communication system | 2 sets |
| | Water analysis kit | 2 sets | Water analysis kit | 2 sets |
| | | | Standard tools | 35 sets |
| | | | Computer | 1 set |
| C. Medical instruments | Ngara District | | Ngara District | |
| | 1 Public Health Center | 1 set | 1 Public Health Center | 1 set |
| | 19 Clinics | 19 sets | 19 Clinics | 19 sets |
| | Karagwe District | | Karagwe District | |
| | 1 Local Hospital | 1 set | 1 Local Hospital | 1 set |
| | 1 Public Health Center | 1 set | 1 Public Health Center | 1 set |
| | 18 Clinics | 18 sets | 16 Clinics | 16 sets |
| | Total | 40 sets | Total | 38 sets |

This project shall be carried out in two terms in consideration of: ① the time required for the procurement of well drilling equipment, ② the fact that the project will cover 2 districts, ③ the bad road conditions in these areas, and ④ the negative effects of the rainy season on the efficiency of the works.

The first project term shall consist of the implementation design and construction works, with the former taking an estimate of 4.5 months to complete and the latter a total of 15 months. Further, the procurement of equipment shall require a period of 5 months from the time the order is placed until the order is completely manufactured. The shipment, transportation and delivery of the equipment are estimated to take 2 months. The second term of the project shall require 3 months for implementation design and 8.5 months for construction works.

This project is implemented under the Japanese Grant Aid program. The estimated cost of the Government of Tanzania is 16.5 million Tsh.

The operation and maintenance of the water supply facilities to be constructed in this project shall be conducted by the water committees organized for each village. The Regional Water Engineer's Office and District Water Engineer's Office shall, under the supervision of the Consultant, train the water committees on equipment and facility operation and maintenance during the construction work period, in order to establish a sustainable operation and maintenance system.

Each water committee is estimated to require 70,200 shillings for the annual operation and maintenance of each facility. This amount shall be raised by collecting water fees from the villagers. The operation and maintenance expenses that will be incurred by the Kagera District Water Engineer's Office and Regional Water Engineer's Office shall be appropriated from their respective budgets.

This project shall be implemented in the frontier of Tanzania where the villages are without water supply facilities. Accordingly, this project intends to secure a stable and clean drinking water supply for the villagers and improve the environmental conditions of the area. This project shall directly fulfill the BHN of 65,535 beneficiaries. The implementation of this project is also expected to reduce the time spent by women and children for water fetching activities, thereby allowing them to help in agricultural work and/or participate in various community activities.

The influx of refugees from Rwanda and Burundi has affected the quantity and quality of the existing water resources of the project area. However, the completion of the construction of water supply facilities through this project will provide the area with a safe, clean, and stable drinking water supply. Consequently, the adverse impacts in the

project area will be markedly reduced and the disparity in public services, between the refugee camps and the refugee affected areas, rectified.

This project shall be executed according to the "Water Policy" of the Government of Tanzania. The "Water Policy" fundamentally refers to the establishment of a village water committee for the independent operation and maintenance of the water supply facilities. Accordingly, as a perfect model for the National Rural Water Supply Development Plan, the implementation of this project is expected to immensely influence the promotion of this National Development Plan in the future.

The implementation of the project shall also remarkably improve the sanitary conditions in the project area, and eventually reduce the incidence rate of water born diseases such as dysentery, helminthes, skin diseases, and eye diseases, in the area.

With these remarkable impacts, the implementation of the project under the Japanese Grant Aid Program would be extremely significant.

However, in order to make this project effective, the following should be carried out: ① appointment of villagers as water committee chairman, accountant, and caretaker, ② establishment of a water fund by the committee by collecting water fees from the villagers, and ③ the establishment of a sustainable operation and maintenance system. To firmly establish the activities of the water committees, the Regional and District Water Engineer's Offices should supervise their organization and operation, train, guide and instruct the Committees on facility operation and maintenance, and strive to upgrade the operation and maintenance skills of the villagers. Accordingly, the following should be carried out:

- thoroughly explain to the villagers their responsibilities in the operation and maintenance of the water facilities, as users of the facilities; gain the support of MOW, and the formulation of practical water committee rules.

- educate and train the residents on the proper facility operation methods, and maintenance and repair techniques during the construction period

- conduct regular training and supervision to ensure the sustainable operation and maintenance of constructed water facilities

- storage of spare parts in the Regional and District Water Engineer's Offices, and the conduct of seminars and training programs to upgrade the technical capabilities of the local engineers and mechanics

- explain to the medical centers the handling and storage specifications of the medical facilities upon delivery

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# CHAPTER 1

# BACKGROUND OF THE PROJECT

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The United Republic of Tanzania is an agricultural country lying between the Indian Ocean to the east and the Central African Highlands to the west. It covers an area of 945,000 km$^2$ (2.5 times as large as Japan) and has a population of 25,160,000 (1991 estimate).

The project area is located in the frontier of Tanzania that comprises the Karagwe and Ngara districts in the Kagera Region. It is more than 1,500 km from the city of Dar Es Salaam, which is the center of all political and economic activities in the country, and bordered by Rwanda and Burundi to the west and Uganda to the north.

The assassination of the Presidents of Rwanda and Burundi in April of 1994 triggered massive inter-tribal genocide in Rwanda. This tribal annihilation induced a large number of the people of the area to flee into the region of Tanzania for refuge. This massive refugee influx drastically transformed this comparatively tranquil region.

The number of refugees skyrocketed to more than 600,000 and seriously affected the infrastructure (land, water, food, hospitals and schools) of the project area. The influx immensely affected the existing water resources of the project area and further aggravated already critical water supply conditions .

Several shallow wells and deep wells are drilled in the refugee camps to urgently cope with the needs of the refugees. However, because the amount these wells produce is insufficient, tank lorries are used to distribute water collected from existing springs and reservoirs. Water born diseases are also prevalent in the project area as drainage runoff from the refugee camps seriously contaminate surface water resources.

Whereas several wells were constructed in the refugee camps, the villages where these camps are established have none -- a condition that has significantly affected the surrounding environment and intensified the dissatisfaction of the villagers regarding biased public services.

Although organizations such as the UNCHR, UNICEF, and other non-governmental organizations have extended assistance for the construction and improvement of water supply facilities in these villages, their efforts have been insufficient. The adequate treatment of numerous patients affected with water borne diseases has also been hampered by the absence of necessary medical facilities.

In consideration of the aforementioned conditions, UNDP and the Government of Tanzania held a donor conference to conclude the support policy to be implemented for

the refugee affected areas. In accordance with this policy, the Government of Tanzania requested grant aid from the Government of Japan for the improvement of the water supply conditions and sanitary environment of these areas.

This project aims to improve the water supply and environmental conditions of the villages of Ngara and Karagwe inhabited by refugees from Rwanda and Burundi, through the construction and procurement of water supply facilities and equipment. Simultaneously, the project also aims to rectify the disparity in the level of public services provided to the refugee camps and the refugee affected areas.

# CHPTER 2

# CONTENTS OF THE PROJECT

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## 2-1 Objectives of the Project

This project is intended to provide for basic human needs and to improve the resident's standard of living by supplying potable water to the villages, 10 villages in Ngara district and 29 villages in Karagwe district in Kagera region, located along the north-western border of Tanzania which is currently accepting refugees from Rwanda and Burundi. It also aims to establish a base that shall promote sustainable development by successfully creating a healthy and sanitary environment.

This project is implemented as a part of the National Water Policy . The Water Policy aims to provide 20 liters of drinking water per capita per day nationwide by the year 2002. It also aims to strengthen the operation and maintenance sector of the water supply system. By establishing a proper operation and maintenance system through its implementation, this project shall therefore serve as a model for future village water supply projects.

Since the project area is accepting refugees from neighboring countries, various international organizations, such as UNHCR, UNICEF, and non-governmental organizations, are giving assistance in the water supply sector. Accordingly, this project must be implemented in harmony with other water supply plans and must have a good impact on the districts.

## 2-2 Basic Concept of the Project

### 2-2-1 Justification of the Project

As an important aspect of rural development, the Government of Tanzania promoted a 20 year Rural Water Supply Program for the past two decades (1971-1991). Notwithstanding the implementation of a new plan in 1991, in line with the National Water Policy to accelerate rural water supply development, the service ratio still remains at 46%. Hence, the majority of the rural population traditionally resort to the use of shallow dug wells, and contaminated rivers and ponds for their domestic water needs.

The project area, which consists of the Ngara and Karagwe districts in the Kagera region, is located in the border of Tanzania. The water supply condition in the project area is unfavorable. Despite the assistance extended by the UNICEF in 1994 for the development of water supply systems in Rulenge, south of the Ngara district, there is still a shortage in facilities necessary for the supply of clean and sufficient volume of

drinking water. Moreover, the influx of refugees from Rwanda and Burundi since 1994 has further deteriorated conditions.

Accordingly this project intends to mainly construct deep wells and supply equipment and materials for deep well drilling, operation and maintenance, and medical instruments to improve water supply conditions, public health and sanitation, and the residents' standard of living. Finally, the project shall contribute to the sustainable development of the community through the improvement of health and sanitary environments.

### 2-2-2 Study of the Request

The Government of Tanzania requested the implementation of this project in August 1995. Discussions held between the Tanzanian counterparts and the Preliminary Study Team dispatched by JICA from October to November 1995, resulted in the modification of the original request. After conducting discussions with the Basic Design Study Team, the Government of Tanzania requested the following (refer to the Minutes of Discussions):

A. Construction of Water Supply Systems

| | | | |
|---|---|---|---|
| 1) | Deep well with hand pump | Ngara district | 10 villages |
| | | Karagwe district | 15 villages |
| 2) | Shallow well with hand pump | Karagwe district | 6 villages |
| 3) | Small dam | Karagwe district | 7 villages |
| 4) | Gravity water supply facilities (New) | Katanda village | |
| 5) | Gravity water supply facilities (Rehabilitation) | Kihanga village | |

B. Equipment and Materials

| | | |
|---|---|---|
| 1) | Drilling rig with accessories and supporting equipment | 1 set |
| 2) | Equipment for maintenance and education | 1 set |
| 3) | Medical instruments | 40 sets |

Table 2.1 shows the villages in the provinces of Ngara and Karagwe to be covered by this project, and their respective population. Table 2.4 shows the details of the requested equipment and materials.

The contents of the request shall be examined based on the data and information obtained during the field survey.

(1) Deep well

A. Drilling site and number of wells

According to the hydrogeological and geophysical surveys, exploitable groundwater exists in the weathered zone, and the fissures and cracks in quartzite, granite and phyllite, which are widely distributed in the project area. However, some of the drilling sites selected based on the hydrogeological survey are inaccessible due to the absence of roads and steep terrain. The inaccessibility of the candidate drilling site is a major constraint to be considered in the implementation of this project.

4 to 8 candidate drilling sites were selected in each village, considering rock lithology, distribution of surface deposit, stream, spring, existing well and road conditions. The feasible drilling sites were determined by evaluating existing water resources, groundwater potential and accessibility of the candidate sites.

(i) Groundwater potential

The factors that determine groundwater potential are terrain, lithology of rock, thickness of surface deposit, groundwater level, existence of the fracture zone, and catchment area size. Each factor was ranked according to the following evaluation:

A: 3 points B: 2 points
C: 1 point D: 0

Groundwater potential was evaluated as follows:

rank A: Promising 15-18 points
rank B: High 12-14 points
rank C: Medium 9-11 points
rank D: Low 6- 8 points

(ii) Accessibility (Mobilization)

The distance from the site to the nearby road was measured, although the sites requiring a bridge, are located at steep slopes and extremely far from the road were excluded.

rank A: Nearby road, ease in mobilisation
rank B: less than 200m from road (felling, land readjustment)
rank C: more than 200 m from road ( do )
rank D: more than 500 m from road ( do )

(iii) Evaluation

The following table was used for the evaluation of the candidate drilling sites. "a" and "b" were evaluated as feasible drilling sites for this project.

| Groundwater Potential / Access | A | B | C | D |
|---|---|---|---|---|
| A | a | a | b | c |
| B | a | a | b | c |
| C | c | c | c | d |
| D | c | c | d | d |

The results of the evaluation are shown in Table 2.2. There are 44 drilling sites in Karagwe district (15 villages), of which 35 are categorized under "a" and 9 under "b". Two of the 15 villages in this district (Kibona and Nyabwegira) have no feasible drilling sites. In the district of Ngara, there are 40 feasible wells, of which 32 and 8 were categorized under "a" and "b", respectively. Table 2.3 shows the feasible drilling sites in each village.

Almost all existing water resources are evaluated as urgent in terms of quantity and quality.

Two villages in the district of Karagwe were considered areas geologically difficult for deep well drilling. As an alternative, plans to protect existing springs, develop new springs, and rehabilitate existing wells should be made.

B. Depth and structure of deep wells

The depth of the deep well shall be designed in consideration of the following:

(i) water level of springs, existing wells and lakes, including their hydraulic gradients;
(ii) tapping water reserves in fissures of fresh rocks by drilling 20 to 30m from the bottom of weathered zones; the thickness of the weathered zone shall be estimated by conducting electrical prospecting.

The depth of the wells to be constructed at each site was estimated from the above considerations and is presented in Table 2.3. The standard deep well shall be 5 inches in diameter, gravel packed, and with screen openings of more than 3%.

(2) Changing shallow wells to deep wells

A policy of the basic design study was to construct deep wells instead of shallow wells and small dams if construction of the latter is judged difficult or unsuitable.

The requested shallow well shall be drilled up to 5 to 10m deep and lined with concrete ring and slab for protection. They shall basically be located at the valley swamps. Most of the existing shallow wells are dug wells without protection rings. The water quality of these wells generally shows high iron contents, turbidity, and smells odd possibly due to surface deposits and the surrounding vegetation. Further, the quality of the groundwater used in these areas does not meet the criteria for drinking water.

Groundwater level declines and often dries up in the dry season. On the other hand, the hydrogeological survey states that deep well construction is possible in the villages where shallow well construction was requested. Therefore, the construction of deep wells instead of shallow wells in 6 of the villages in Karagwe District would be appropriate.

Based on the groundwater potential and accessibility assessments, there are 26 feasible deep well drilling sites in the 6 villages intended for shallow well construction ( a: 25, b: 1, Refer to Table 2.2).

## Table 2.1 Village Population and Facilities Requested

| District | No. | Village | Population | Facility |
|---|---|---|---|---|
| Ngara | 1 | Kihinga | 3,477 | Deep well |
| | 2 | kumbungu | 1,215 | do |
| | 3 | Magamba | 1,978 | do |
| | 4 | Muganza | 2,527 | do |
| | 5 | Mukalinzi | 2,331 | do |
| | 6 | Mukubu | 2,394 | do |
| | 7 | Mululama | 3,188 | do |
| | 8 | Murubanga | 1,514 | do |
| | 9 | Ntanga | 1,531 | do |
| | 10 | Nyabihanga | 1,532 | do |
| | Sub-total | | 21,687 | |
| Karagwe | 1 | Bugara | 2,758 | Deep well |
| | 2 | Businde | 4,200 | do |
| | 3 | Chanya | 1,800 | do |
| | 4 | Itera | 2,900 | do |
| | 5 | Kamuli | 1,918 | do |
| | 6 | Kayugu | 2,079 | do |
| | 7 | Kibare | 5,400 | do |
| | 8 | Kibona | 4,100 | do |
| | 9 | Kibondo | 1,990 | do |
| | 10 | Kitwe | 1,640 | do |
| | 11 | Masheshe | 2,760 | do |
| | 12 | Nyabwegira | 3,200 | do |
| | 13 | Nyakabanga | 3,000 | do |
| | 14 | Nyakatuntu | 4,200 | do |
| | 15 | Nyamiaga | 4,140 | do |
| | Sub-total | | 46,085 | |
| | 16 | Kagenyi | 3,300 | Shallow well |
| | 17 | Kitwechenkura | 3,900 | do |
| | 18 | Murongo | 1,880 | do |
| | 19 | Nkwenda | 5,300 | do |
| | 20 | Nyakasimbi | 2,205 | do |
| | 21 | Songambele | 2,400 | do |
| | Sub-total | | 18,985 | |
| | 22 | Bukangara | 3,320 | Small dam |
| | 23 | Kahundwe | 2,216 | do |
| | 24 | Kashanda | 960 | do |
| | 25 | Katera | 1,020 | do |
| | 26 | Nyakahite | 2,100 | do |
| | 27 | Rugera | 3,090 | do |
| | 28 | Ruhita | 1,400 | do |
| | Sub-total | | 14,106 | |
| | 29 | Kihanga | 1,914 | Rehabilitation |
| | 30 | Katanda | 2,024 | Construction |
| | Sub-total | | 3,938 | |
| | Total | | 104,801 | |

## Table 2.2 Evaluation of Candidate Drilling Sites

| District | No. | Village | Population | Request | Number* | Rank A | Rank B | Rank C |
|---|---|---|---|---|---|---|---|---|
| Ngara | 1 | Kihinga | 3,477 | Deep well | 10 | 5 | 0 | 5 |
| | 2 | kumbungu | 1,215 | do | 9 | 0 | 1 | 8 |
| | 3 | Magamba | 1,978 | do | 6 | 2 | 2 | 2 |
| | 4 | Muganza | 2,527 | do | 8 | 6 | 0 | 2 |
| | 5 | Mukalinzi | 2,331 | do | 6 | 0 | 1 | 5 |
| | 6 | Mukubu | 2,394 | do | 10 | 3 | 0 | 7 |
| | 7 | Mululama | 3,188 | do | 9 | 6 | 0 | 3 |
| | 8 | Murubanga | 1,514 | do | 7 | 3 | 3 | 1 |
| | 9 | Ntanga | 1,531 | do | 7 | 3 | 1 | 3 |
| | 10 | Nyabihanga | 1,532 | do | 6 | 4 | 0 | 2 |
| | Sub-total | | 21,687 | | 78 | 32 | 8 | 38 |
| Karagwe | 1 | Bugara | 2,758 | Deep well | 7 | 2 | 2 | 3 |
| | 2 | Businde | 4,200 | do | 7 | 2 | 2 | 3 |
| | 3 | Chanya | 1,800 | do | 7 | 1 | 0 | 6 |
| | 4 | Itera | 2,900 | do | 8 | 1 | 0 | 7 |
| | 5 | Kamuli | 1,918 | do | 5 | 2 | 1 | 2 |
| | 6 | Kayugu | 2,079 | do | 6 | 6 | 0 | 0 |
| | 7 | Kibare | 5,400 | do | 4 | 2 | 0 | 2 |
| | 8 | Kibona | 4,100 | do | 7 | 0 | 0 | 7 |
| | 9 | Kibondo | 1,990 | do | 5 | 4 | 0 | 1 |
| | 10 | Kitwe | 1,640 | do | 6 | 3 | 2 | 1 |
| | 11 | Masheshe | 2,760 | do | 6 | 2 | 1 | 3 |
| | 12 | Nyabwegira | 3,200 | do | 8 | 0 | 0 | 8 |
| | 13 | Nyakabanga | 3,000 | do | 7 | 5 | 0 | 2 |
| | 14 | Nyakatuntu | 4,200 | do | 6 | 1 | 1 | 4 |
| | 15 | Nyamiaga | 4,140 | do | 8 | 4 | 0 | 4 |
| | Sub-total | | 46,085 | | 97 | 35 | 9 | 53 |
| | 16 | Kagenyi | 3,300 | Shallow well | 4 | 4 | 0 | 0 |
| | 17 | Kitwechenkura | 3,900 | do | 5 | 4 | 0 | 1 |
| | 18 | Murongo | 1,880 | do | 5 | 4 | 0 | 1 |
| | 19 | Nkwenda | 5,300 | do | 6 | 6 | 0 | 0 |
| | 20 | Nyakasimbi | 2,205 | do | 6 | 2 | 1 | 3 |
| | 21 | Songambele | 2,400 | do | 5 | 5 | 0 | 0 |
| | Sub-total | | 18,985 | | 31 | 25 | 1 | 5 |

*Number of total candidate drilling sites selected in the field survey

## Table 2.3 Evaluation of Drilling Sites (1)

| District | Village | Population June/95 | Existing Source: Quality | Existing Source: Quantity | Existing Source: Distance | Existing Source: Access | Drilling Point No. | Groundwater Potential: Terrain | Rank | Geology | Rank | Surface | Rank | G.W. m | Rank | Fracture | Rank | C. Area Km² | Rank | Rank | Access (m) | Rank | Rank a,b,c,d | Depth (m) Surface | Depth (m) Rock |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ngara | Mukalinzi | 2,580 | | | | | 1 | Rd, V | A | Phl, Qtz | B | Cl | B | 8 | A | Vague | B | 0.5 | B | 14B | 50 | A | a | 20 | 20 |
| | | | | | | | 2 | Rd, V | A | Phl, Qtz | B | Cl | B | 15 | B | Vague | B | 0.12 | B | 13B | 400 | D | c | 25 | 20 |
| | | | | | 150m | | 3 | Rd, V | A | Phl | C | Cl | B | 10 | A | Vague | B | 1.2 | A | 14B | 100 | D | c | 25 | 20 |
| | | | | | \| | | 4 | Rd, V | A | Qtz | B | Cl | A | 8 | A | Vague | B | 0.3 | B | 15A | 20 | A | a | 30 | 10 |
| | | | | | 2,500m | | 5 | Rd | B | Phl, Qtz | B | Sg, Cl | A | 15 | B | Vague | B | 0.2 | B | 13B | 100 | B | a | 35 | 25 |
| | | | | | | | 6 | Rd | B | Phl, Qtz | B | Sg, Cl | A | 12 | B | Vague | B | 0.24 | B | 13B | 200 | B | a | 20 | 30 |
| | | | | | | | 7 | Rd | B | Phl, Qtz | B | Cl | B | 20 | B | Vague | B | 0.11 | B | 12B | 450 | C | b | 20 | 20 |
| | | | | | Max | | 8 | Rd, V | A | Phl, Qtz | B | Sg, Cl | B | 7 | A | Clear | A | 0.13 | B | 15A | 1,000 | D | c | 30 | 10 |
| | | | | | 1,000m | | 9 | Rd, V | A | Phl, Qtz | B | Sg, Cl | A | 8 | A | Vague | B | 0.6 | B | 15A | 1,300 | D | c | 30 | 10 |
| | | | B-C | B-C | C | C | 10 | Rd, V | A | Phl, Qtz | B | Cl | B | 8 | A | Clear | A | 0.5 | B | 15A | 200 | B | a | 20 | 20 |
| | Mukubu | 3,360 | | | | | 1 | Rd, V | A | Phl | C | Sg, Cl | C | 6 | A | no | C | 0.2 | B | 11C | ③+1,200 | D | d | 10 | 20 |
| | | | | | | | 2 | Rd, V | A | Phl | C | Sg, Cl | B | 5 | A | Vague | B | 1.1 | A | 14B | ②+ 500 | D | c | 20 | 20 |
| | | | | | 150m | | 3 | Rd | B | Phl | C | Cl | B | 8 | A | Clear | A | 0.12 | B | 13B | 1,200 | D | c | 15 | 20 |
| | | | | | \| | | 4 | Rd, V | A | Phl, Qtz | B | Sg, Cl | B | 8 | A | Clear | A | 1.4 | A | 16A | ③+1,000 | D | c | 15 | 20 |
| | | | | | 1,500m | | 5 | Rd, V | A | Phl, Qtz | B | Sg, Cl | B | 10 | B | Clear | A | 1.2 | A | 15A | ④+ 500 | D | c | 15 | 20 |
| | | | | | | | 6 | Rd, V | A | Phl, Qtz | B | Sg, Cl | B | 5 | A | Vague | B | 0.2 | B | 14B | ⑦+ 200 | D | c | 20 | 20 |
| | | | | | | | 7 | Rd, V | A | Phl, Qtz | B | Sg, Cl | B | 10 | B | Vague | B | 0.11 | B | 13B | ③+2,200 | D | c | 15 | 20 |
| | | | | | | B | 8 | Rd, V | A | Phl, Qtz | B | Sg, Cl | B | 5 | A | no | C | 0.3 | B | 13B | ⑦+ 350 | D | c | 15 | 20 |
| | | | | | 500m | \| | 9 | Rd, V | A | Phl | C | Sg, Cl | C | 40 | C | Vague | B | 0.14 | B | 10C | 100 | B | b | 10 | 60 |
| | | | A-B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Mururama | 3,063 | | | | | 1 | V | A | Phl, Qtz | B | Sg, Cl | B | 30 | C | no | C | 0.3 | B | 11C | 150 | B | b | 10 | 50 |
| | | | | | | | 2 | Rd, V | B | Qtz | B | Sg, Cl | B | 40 | C | no | C | 0.2 | B | 10C | 100 | B | b | 15 | 50 |
| | | | | | 300m | | 3 | V | A | Qtz | B | Sg, Cl | B | 5 | A | Clear | A | 0.2 | B | 15A | 50 | A | a | 15 | 30 |
| | | | | | \| | | 4 | Rd | B | Qtz | B | Sg, Cl | B | 25 | B | Clear | A | 0.06 | C | 12B | 250 | C | b | 10 | 50 |
| | | | | | 1,000m | | 5 | Rd | B | Qtz | B | Sg, Cl | B | 30 | C | Clear | A | 0.12 | B | 12B | 600 | D | c | 15 | 50 |
| | | | | | | | 6 | Rd, V | A | Qtz | B | Sg | B | 20 | B | Clear | A | 0.3 | B | 14B | 200 | B | a | 20 | 50 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| | | | | | | B | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | 600m | \| | 9 | | | | | | | | | | | | | | | | | | |
| | | | A-B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Murubanga | 2,109 | | | | | 1 | Rd, V | A | Phl, Qtz | B | Cl | B | 8 | A | Clear | A | 0.15 | B | 15A | 100 | A | a | 20 | 30 |
| | | | | | | | 2 | Rd | B | Phl, Qtz | B | Cl | B | 12 | B | Vague | B | 0.16 | B | 12B | 150 | B | a | 20 | 30 |
| | | | | | 400m | | 3 | V | A | Phl, Qtz | B | Cl | B | 5 | A | Clear | A | 2+ | A | 16A | 50 | A | a | 15 | 20 |
| | | | | | \| | | 4 | Rd | B | Phl, Qtz | B | Cl | B | 8 | A | Vague | B | 0.18 | B | 13B | 150 | B | a | 20 | 20 |
| | | | | | 1,500m | | 5 | V | A | Phl, Qtz | B | Cl | B | 5 | A | Clear | A | 2+ | A | 16A | 200 | B | a | 15 | 20 |
| | | | | | | | 6 | V | A | Phl, Qtz | B | Cl | A | 7 | A | Vague | B | 0.2 | B | 15A | 1,000 | D | c | 30 | 20 |
| | | | | | | | 7 | V | A | Phl, Qtz | B | Sg, Cl | B | 10 | A | Clear | A | 1.5+ | A | 16A | 2,600 | D | c | 20 | 30 |
| | | | | | | | 8 | V | A | Phl, Qtz | B | Cl | A | 5 | A | Vague | B | 2+ | A | 16A | 100 | A | a | 30 | 20 |
| | | | | | 700m | | 9 | | | | | | | | | | | | | | | | | | |
| | | | C | B | C | C | 10 | | | | | | | | | | | | | | | | | | |

Legend: Rd = River deposit; Dt = Talus deposit; V = Valley; Ld = Lake deposit; Lat = Laterite; S = Slope; Qtz = Quartzite; Phl = Phyllite; R = Ridge; Dol = Dolerite; Gr = Granite; Sg = Sand and Gravel; Cl = Clay; Shist = Sh

## Table 2.3 Evaluation of Drilling Sites (2)

| District | Village | Population June/95 | Existing Source | | | | Drilling Point No. | Groundwater Potential | | | | | | | | | | | | Access (m) | | Rank a,b,c,d | Depth (m) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quality | Quantity | Distance | Access | | Terrain | Rank | Geology | Rank | Surface | Rank | G.W. m | Rank | Fracture | Rank | C. Area $km^2$ | Rank | Rank | | | Surface | Rock |
| Ngara | Kihinga | 3,768 | | | | | 1 | Rd | B | Qtz | B | Cl | B | 15 | B | Vague | B | 0.15 | B | 12B | 300 | C | b | 20 | 40 |
| | | | | | | | 2 | Rd | B | Qtz | B | Sg, Cl | B | 17 | B | Vague | B | 0.08 | C | 11C | 200 | B | b | 15 | 50 |
| | | | | | 150m | | 3 | V | A | Gr | A | Cl | B | 8 | A | Vague | B | 1.0+ | A | 16A | 300 | C | b | 15 | 30 |
| | | | | | \| | | 4 | V | A | Gr | A | Cl | A | 15 | B | Clear | A | 0.08 | C | 15A | 900 | D | c | 20 | 30 |
| | | | | | 1,000m | | 5 | V | A | Gr | A | Cl | B | 12 | B | Vague | B | 0.08 | C | 13B | 400 | C | b | 10 | 40 |
| | | | | | | | 6 | Rd | B | Gr | A | Sg, Cl | C | 25 | B | Clear | A | 0.02 | C | 12B | 300 | C | b | 10 | 60 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| | | | | | | B | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | 600m | \| | 9 | | | | | | | | | | | | | | | | | | |
| | | | A-B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Kumubuga | 2,045 | | | | | 1 | Rd | B | Sh, Gr | A | Cl | B | 20 | B | Vague | B | 0.03 | C | 12B | 250 | C | b | 20 | 30 |
| | | | | | | | 2 | V | A | Sh, Gr | A | Cl | B | 15 | B | Clear | A | 0.5 | B | 15A | 300 | C | b | 15 | 30 |
| | | | | | 200m | | 3 | V | A | Sh, Gr | A | Cl | B | 5 | A | no | C | 1.1+ | A | 15A | 50 | A | a | 20 | 20 |
| | | | | | \| | | 4 | V | A | Sh, Gr | A | Cl | A | 10 | A | Vague | B | 1+ | A | 17A | 100 | A | a | 30 | 20 |
| | | | | | 3,500m | | 5 | V | A | Sh, Gr | A | Cl | A | 8 | A | Vague | B | 1+ | A | 17A | 50 | A | a | 30 | 20 |
| | | | | | | | 6 | V | A | Sh, Gr | A | Cl | A | 8 | A | no | C | 1+ | A | 16A | 1,500 | D | c | 30 | 20 |
| | | | | | | | 7 | V | A | Sh, Gr | A | Cl | B | 10 | A | no | C | 0.7 | B | 14B | 800 | D | c | 15 | 30 |
| | | | | | | | 8 | Rd | B | Sh, Gr | A | Cl | B | 20 | B | Clear | A | 0.2 | B | 14B | 2,000 | D | c | 20 | 20 |
| | | | | | 1,500m | | 9 | Rd, V | A | Sh, Gr | A | Cl | B | 8 | A | no | C | 1+ | A | 16A | 300 | C | b | 15 | 30 |
| | | | C | B-C | C | C | 10 | Rd | B | Sh, Gr | A | Cl | A | 15 | B | Clear | A | 0.24 | B | 15A | 4,500 | D | c | 20 | 20 |
| | Magamba | 2,885 | | | | | 1 | V | A | Sh, Gr | A | Cl | B | 10 | B | no | C | 0.3 | B | 13B | 30 | A | a | 20 | 30 |
| | | | | | | | 2 | Rd | B | Sh, Gr | A | Cl | B | 15 | B | no | C | 1+ | A | 13B | 50 | A | a | 15 | 30 |
| | | | | | 200m | | 3 | V | A | Sh, Gr | A | Sg, Cl | B | 12 | B | no | C | 0.4 | B | 13B | 100 | A | a | 20 | 20 |
| | | | | | \| | | 4 | Rd | B | Sh, Gr | A | Sg, Cl | C | 30 | C | Clear | A | 0.12 | B | 12B | 100 | A | a | 10 | 50 |
| | | | | | 4,500m | | 5 | Rd, V | B | Sh, Gr | A | Sg, Cl | B | 30 | B | Vague | B | 0.12 | B | 13B | 50 | D | c | 15 | 40 |
| | | | | | | | 6 | V | A | Sh, Gr | A | Cl | B | 10 | A | Vague | B | 0.8 | B | 15A | 350 | C | b | 20 | 20 |
| | | | | | | | 7 | V | A | Sh, Gr | A | Sg, Cl | B | 25 | B | Vague | B | 0.18 | B | 14B | 900 | D | c | 10 | 40 |
| | | | | | | | 8 | Rd, V | B | Sh, Gr | A | Sg, Cl | B | 15 | B | Clear | A | 0.1 | C | 13B | 50 | A | a | 15 | 40 |
| | | | | | 1,500m | | 9 | V | A | Sh, Gr | A | Sg, Cl | B | 10 | A | Vague | B | 0.3 | B | 15A | 30 | A | a | 10 | 30 |
| | | | C | B-C | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Muganza | 3,666 | | | | | 1 | V | A | Phl | C | Cl | C | 5 | A | Vague | B | 1+ | A | 13B | 25 | A | a | 10 | 40 |
| | | | | | | | 2 | V | A | Phl | C | Cl | B | 10 | A | Vague | B | 1+ | A | 14B | 250 | B | a | 10 | 40 |
| | | | | | 200m | | 3 | V | A | Phl | C | Sg, Cl | C | 5 | A | Vague | B | 0.15 | B | 12B | 30 | A | a | 8 | 30 |
| | | | | | \| | | 4 | Rd | B | Phl | C | Cl | B | 40 | C | Vague | B | 0.12 | B | 10C | 250 | B | b | 20 | 60 |
| | | | | | 800m | | 5 | Rd | B | Phl | C | Cl | B | 30 | C | no | C | 0.15 | B | 9C | 150 | A | b | 12 | 60 |
| | | | | | | | 6 | Rd | B | Phl | C | Cl | B | 30 | C | no | C | 0.3 | B | 9C | 350 | C | c | 15 | 50 |
| | | | | | | | 7 | Rd | B | Phl | C | Cl | B | 25 | B | no | C | 0.08 | C | 9C | 200 | A | b | 15 | 50 |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | 500m | | 9 | | | | | | | | | | | | | | | | | | |
| | | | A-B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |

Legend: Rd = River deposit; Dt = Talus deposit; V = Valley; Ld = Lake deposit; Lat = Laterite; S = Slope; Qtz = Quartzite; Phl = Phyllite; R = Ridge; Dol = Dolerite; Gr = Granite; Sg = Sand and Gravel; Cl = Clay; Shist = Sh

## Table 2.3 Evaluation of Drilling Sites (3)

| District | Village | Population June/95 | Existing Source | | | | Drilling Point No | Groundwater Potential | | | | | | | | | | | | | Access (m) | | Rank a,b,c,d | Depth (m) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quality | Quantity | Distance | Access | | Terrain | Rank | Geology | Rank | Surface | Rank | G.W. m | Rank | Fracture | Rank | C. Area Km² | Rank | Rank | | Rank | | Surface | Rock |
| Ngara | Ntanga | 1,799 | | | | | 1 | V | A | Sh, Gr | A | Cl | B | 5 | A | no | C | 1.2 | A | 15A | 300 | B | a | 20 | 30 |
| | | | | | | | 2 | Rd | B | Sh, Gr | A | Cl | B | 15 | B | no | C | 0.3 | B | 12B | 50 | A | a | 15 | 30 |
| | | | | | 300m | | 3 | Rd, V | A | Sh, Gr | A | Cl | B | 10 | A | Vague | B | 1+ | A | 16A | 400 | C | b | 10 | 30 |
| | | | | | \| | | 4 | Rd | B | Sh, Gr | A | Sg, Cl | B | 15 | B | Vague | B | 0.25 | B | 13B | 700 | D | c | 15 | 30 |
| | | | | | 2,000m | | 5 | Rd, V | B | Sh, Gr | A | Sg, Cl | C | 10 | A | Vague | B | 0.4 | B | 13B | 600 | D | c | 10 | 40 |
| | | | | | | | 6 | V | A | Sh, Gr | A | Cl | B | 10 | A | Vague | B | 1+ | A | 16A | 50 | A | a | 15 | 20 |
| | | | | | | | 7 | Rd | B | Sh, Gr | A | Cl | B | 30 | C | Vague | B | 0.09 | C | 11C | 50 | A | b | 10 | 60 |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | 1,000m | | 9 | | | | | | | | | | | | | | | | | | |
| | | | C | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Nyabihanga | 1,570 | | | | | 1 | Rd | B | Gr | A | Cl | B | 12 | B | Vague | B | 0.08 | C | 12B | 300 | B | a | 15 | 30 |
| | | | | | | | 2 | V | A | Gr | A | Cl | B | 8 | A | Clear | A | 0.12 | B | 16A | 100 | A | a | 10 | 40 |
| | | | | | 500m | | 3 | Rd | B | Gr | A | Cl | B | 20 | B | Clear | A | 0.08 | C | 13B | 400 | C | b | 15 | 30 |
| | | | | | \| | | 4 | Rd | B | Gr | A | Cl | B | 20 | B | Vague | B | 0.1 | B | 13B | 350 | C | b | 20 | 40 |
| | | | | | 900m | | 5 | V | A | Gr | A | Cl | C | 8 | A | Vague | B | 0.4 | B | 14B | 50 | A | a | 10 | 25 |
| | | | | | | | 6 | V | A | Gr | A | Cl | C | 5 | A | Vague | B | 1+ | A | 15A | 50 | A | a | 10 | 25 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | 600m | | 9 | | | | | | | | | | | | | | | | | | |
| | | | B-C | B | C | C | 10 | | | | | | | | | | | | | | | | | | |

Legend
Rd = River deposit
Dt = Talus deposit
V = Valley
Ld = Lake deposit
Lat = Laterite
S = Slope
Qtz = Quartzite
Phl = Phyllite
R = Ridge
Dol = Dolerite
Gr = Granite
Sg = Sand and Gravel
Cl = Clay
Shist = Sh

## Table 2.3 Evaluation of Drilling Sites (4)

| District | Village | Population June/'95 | Existing Source: Quality | Existing Source: Quantity | Existing Source: Distance | Existing Source: Access | Drilling Point No. | Groundwater Potential: Terrain | Rank | Geology | Rank | Depth (m) | Rank | G.W. m | Rank | Fracture | Rank | C. Area km² | Rank | Rank | Access (m) | Rank | Rank a.b.c.d | Depth (m) Surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Karagwe | Bugara | 2,758 | | | | | 1 | R | C | Phl, Qtz | A | 10 | B | 30 | B | Clear | A | 0.1 | C | C | 30 | B | b | 80 |
| | | | | | | | 2 | V | A | Rd, Qtz | C | 50 | A | 5 | A | Vague | B | 67 | A | A | 0 | A | a | 70 |
| | | | | | | | 3 | V | A | Rd, Dt | C | 50 | A | 5 | A | Vague | B | 11 | A | A | 0 | A | a | 70 |
| | | | | | | | 4 | S | B | Phl | C | 10 | B | 80 | C | Vague | B | 0.3 | B | D | 500 | D | d | 120 |
| | | | | | | | 5 | R | C | Qtz | A | 10 | B | 30 | B | Clear | A | 0.1 | C | C | 100 | B | b | 80 |
| | | | | | | | 6 | S | B | Phl | C | 50 | A | 60 | C | Vague | B | 2 | A | C | 1,500 | D | d | 100 |
| | | | | | | | 7 | R | C | Phl, Qtz | A | 10 | B | 30 | B | Clear | A | 0.1 | C | C | 200 | C | c | 80 |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Businde | 4,200 | | | | | 1 | R | C | Qtz | A | 10 | B | 60 | C | Clear | A | 0.1 | C | C | 200 | C | c | 80 |
| | | | | | | | 2 | S | B | Dt, Phl | C | 50 | A | 30 | B | Vague | B | 0.1 | C | D | 0+ | A | c | 70 |
| | | | | | | | 3 | V | A | Dt, Phl | C | 30 | A | 20 | B | Clear | A | 2 | A | A | 0+ | A | a | 50 |
| | | | | | | | 4 | S | B | Dt, Phl | C | 50 | A | 30 | B | Vague | B | 0.3 | B | D | 0+ | A | c | 50 |
| | | | | | | | 5 | V | A | Dt, Phl | C | 30 | A | 20 | B | Clear | A | 1.5 | A | A | 0+ | A | a | 50 |
| | | | | | | | 6 | V | A | Phl, Rd | C | 30 | A | 10 | A | Clear | A | 5 | A | A | 900 | D | c | 50 |
| | | | | | | | 7 | V | A | Phl, Rd | C | 30 | A | 5 | A | Clear | A | 14 | A | A | 0 | C | b | 50 |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Chanya (Sub-village of Itera) | 1,800 | | | | | 1 | V | A | Rd, Dt | C | 10 | B | 5 | A | Clear | A | 11 | A | A | 0+ | A | a | 30 |
| | | | | | | | 2 | V | A | Rd, Dt | C | 20 | A | 10 | A | Clear | A | 4 | A | A | 2,000 | D | c | 40 |
| | | | | | | | 3 | V | A | Rd, Dt | C | 10 | B | 5 | A | Vague | B | 7 | A | B | 500 | D | c | 30 |
| | | | | | | | 4 | V | A | Rd, Dt | C | 20 | A | 10 | A | Clear | A | 1.5 | A | A | 2,000 | D | c | 40 |
| | | | | | | | 5 | V | A | Rd, Dt | C | 10 | B | 5 | A | Vague | B | 6 | A | B | 1,000 | D | c | 30 |
| | | | | | | | 6 | V | A | Rd, Dt | C | 10 | B | 5 | A | Clear | A | 2 | A | A | 1,000 | D | c | 30 |
| | | | | | | | 7 | V | A | Rd, Dt | C | 10 | B | 5 | A | Clear | A | 10 | A | A | 2,000 | D | c | 30 |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Itera | 2,900 | | | | | 1 | V | A | Rd, Dt | C | 10 | B | 5 | A | Vague | B | 2 | A | B | 100+ | B | a | 30 |
| | | | | | | | 2 | V | A | Rd, Dt | C | 10 | B | 5 | A | Clear | A | 4.5 | A | A | 200+ | C | b | 30 |
| | | | | | | | 3 | S | B | Dt, Phl | C | 40 | A | 60 | C | Clear | A | 0.3 | B | C | 500+ | D | d | 100 |
| | | | | | | | 4 | V | A | Rd, Dt | C | 10 | B | 5 | A | Clear | A | 4 | A | A | 2,000+ | D | c | 30 |
| | | | | | | | 5 | S | B | Dt, Phl | C | 40 | A | 20 | B | Clear | A | 1 | A | B | 500+ | D | c | 60 |
| | | | | | | | 6 | S | B | Dt, Phl | C | 40 | A | 60 | C | Clear | A | 0.3 | B | C | 500+ | D | d | 80 |
| | | | | | | | 7 | V | A | Dt, Phl | C | 10 | B | 20 | B | Vague | B | 0.3 | B | D | 500+ | D | d | 40 |
| | | | | | | | 8 | V | A | Rd, Dt | C | 10 | B | 10 | A | Vague | B | 2 | A | B | 2,000+ | D | c | 30 |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |

Legend: Rd = River deposit; Dt = Talus deposit; V = Valley; Ld = Lake deposit; Lat = Laterite; S = Slope; Qtz = Quartzite; Phl = Phyllite; R = Ridge; Dol = Dolerite; Gr = Granite; Sg = Sand and Gravel; Cl = Clay; Shist = Sh

## Table 2.3 Evaluation of Drilling Sites (5)

| District | Village | Population June/'95 | Existing Source: Quality | Existing Source: Quantity | Existing Source: Distance | Existing Source: Access | Drilling Point No. | Groundwater Potential: Terrain | Rank | Geology | Rank | Depth (m) | Rank | G.W. m | Rank | Fracture | Rank | C. Area km² | Rank | Rank | Access (m) | Rank | Rank a b c d | Depth (m) Surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Karagwe | Kamuli | 1,918 | | | | | 1 | S | B | Phl, Qtz | C | 20 | B | 60 | C | Vague | B | 0.1 | C | D | 100+ | B | e | 80 |
| | | | | | | | 2 | S | B | Phl | C | 30 | A | 40 | C | Vague | B | 0.01 | C | D | 200 | C | d | 60 |
| | | | | | | | 3 | S | B | Rd, Dt | A | 20 | B | 5 | A | Vague | B | 6 | A | B | 0+ | A | a | 40 |
| | | | | | | | 4 | S | B | Qtz | A | 20 | B | 80 | C | Clear | A | 0.3 | B | C | 500 | D | d | 120 |
| | | | | | | | 5 | S | B | Rd, Dt | A | 10 | B | 5 | A | Clear | A | 5 | A | A | 0+ | A | a | 30 |
| | | | | | | | 6 | | | | | | | | | | | | | | | | | |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | A | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Kayungu | 2,079 | | | | | 1 | S | B | Dt, Dol | B | 30 | A | 10 | A | Vague | B | 1 | A | B | 0 | A | a | 50 |
| | | | | | | | 2 | S | B | Dt, Dol | B | 30 | A | 10 | A | Vague | B | 0.3 | B | C | 0 | A | b | 50 |
| | | | | | | | 3 | S | B | Dt, Dol | B | 30 | A | 5 | A | Vague | B | 10 | A | B | 0 | A | a | 50 |
| | | | | | | | 4 | V | A | Dt, Qtz | A | 20 | B | 5 | A | Vague | B | 11 | A | A | 0 | A | a | 40 |
| | | | | | | | 5 | V | A | Dt, Qtz | A | 20 | B | 5 | A | Vague | B | 5 | A | A | 0 | A | a | 40 |
| | | | | | | | 6 | V | A | Phl, Rd | C | 40 | A | 5 | A | Vague | B | <100 | A | A | 0 | A | a | 60 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Kibare | 5,400 | | | | | 1 | S | B | Qtz, Dt | A | 20 | B | 30 | C | Vague | B | 1 | A | C | 1,000+ | D | d | 60 |
| | | | | | | | 2 | S | B | Qtz, Dt | A | 20 | B | 30 | C | Vague | B | 1.5 | A | C | 500+ | D | d | 60 |
| | | | | | | | 3 | S | B | Qtz, Dt | A | 50 | A | 30 | C | Clear | A | 2 | A | A | 0+ | A | a | 70 |
| | | | | | | | 4 | V | A | Rd, Dt | C | 40 | A | 10 | A | Vague | B | <20 | A | A | 0 | A | a | 60 |
| | | | | | | | 5 | | | | | | | | | | | | | | | | | |
| | | | | | | | 6 | | | | | | | | | | | | | | | | | |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Kibona | 4,100 | | | | | 1 | V | A | Rd | C | 20 | B | 5 | A | Vague | B | 6 | A | B | 3,000 | D | c | 40 |
| | | | | | | | 2 | V | A | Rd | C | 20 | B | 5 | A | Vague | B | 6 | A | B | 2,000 | D | c | 40 |
| | | | | | | | 3 | S | B | Dt, Phl | C | 20 | B | 60 | C | Vague | B | 0.1 | C | D | 300 | C | d | 100 |
| | | | | | | | 4 | V | A | Rd, Dt | C | 20 | B | 5 | A | Vague | B | 0.3 | B | C | 1,000 | D | d | 40 |
| | | | | | | | 5 | S | B | Dt, Phl | C | 20 | B | 20 | B | Vague | B | 0.3 | B | D | 1,000 | D | d | 40 |
| | | | | | | | 6 | S | B | Dt, Phl | C | 20 | B | 30 | C | Vague | B | 0.3 | B | D | 1,000 | D | d | 60 |
| | | | | | | | 7 | V | A | Dt, Phl | C | 20 | B | 10 | A | Clear | A | 0.1 | C | B | 1,000 | D | c | 40 |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | A | B | C | C | 10 | | | | | | | | | | | | | | | | | |

Legend
Rd = River deposit
Dt = Talus deposit
V = Valley
Ld = Lake deposit
Lat = Laterite
S = Slope
Qtz = Quartzite
Phl = Phyllite
R = Ridge
Dol = Dolerite
Gr = Granite
Sg = Sand and Gravel
Cl = Clay
Shist = Sh

## Table 2.3 Evaluation of Drilling Sites (6)

| District | Village | Population June/95 | Existing Source | | | | Drilling Point No. | Groundwater Potential | | | | | | | | | | | | | | Access (m) | | Rank a b c d | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quality | Quantity | Distance | Access | | Terrain | Rank | Geology | Rank | Depth (m) | Rank | G.W. m | Rank | Fracture | Rank | C. Area $Km^2$ | Rank | Rank | | | Rank | | Surface |
| Karagwe | Kibondo | 1,990 | | | | | 1 | S | B | Dt, Dol | B | 30 | A | 10 | A | Vague | B | 0.3 | B | C | | 100+ | B | b | 50 |
| | | | | | | | 2 | V | A | Dt, Dol | B | 60 | A | 5 | A | Vague | B | 4 | A | A | | 0 | A | a | 80 |
| | | | | | | | 3 | V | A | Dt, Dol | B | 60 | A | 5 | A | Vague | B | 4 | A | A | | 300+ | C | b | 80 |
| | | | | | | | 4 | S | B | Dt, Dol | B | 30 | A | 5 | A | Vague | B | 12 | A | B | | 0 | A | a | 50 |
| | | | | | | | 5 | S | B | Dt, Dol | B | 30 | A | 10 | A | Vague | B | 7 | A | B | | 0 | A | a | 50 |
| | | | | | | | 6 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Kitwe | 1,640 | | | | | 1 | S | B | Dt, Qtz | A | 50 | A | 5 | A | Vague | B | 13.5 | A | A | | 0 | A | a | 70 |
| | | | | | | | 2 | S | B | Dt, Qtz | A | 50 | A | 5 | A | Vague | B | 2 | A | A | | 0+ | A | a | 70 |
| | | | | | | | 3 | V | A | Phl, Rd | A | 50 | A | 5 | A | Clear | A | 8 | A | A | | 0 | A | a | 70 |
| | | | | | | | 4 | S | B | Lat,Phl | C | 50 | A | 40 | C | Vague | B | 0.3 | B | C | | 200+ | C | d | 70 |
| | | | | | | | 5 | S | B | Lat,Phl | C | 50 | A | 60 | C | Vague | B | 0.3 | B | A | | 50 | A | c | 80 |
| | | | | | | | 6 | S | B | Phl, Qtz | B | 50 | A | 60 | C | Vague | B | 0.1 | C | A | | 50+ | A | c | 80 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Mashesha | 2,760 | | | | | 1 | S | B | Phl, Dt | C | 15 | B | 5 | A | Vague | B | 1 | A | A | | 0+ | A | b | 40 |
| | | | | | | | 2 | S | B | Phl, Dt | C | 15 | B | 15 | B | Vague | B | 0.3 | B | A | | 0 | A | c | 40 |
| | | | | | | | 3 | S | B | Phl, Dt | C | 15 | B | 10 | A | Vague | B | 3.5 | A | A | | 0 | A | b | 40 |
| | | | | | | | 4 | V | A | Rd, Phl | C | 30 | A | 5 | A | Vague | B | <30 | A | C | | 200 | C | b | 50 |
| | | | | | | | 5 | V | A | Rd, Phl | C | 30 | A | 5 | A | Vague | B | <30 | A | D | | 500 | D | c | 50 |
| | | | | | | | 6 | V | A | Rd, Phl | C | 30 | A | 5 | A | Vague | B | <30 | A | D | | 500 | D | c | 50 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Nyabwegira | 3,200 | | | | | 1 | S | B | Dt, Phl | C | 30 | A | 20 | B | Clear | A | 1 | A | D | | 500+ | D | c | 50 |
| | | | | | | | 2 | S | B | Dt, Phl | C | 30 | A | 40 | C | Clear | A | 0.3 | B | D | | 300+ | D | d | 80 |
| | | | | | | | 3 | S | B | Dt, Phl | C | 30 | A | 60 | C | Vague | B | 0.1 | C | D | | 300+ | D | d | 100 |
| | | | | | | | 4 | S | B | Dt, Phl | C | 30 | A | 40 | C | Vague | B | 0.1 | C | C | | 200+ | C | d | 80 |
| | | | | | | | 5 | S | B | Dt, Phl | C | 30 | A | 60 | C | Vague | B | 0.3 | B | D | | 500+ | D | d | 100 |
| | | | | | | | 6 | V | A | Rd, Phl | C | 20 | B | 5 | A | Vague | B | <30 | A | D | | 1,000+ | D | e | 40 |
| | | | | | | | 7 | V | A | Rd, Phl | C | 20 | B | 5 | A | Vague | B | <20 | A | D | | 1,000+ | D | e | 40 |
| | | | | | | | 8 | V | A | Rd, Phl | C | 20 | B | 5 | A | Vague | B | 7 | A | D | | 1,000+ | D | e | 40 |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | | |
| | | | A | B | C | C | 10 | | | | | | | | | | | | | | | | | | |

Legend
Rd = River deposit
Dt = Talus deposit
V = Valley
Ld = Lake deposit
Lat = Laterite
S = Slope
Qtz = Quartzite
Phl = Phyllite
R = Ridge
Dol = Dolerite
Gr = Granite
Sg = Sand and Gravel
Cl = Clay
Shist = Sh

## Table 2.3 Evaluation of Drilling Sites (7)

| District | Village | Population June/95 | Existing Source | | | | Drilling Point No. | Groundwater Potential | | | | | | | | | | | | | | Access (m) | | Rank a,b,c,d | Depth (m) Surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quality | Quantity | Distance | Access | | Terrain | Rank | Geology | Rank | Depth (m) | Rank | G.W. m | Rank | Fracture | Rank | C. Area km² | Rank | Rank | | | Rank | | |
| Karagwe | Nyakabanga | 3,000 | | | | | 1 | S | B | Dt, Dol | B | 30 | A | 10 | A | Vague | B | 1 | B | B | | 200+ | C | b | 50 |
| | | | | | | | 2 | S | B | Dt, Dol | B | 15 | B | 5 | A | Vague | B | 3 | C | C | | 0 | A | b | 40 |
| | | | | | | | 3 | S | B | Dt, Dol | B | 40 | A | 5 | A | Vague | B | 1 | B | B | | 0 | A | a | 60 |
| | | | | | | | 4 | S | B | Dt, Dol | B | 40 | A | 5 | A | Vague | B | 6 | B | B | | 0 | A | a | 60 |
| | | | | | | | 5 | S | B | Dt, Dol | B | 30 | A | 5 | A | Vague | B | 3 | B | B | | 0 | A | a | 50 |
| | | | | | | | 6 | S | B | Dt, Dol | B | 40 | A | 10 | A | Vague | B | 1 | B | B | | 0 | A | a | 60 |
| | | | | | | | 7 | S | B | Dt, Dol | B | 30 | A | 10 | A | Vague | B | 0.3 | B | B | | 200+ | C | b | 50 |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Nyakatuntu | 4,200 | | | | | 1 | V | A | Phl, Rd | C | 30 | A | 5 | A | Vague | B | <100 | A | A | | 0 | A | a | 50 |
| | | | | | | | 2 | S | B | Phl, Dt | C | 40 | A | 30 | C | Vague | B | 0.3 | B | D | | 100+ | B | c | 60 |
| | | | | | | | 3 | S | B | Lat,Phl | C | 40 | A | 150 | C | Clear | A | 0.1 | C | D | | 200+ | C | d | 200 |
| | | | | | | | 4 | S | B | Lat,Phl | C | 40 | A | 150 | C | Vague | B | 0.1 | C | D | | 200+ | C | d | 200 |
| | | | | | | | 5 | S | B | Lat,Phl | C | 40 | A | 150 | C | Clear | A | 0.1 | C | C | | 500+ | D | d | 200 |
| | | | | | | | 6 | S | B | Lat,Phl | C | 40 | A | 150 | C | Vague | B | 0.3 | B | D | | 1,000+ | D | d | 200 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |
| | Nyamiyaga | 4,140 | | | | | 1 | S | B | Phl, Dt | C | 40 | A | 60 | C | Clear | A | 0.1 | C | C | | 1,000+ | D | d | 120 |
| | | | | | | | 2 | S | B | Phl, Dt | C | 40 | A | 40 | C | Vague | B | 0.3 | B | D | | 1,000+ | D | d | 80 |
| | | | | | | | 3 | S | B | Phl, Dt | C | 40 | A | 40 | C | Clear | A | 1 | A | B | | 1,000+ | D | c | 80 |
| | | | | | | | 4 | V | A | Phl, Dt | C | 30 | A | 10 | A | Vague | B | 4 | A | A | | 200+ | C | b | 50 |
| | | | | | | | 5 | V | A | Rd, Phl | C | 30 | A | 10 | A | Vague | B | 8 | A | A | | 0+ | A | a | 50 |
| | | | | | | | 6 | V | A | Rd, Phl | C | 30 | A | 10 | A | Vague | B | 11 | A | A | | 0+ | A | a | 50 |
| | | | | | | | 7 | S | B | Phl, Dt | C | 40 | A | 20 | B | Vague | B | 2 | A | C | | 0+ | A | b | 60 |
| | | | | | | | 8 | S | B | Phl, Dt | C | 40 | A | 20 | B | Vague | B | 1.5 | A | C | | 0+ | A | b | 60 |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | | |

Legend: Rd = River deposit; Dt = Talus deposit; V = Valley; Ld = Lake deposit; Lat = Laterite; S = Slope; Qtz = Quartzite; Phl = Phyllite; R = Ridge; Dol = Dolerite; Gr = Granite; Sg = Sand and Gravel; Cl = Clay; Shist = Sh

## Table 2.3 Evaluation of Drilling Sites (8)

| District | Village | Population June/'95 | Existing Source: Quality | Existing Source: Quantity | Existing Source: Distance | Existing Source: Access | Drilling Point No. | Groundwater Potential: Terrain | Rank | Geology | Rank | Depth (m) | Rank | G.W. m | Rank | Fracture | Rank | C. Area km² | Rank | Rank | Access (m) | Rank | Rank a,b,c,d | Depth (m) Surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Karagwe | Kagenyi | 3,300 | | | | | 1 | V | A | Dt, Ld | C | 10 | A | 10 | A | Vague | B | 1.5 | A | B | 0 | A | a | 30 |
| | | | | | | | 2 | V | A | Dt, Phl | C | 20 | A | 10 | A | Vague | B | 0.3 | B | C | 0 | A | b | 40 |
| | | | | | | | 3 | V | A | Dt, Phl | C | 10 | A | 10 | A | Vague | B | 2.5 | A | B | 0 | A | a | 30 |
| | | | | | | | 4 | V | A | Rd, Phl | C | 15 | A | 10 | A | Clear | A | <10 | A | A | 0 | A | a | 40 |
| | | | | | | | 5 | | | | | | | | | | | | | | | | | |
| | | | | | | | 6 | | | | | | | | | | | | | | | | | |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Kitwechenkula | 3,900 | | | | | 1 | V | A | Dt, Ld | C | 40 | A | 10 | A | Vague | B | 1 | A | A | 0 | A | a | 60 |
| | | | | | | | 2 | V | A | Dt, Ld | C | 30 | A | 20 | B | Vague | B | 4 | A | B | 2,000 | D | c | 50 |
| | | | | | | | 3 | V | A | Ld | C | 30 | A | 10 | A | Vague | B | 8 | A | A | 0 | A | a | 50 |
| | | | | | | | 4 | V | A | Dt, Ld | C | 20 | B | 25 | B | Vague | B | 2 | A | C | 0+ | A | b | 40 |
| | | | | | | | 5 | V | A | Ld | C | 40 | A | 10 | A | Vague | B | 2 | A | A | 0+ | A | a | 60 |
| | | | | | | | 6 | | | | | | | | | | | | | | | | | |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Murongo | 1,880 | | | | | 1 | S | B | Gr, Dt | B | 40 | A | 5 | A | Vague | B | 0.3 | B | C | 0 | A | b | 60 |
| | | | | | | | 2 | V | A | Gr, Dt | B | 30 | A | 5 | A | Vague | B | 2 | A | A | 500+ | D | c | 50 |
| | | | | | | | 3 | V | A | Gr, Dt | B | 20 | B | 5 | A | Vague | B | 1 | A | B | 0 | A | a | 40 |
| | | | | | | | 4 | V | A | Gr, Dt | B | 20 | B | 5 | A | Vague | B | 1 | A | B | 0 | A | a | 40 |
| | | | | | | | 5 | V | A | Phl, Dt | C | 30 | A | 15 | B | Vague | B | 0.1 | C | C | 50+ | B | b | 50 |
| | | | | | | | 6 | | | | | | | | | | | | | | | | | |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Nkwenda | 5,300 | | | | | 1 | V | A | Rd, Dt | C | 40 | A | 5 | A | Vague | B | 5 | A | A | 0 | A | a | 30 |
| | | | | | | | 2 | V | A | Rd, Dt | C | 50 | A | 5 | A | Vague | B | 7 | A | A | 100+ | B | a | 30 |
| | | | | | | | 3 | V | A | Rd, Dt | C | 50 | A | 5 | A | Vague | B | 15 | A | A | 0 | A | a | 30 |
| | | | | | | | 4 | V | A | Rd, Dt | C | 50 | A | 10 | A | Vague | B | 7 | A | A | 0 | A | a | 30 |
| | | | | | | | 5 | V | A | Rd, Dt | C | 50 | A | 10 | A | Vague | B | 3 | A | A | 0 | A | a | 30 |
| | | | | | | | 6 | V | A | Rd, Dt | C | 60 | A | 5 | A | Vague | B | <30 | A | A | 0 | A | a | 30 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |

Legend
Rd = River deposit; Dt = Talus deposit; V = Valley; Ld = Lake deposit; Lat = Laterite; S = Slope; Qtz = Quartzite; Phl = Phyllite; R = Ridge; Dol = Dolerite; Gr = Granite; Sg = Sand and Gravel; Cl = Clay; Shist = Sh

## Table 2.3 Evaluation of Drilling Sites (9)

| District | Village | Population June/95 | Existing Source | | | | Drilling Point No | Groundwater Potential | | | | | | | | | | | | Access (m) | | Rank a,b,c,d | Depth (m) Surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quality | Quantity | Distance | Access | | Terrain | Rank | Geology | Rank | Depth (m) | Rank | G.W. m | Rank | Fracture | Rank | C. Area $km^2$ | Rank | Rank | | | |
| Karagwe | Nyakasimbi | 2,205 | | | | | 1 | S | B | Dt, Qtz | A | 40 | A | 60 | C | Clear | A | 0.3 | B | B | 0 | A | a | 100 |
| | | | | | | | 2 | V | A | Dt, Phl | B | 40 | A | 30 | C | Clear | A | 3 | A | A | 0 | A | a | 60 |
| | | | | | | | 3 | S | B | Qtz | A | 30 | A | 60 | C | Vague | B | 1.5 | A | B | 3,000 | D | c | 80 |
| | | | | | | | 4 | S | B | Qtz | A | 40 | A | 50 | C | Vague | B | 2 | A | B | 1,000 | D | a | 80 |
| | | | | | | | 5 | S | B | Qtz | A | 20 | B | 40 | C | Clear | A | 0.1 | C | C | 50+ | B | b | 80 |
| | | | | | | | 6 | S | B | Dt, Qtz | A | 20 | B | 50 | C | Vague | B | 0.3 | B | D | 200 | C | d | 100 |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |
| | Songambele | 2,400 | | | | | 1 | V | A | Rd, Phl | C | 40 | A | 5 | A | Vague | B | 15 | A | A | 0+ | A | a | 60 |
| | | | | | | | 2 | S | B | Dt, Phl | C | 30 | A | 20 | B | Vague | B | 2 | A | C | 0+ | A | b | 50 |
| | | | | | | | 3 | S | B | Dt, Phl | C | 30 | A | 20 | B | Vague | B | 2 | A | C | 0+ | A | b | 50 |
| | | | | | | | 4 | S | B | Dt, Phl | C | 30 | A | 10 | A | Vague | B | 1 | A | B | 0+ | A | a | 50 |
| | | | | | | | 5 | S | B | Dt, Phl | C | 30 | A | 10 | A | Vague | B | 1.5 | A | B | 0+ | A | a | 50 |
| | | | | | | | 6 | | | | | | | | | | | | | | | | | |
| | | | | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | B | B | C | C | 10 | | | | | | | | | | | | | | | | | |

Legend

Rd = River deposit
Dt = Talus deposit
V = Valley

Ld = Lake deposit
Lat = Laterite
S = Slope

Qtz = Quartzite
Phl = Phyllite
R = Ridge

Dol = Dolerite
Gr = Granite
Sg = Sand and Gravel

Cl = Clay
Shist = Sh

(3) Changing small dams to deep wells

Small dams are not only intended to supply drinking water to the villagers but to also provide water to livestock. The construction of small dams was requested for 7 villages where stock farming is particularly thriving. However, the terrain, geology and water system of these areas do not make them suitable for small dam construction. Even if a suitable site is found, development would still be hampered by the distance of the bank, which exceeds several hundred meters, and the size of the catchment area, which is so small to meet storage requirements. In addition, soil and rock materials for the dam foundation cannot be obtained near the site. Therefore, the construction of deep wells instead of small dams would be appropriate in these areas.

Rugera is one of the villages for which the construction of these facilities was requested. It is excluded in this project however because its water supply condition is better than other villages, with: ① the recent construction of 4 deep wells (equipped with hand pumps) with the assistance of TCRS, ② the existence of a reservoir, and ③ abundant water reserves as it measures about 4,400 $m^2$ of the water area.

In consideration of the hydrogeological and topographical conditions of these villages, the construction of 3 - 4 deep wells per village is assumed feasible. Accordingly, this project plans to construct 20 deep wells, instead of shallow wells, in the aforesaid 6 villages.

In addition to the above, the following alternative is planned for the drinking water supply of the villagers,:

Rehabilitation of collection ditch: Bukangara

(4) Alternatives for the deep well

According to the groundwater potential and accessibility assessment, there are 4 feasible drilling sites in the district of Ngara, 2 each in Mukubu and Kihinga. No sites were considered suitable for well drilling in Kibona and Nybwegira. One site is considered suitable for well drilling in Chanya, and also another one in Itera.

The existing water resources in these villages are shallow wells, tube wells, springs, rivers and ponds. Due to the absence of protection measures however these water resources are all contaminated with human and livestock waste. In consideration of this condition, this project shall also entail the installation of protection measures for existing springs (including the development of new springs) and the rehabilitation of existing wells.

(5) Rehabilitation of Gravity Water Supply System in Kihanga

The inhabitants of Kishojo, a small community within the village of Kihanga, are reliant on the water intake facilities constructed in Kishojo river for their water supply. The flow rate at the intake point is 200 l/min, serving a population of 1,914. Leakage and sand deposits are found in the facility, in addition to remarkable damage in the spillway due to washing. Leakage in the pipeline and damages in taps are also discernible. Because it would not be appropriate to stop the water supply during construction, a temporary intake facility shall be constructed. The rehabilitation of the existing facility shall be carried out using the diversion method in order to secure a water supply of 20 liters/capita/day.

The DWE shall extend guidance to the water committee to ensure proper operation and maintenance of the water supply system.

(6) Construction of Gravity Water Supply System in Katanda

The water supply system in Katanda is composed of intake facilities, storage tanks, pipelines and communal faucets. These facilities are constructed at the foot of the Kisoko fall. Because this place is located within a banana farm, the mobilization of construction machinery would be difficult. As a consequence, the intake and the reservoir tank shall be constructed by hand.

In consideration of the total construction term, the contractor should subcontract a local contractor or the water committee, to construct the storage tank and to install the pipeline under the supervision of the consultant.

Water taps shall be installed according to the discussions between the DWE and the water committee. However, the taps shall be installed at an interval of 200-250m based on the design manual of the MOW. The service population is set at 2,024. Since the flow rate at the source is small, time restrictions shall be introduced in the supply operation and maintenance manual. Total distance of the pipeline is designed at about 3 - 4km.

(7) Equipment and Material

A. Drilling Rig, Accessories and Supporting Equipment

The MOW is presently equipped with 50 drilling rigs. Twenty three (23) of these are percussion rigs mainly utilized for the drilling of unconsolidated formations at the coastal area of Tanzania. The percussion rig is unsuitable for drilling in hard rock

areas such as the project area. The rest of the rigs, 27, are of the rotary type, but were mostly purchased more than 20 years ago and are not sophisticated therefore.

Accordingly, this project plans to procure a drilling rig, including its accessories and supporting equipment, for deep well construction. These equipment will be used by the MOW after completion of the project for the construction of deep wells mainly in the Kagera region in accordance with the National Water Policy.

The specification of the rig is determined considering geological and hydrogeological conditions, terrain and accessibility, capability of operation and maintenance of the Tanzanian side, spare parts availability and cost.

Taking the geological and hydrogeological conditions of the project area into account, this project should purchase the rotary type Down the Hole (DTH) hammer method rig which is capable of drilling into hard rock formations, such as quartzite, phyllite and granite. This rig can drill 8.5 inches in diameter and a depth of 200m. In view of the terrain and accessibility of the area, the rig must be truck-mountable, small and compact. The supporting equipment, such as high air compressor and vehicles shall be procured as requested.

These equipment shall be procured in third countries, which were particularly surveyed in this study. Procurement shall be decided based on the specification, the cost, including transportation, delivery time, and availability of spares.

B. Equipment for Maintenance and Education

To ensure that the operation of the water supply systems continues even after the completion of the project, the project plans to procure the necessary equipment for such operation and for the training of the village people. The present district or regional organization is not capable of conducting educational programmes or training on the operation and maintenance in terms of manpower, materials and vehicles. The software for operation and maintenance shall be provided by the consultant as mentioned in the following section. However, the hardware, such as hand pump spares, standard tools, pick-up trucks and motorcycles for the O&M operations shall be procured through the grant. These equipment can be procured locally in Tanzania.

C. Medical instruments

The district of Karagwe has 1 hospital, a public health center, and 16 clinics, while Ngara has a public health center and 19 clinics. These areas shall be provided with basic first aid medical instruments and supplies. The medical instruments basically

considered for this request were manually operated medical instruments. Medical instruments provided in the Expanded Immunization Program (EPI) established by UNICEF and other assistance by other donors shall not be included in the request.

(8) Operation and Maintenance Plan

Prior to the construction of the water supply system, the villagers have to establish their own water committee and learn how to conduct the operation and maintenance aspect independently. The operation and maintenance plan involves the following three stages:

Planning :

- Thorough introduction and explanation of the plan at the village meeting
- Gaining a consensus on monetary and labor contributions
- Organizing a water committee and election of chairperson, accountant and caretaker
- Establishment of a fund

Construction :

- Voluntary contribution of services for arrangement of the access road, installation of roof and fences;
- Installation of hand pumps by villagers under the guidance of the consultant;
- Purchase of spares and tools
- Maintenance training

Operation & Maintenance :

- Collection of water fee
- Periodical check-ups
- Repair of pumps and replacement of spares
- Purchase of spares and recharging
- Periodical report

The consultant shall extend guidance services on the establishment of a water committee, the education and training services for hand pump installation and repair, jointly with village authorities and the DWE.

### 2-2-3 Basic Concept of Cooperation

Based on the above, the basic concept of the project is to construct the water supply systems mainly through the construction of deep wells, and to procure the drilling rig and the equipment for maintenance and education and medical instruments. The project aims to supply a drinking water of 20 liters/capita/day in 10 villages in the district of Ngara and 29 villages in the district of Karagwe, in accordance with the Water Policy of the Government of Tanzania.

The implementation of the project shall improve water supply conditions and shall benefit the refugee affected areas of Ngara and Karagwe districts in the region of Kagera, areas which are constantly under the cynosure of the international community. In addition, the implementation of this project shall bear a significant influence on the future promotion of rural water supply programs in Tanzania. Accordingly, it is significant to carry out this project under the Japanese Grant Aid program . However, as previously mentioned, the requests for the construction of shallow wells and small dams shall be changed to deep wells, in view of the terrain and geological conditions of the sites.

Table 2.4 presents the list of facilities, equipment and materials, which were thought necessary according to the above assessments.

## 2-3 Basic Design

### 2-3-1 Design Policy

The project area is located in the highlands situated in the border of Rwanda, Burundi and Uganda. It is more than 1,500 km from the capital and has poor road and communication systems. The project area is separated into two districts, Ngara and Karagwe, which are also connected by poor road conditions. The villages proposed in this project are all located on the hillside, and the houses are scattered. Accordingly, the water supply systems should be constructed at the slope or the valley, and a long road should be constructed to facilitate construction works.

The natural conditions of the highlands and mountains, the unpaved roads that are sometimes impassable in the rainy season, and poor transportation and communication systems should be considered when determining the design of the facilities and equipment. In view of these conditions, this project is designed according to the following policies:

## Table 2.4 Basic Design of the Facilities and the Equipment

| Item | Request | | | | Basic Design Study | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Supply Facility** | | | | | | | | |
| A.Deep wells | Ngara | | 10 villages | 70 wells | Ngara | | 10 villages | 40 wells |
| | Karagwe | | 15 villages | 133 wells | Karagwe | | 13 villages | 41 wells |
| | Total | | | 207 wells | Total | | | 81 wells |
| B.Shallow wells | Karagwe | | 6 villages | 55 wells | Change to deep well | | 6 villages | 26 wells |
| C.Small dams | Karagwe | | 7 villages | 7 dams | Change to deep well | | 6 villages | 20 wells |
| D.Rehabilitation of collection ditches | | | | | | | 1 village | 1 ditch |
| E.Installation of protection devices for existing springs | | | | | | | 25 villages | 36 springs |
| F.Rehabilitation of existing wells | | | | | | | 2 villages | 2 wells |
| G.Rehabilitation of gravity water supply system | Karagwe | Kihanga | | 1 system | Karagwe | Kihanga | | 1 system |
| H.Construction of gravity water supply system | Karagwe | Katanda | | 1 system | Karagwe | Katanda | | 1 system |
| **Equipment** | | | | | | | | |
| A.Drilling rig and accessories | Top drive type | | | 1 | Top drive type | | | 1 |
| | Standarad accessories | | | 1 set | Standarad accessories | | | 1 set |
| (Supporting Vehicles) | Compressor | | | 1 | Compressor | | | 1 |
| | Large size truck | | | 1 | none | | | |
| | Medium size truck | | | 1 | Medium size truck with crane | | | 2 |
| | Water tank lorry | | | 1 | Water tank lorry | | | 1 |
| | Fuel tank truck | | | 1 | Fuel tank truck | | | 1 |
| | Pick up truck | | | 3 | none | | | |
| | Concrete mixer | | | 3 | none | | | |
| | Electoric logging equipment | | | 2 | Electoric logging equipment | | | 1 |
| | Submersible motor pump | | | 2 | Submersible motor pump | | | 2 |
| | Welder | | | 1 | Welder | | | 1 |
| | Generator | | | 2 | Generator | | | 1 |
| | Bentonite | | | 1 set | Bentonite | | | 1 set |
| | CMC etc | | | 1 set | CMC etc | | | 1 set |
| | Hand pump | | | 250 | Hand pump | | | 145 |
| | PVC Casing | | | 3125 | PVC Casing | | | 1712 |
| | Screen | | | 1563 | Screen | | | 466 |
| B.Maintenance and education | Well service car | | | 2 | Pick up truck | | | 2 |
| | Motor cycles | | | 6 | Motor cycles | | | 4 |
| | Wireless communication system | | | 2 sets | Wireless communication system | | | 2 sets |
| | Water analysis kit | | | 2 sets | Water analysis kit | | | 2 sets |
| | | | | | Standard tools | | | 35 sets |
| | | | | | Computer | | | 1 set |
| C.Medical instruments | Ngara | 1 Public Health Center | | 1 set | Ngara | 1 Public Health Center | | 1 set |
| | | 19 Clinics | | 19 set | | 19 Clinics | | 19 set |
| | Karagwe | 1 Local Hospital | | 1 set | Karagwe | 1 Local Hospital | | 1 set |
| | | 1 Public Health Center | | 1 set | | 1 Public Health Center | | 1 set |
| | | 18 Clinics | | 18 sets | | 18 Clinics | | 16 sets |
| | | Total | | 40 sets | | Total | | 38 sets |

The water supply system is designed according to the standards stipulated in the National Water Policy. Further, in order to improve the water supply service ratio, an optimum design was adopted for this project with due consideration of the natural conditions and the accessibility of the sites.

The water supply systems to be mainly constructed and rehabilitated through this project are deep wells and facilities operated through the gravity system. Deep wells shall be constructed instead of shallow wells and small dams. The protection of existing springs and the development of new ones are planned for the villages where deep well drillings are unfeasible. The facilities to be constructed in this project shall be designed with due consideration of the current use of existing facilities and in a manner that will make operation and maintenance easy for the villagers.

The drilling rig and the supporting equipment to be selected for this project must be transportable through rough roads in highlands and mountains, can be placed on slopes, and capable of high speed drilling in hard rock formations. The drilling rig in particular shall be a truck-mountable rotary rig with a DTH function. Since the MOW is responsible for the operation and maintenance of the rig, it is necessary to consider the maintenance level in Tanzania. The third countries shall be taken into consideration for the procurement of the rig and equipment.

The hand pumps, casings and screens shall be procured locally or in third countries. If availability is not a problem, other construction materials shall be procured locally.

In order to smoothly and effectively conduct the construction works, the subcontracting of local and foreign drilling companies shall be incorporated in the construction plan.

The drilling rig to be procured shall be used by the Japanese contractor. The participation of the drilling engineers and technicians of the MOW in some of the drilling works, under the supervision of the contractor, as a part of the OJT should be incorporated in the plan as well .

The consultant shall conduct an operation and maintenance program prior to the construction works. The program shall entail the establishment of a village water committee and their training and education on operation and maintenance techniques. Training and education programs on pump installation and repair shall be performed at the construction stage.

The project offices shall be located in the districts of Karagwe and Ngara taking the following conditions into account:

- Natural conditions, i.e. climate, topography and geology
- Social conditions, i.e. water supply, road and communications system, the size of the project area
- Procurement, transportation and storage of equipment and materials

Medical instruments need to instruct how to handle, stock and maintain at each medical facility. Medical instruments shall be transported from Dar es salaam to Ngara and Karagwe districts respectively and kept temporarily at health center in both districts. Then these instruments shall be transported to each clinic under control of the consultant. The consultant shall instruct how to handle, stock and maintain at each clinic.

The construction works shall be divided into two stages considering the time required for the procurement and transportation of the equipment and materials.

**2-3-2 Basic Plan**

(1) Standard water consumption and service population

This project is basically planned in accordance with the National Water Policy. The National Water Policy targets a service population of 200-250 persons within a distance of 400m from every water resource by the year 2002. The standard water consumption is set at 20 liters/capita/day. However, it would be difficult to attain the target with the established distance due to the location and structure of the villages. But the established water consumption rate (20 liters/capita/day) is considered appropriate in view of the present consumption rate of 5-10 liters/capita/day.

A deep well with a hand pump is estimated to have a potential pumping discharge of 5,400 liters/day, if pumping is carried out for 8 hours, and 6,750 liters if pumping is carried out for 10 hours. 10.5 hours of pumping is estimated to serve a population of about 350 persons.

This project intends to construct the deep wells requested for some villages. As previously explained, it also intends to construct deep wells instead of the requested shallow wells and small dams. The groundwater potential and the accessibility assessment results point out several villages where deep well construction is difficult or impossible to carry out (refer to Table 2.2).

The number of deep wells required (i.e., demand) is calculated as one well per 350 persons. The demand-supply ratio, which is the service ratio, averages 64.6% in villages in the Ngara District where the construction of deep wells is requested. In the district

of Karagwe, the service ratio averages 33.4% in villages where deep wells are requested, 47.9% in villages where shallow wells are requested, and 63.5% in villages where small dams are requested (refer to Table 2.5).

This project intends to elevate the service ratio to as high as possible in villages where deep well construction is impossible or difficult to carry out. As alternatives, the protection and development of springs, and the rehabilitation of existing wells are planned. With these alternatives, a service ratio of 63.0% for a population of 97,773 can be achieved, except for the gravity water supply systems to be constructed in the villages of Kihanga and Katanda (Table 2.5).

With regards to the villages where the construction of small dams is requested, the rehabilitation of the collection ditch is planned. Rugera, one of the villages where the construction of a small dam is requested, shall be excluded from the project because it already has 4 deep wells and one big pond.

A 100% service ratio shall be achieved in Kihanga and Katanda after the completion of the works. Through the implementation of this project, the service ratio in the entire project area, where the total population is 101,711, will reach 64 %.

## Table 2-5 The number of water supply facility and water services ratio (1)

**The villages for Deep wells construction** **Ngara District**

| No | Village Name | Population | No. of wells(a) | Beneficiary per well | Number of well demand (b) | Well ratio (a)/(b) | Water supply plan DW | WR | TR | SP | Services Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mukalinzi | 2, 331 | 5 | 466 | 7 | 75. 1% | 5 | | | 1 | 90. 1% |
| 2 | Mukubu | 2, 394 | 1 | 2, 394 | 7 | 14. 6% | 1 | | | 2 | 43. 9% |
| 3 | Mururama | 3, 188 | 4 | 797 | 9 | 43. 9% | 4 | | | 2 | 65. 9% |
| 4 | Murubanga | 1, 514 | 6 | 252 | 4 | 138. 7% | 6 | | | | 138. 7% |
| 5 | Kihinga | 3, 477 | 1 | 3, 477 | 10 | 10. 1% | 1 | 1 | | 2 | 40. 3% |
| 6 | Kumubuga | 1, 215 | 3 | 405 | 3 | 86. 4% | 3 | | | 1 | 115. 2% |
| 7 | Magamba | 1, 978 | 6 | 330 | 6 | 106. 2% | 6 | | | | 106. 2% |
| 8 | Muganza | 2, 527 | 6 | 421 | 7 | 83. 1% | 6 | | | 1 | 97. 0% |
| 9 | Ntanga | 1, 531 | 4 | 383 | 4 | 91. 4% | 4 | | | | 91. 4% |
| 10 | Nyabihanga | 1, 532 | 4 | 383 | 4 | 91. 4% | 4 | | | | 91. 4% |
| | Sub total | 21, 687 | 40 | | 62 | 64. 6% | 40 | 1 | 0 | 9 | 80. 7% |

**The abbreviations for water supply plans**

| | |
|---|---|
| Deep well construction | DW |
| Rehabilitation of existing well | WR |
| Rehabilitation of collecting ditch | TR |
| Rehabilitation of existing water source (spring protection) | SP |

**The villages for Deep well construction** **Karagwe District**

| No | Village Name | Population | No. of wells(a) | Beneficiary per well | Number of well demand (b) | Well ratio (a)/(b) | Water supply plan DW | WR | TR | SP | Services Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Bugara | 2, 758 | 4 | 690 | 8 | 50. 8% | 4 | | | 1 | 63. 5% |
| 2 | Businde | 4, 200 | 4 | 1, 050 | 12 | 33. 3% | 4 | | | 1 | 41. 7% |
| 3 | Cyanya | 1, 800 | 1 | 1, 800 | 5 | 19. 4% | 1 | | | 1 | 38. 9% |
| 4 | Itera | 2, 900 | 1 | 2, 900 | 8 | 12. 1% | 1 | | | 2 | 36. 2% |
| 5 | Kamuli | 1, 918 | 3 | 639 | 5 | 54. 7% | 3 | | | 2 | 91. 2% |
| 6 | Kayugu | 2, 079 | 6 | 347 | 6 | 101. 0% | 6 | | | | 101. 0% |
| 7 | Kibare | 5, 400 | 2 | 2, 700 | 15 | 13. 0% | 2 | | | 2 | 25. 9% |
| 8 | Kibona | 4, 100 | 0 | 0 | 12 | 0. 0% | 0 | | | 2 | 17. 1% |
| 9 | Kibondo | 1, 990 | 4 | 498 | 6 | 70. 4% | 4 | | | 1 | 87. 9% |
| 10 | Kitwe | 1, 640 | 5 | 328 | 5 | 106. 7% | 5 | | | | 106. 7% |
| 11 | Mashesho | 2, 760 | 3 | 920 | 8 | 38. 0% | 3 | | | 1 | 50. 7% |
| 12 | Nyabwegira | 3, 200 | 0 | 0 | 9 | 0. 0% | 0 | | | 1 | 10. 9% |
| 13 | Nyakabanga | 3, 000 | 5 | 600 | 9 | 58. 3% | 5 | | | 2 | 81. 7% |
| 14 | Nyakatuntu | 4, 200 | 2 | 2, 100 | 12 | 16. 7% | 2 | | | 2 | 33. 3% |
| 15 | Nyamiaga | 4, 140 | 4 | 1, 035 | 12 | 33. 8% | 4 | | | 2 | 50. 7% |
| | Sub total | 46, 085 | 44 | | 132 | 33. 4% | 44 | 0 | 0 | 20 | 48. 6% |

## Table 2-5 The number of water supply facility and water services ratio (2)

**The change villages from shallow well to Deep well** **Karagwe District**

| No | Village Name | Population | No. of wells(a) | Beneficiary per well | Number of well demand (b) | Well ratio (a)/(b) | Water supply plan DW | WR | TR | SP | Services Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Kagenyi | 3,300 | 4 | 825 | 9 | 42.4% | 4 | | | 1 | 53.0% |
| 2 | Kitwechenkura | 3,900 | 4 | 975 | 11 | 35.9% | 4 | | | 1 | 44.9% |
| 3 | Murongo | 1,880 | 4 | 470 | 5 | 74.5% | 4 | | | 1 | 93.1% |
| 4 | Nkwenda | 5,300 | 6 | 883 | 15 | 39.6% | 6 | 1 | | 1 | 52.8% |
| 5 | Nyakasimbi | 2,205 | 3 | 735 | 6 | 47.6% | 3 | | | 2 | 79.4% |
| 6 | Songambele | 2,400 | 5 | 480 | 7 | 72.9% | 5 | | | 1 | 87.5% |
| | Sub total | 18,985 | 26 | | 54 | 47.9% | 26 | 1 | 0 | 7 | 62.7% |

**The change villages from small dam to Deep well** **Karagwe District**

| No | Village Name | Population | No. of wells(a) | Beneficiary per well | Number of well demand (b) | Well ratio (a)/(b) | Water supply plan DW | WR | TR | SP | Services Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Bukangara | 3,320 | 2 | 1660 | 9 | 21.1% | 2 | | 8 | | 105.4% |
| 2 | Kahundwe | 2,216 | 4 | 554 | 6 | 63.2% | 4 | | | | 63.2% |
| 3 | Kashanda | 960 | 3 | 320 | 3 | 109.4% | 3 | | | | 109.4% |
| 4 | Katera | 1,020 | 3 | 340 | 3 | 102.9% | 3 | | | | 102.9% |
| 5 | Nyakahite | 2,100 | 4 | 525 | 6 | 66.7% | 4 | | | | 66.7% |
| 6 | Ruhita | 1,400 | 4 | 350 | 4 | 100.0% | 4 | | | | 100.0% |
| 7 | Rugera | 3,090 | 0 | 0 | 9 | 0.0% | 0 | | | | 0.0% |
| | Sub total | 14,106 | 20 | | 31 | 63.5% | 20 | 0 | 8 | 0 | 89.0% |

**The village for intake construction and rehabilitation** **Karagwe District**

| No | Village Name | Population | No. of wells(a) | Beneficiary per tap | Number of tap demand (b) | Well ratio (a)/(b) | Water supply plan DW | WR | TR | SP | Services Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Kihanga(kishojo) | 1,914 | 20 | 96 | 10 | 209.0% | | | | | |
| 2 | Katanda(katanda) | 2,024 | 13 | 156 | 10 | 128.5% | | | | | |
| | Sub total | 3,938 | 33 | | 20 | 167.6% | | | | | |

**The services ratio of whole villages (except villages of intake construction)**

| Water supply area | Population | No. of wells (a) | Beneficiary per well | Number of well demand (b) | (a)/(b) |
|---|---|---|---|---|---|
| Ngara, Karagwe | 97,773 | 130 | 752 | 279 | 46.5% |
| Including well rehabilitation | | 132 | 741 | 279 | 47.3% |
| Including other water sources | | 176 | 556 | 279 | 63.0% |

**The services ratio of whole villages (including villages of intake construction)**

| Water supply area | Population (a) | No. of wells | Beneficiary (b) | Services ratio (b)/(a) |
|---|---|---|---|---|
| 39 villages | 101,711 | 178 | 65,535 | 64% |

(2) Water Supply Systems

1) Deep well with hand pump

A. Depth and Structure of Well

The target well depth and the geological features of the sites designated for well construction are presented in Table 2.6. The diameter of the well is established at 5 inches with a screen opening exceeding 3%. To prevent contaminated surface water seepage, the annular surface of the well shall be cemented to a depth of 5m.

The drilling points are located on the slopes or at the bottom of the valley. Therefore, a temporary road located at a maximum distance of 200m from the points shall be constructed.

B. Hand Pump

The groundwater table at the drilling sites is estimated at 20 - 40m. Therefore, the maximum pumping lift shall be 50m and the pumping rate 15 - 20 liters/minute.

2) Gravity Water Supply System in Kihanga

A new spillway channel shall be constructed, and both sides of the channel shall be lined with adobe. The reservoir tank shall be repaired by the installation of a waterproof board and through banking works. It shall also be connected to the spillway. The pipelines and the valves shall be repaired as well.

The rehabilitation works involved shall be as follows:

a. installation of waterproof board around the storage tank ($7.8m^3$)
b. banking ($60m^3$)
c. construction of a channel with lining
d. partial replacement of pipelines (∅ 100mm))
e. replacement of stop valve, air valve, and drain valve
f. replacement of water taps (20 taps)

Since the scale of the above works is small and the use of machinery is impossible in terms of access, a local contractor shall be hired to carry out the works under the supervision of the Consultant.

3) Gravity Water Supply System in Katanda

The works involved in this area are as follows:

a. intake box ( each measuring $70m^3$)
b. storage tank (each measuring $30m^3$)
c. installation of ∅ 50mm main steel pipes and PVC pipes (1.0km)
d. installation of valves
e. installation of ∅ 35mm distribution pipes and PVC pipes (4.0km)
f. water taps and valve box (13 taps)

4) Spring protection works

The protection works consist of excavation, width expansion and installation of a lining to ensure increase in discharge, and construction of an apron and drain.

5) Existing Well

The hand pumps of damaged wells shall be removed and replaced with new ones after the wells are pumped and washed thoroughly.

(3) Equipment Plan

The outline of the equipment necessary for the implementation of this project is as follows:

1) Drilling rig and accessories

a. Drilling Rig (1 set)

Mountable, capable of drilling hard rocks (quartzite, granite, phyllite) upto a depth of 200m at a final drilling diameter of 8.5 inches. The rig should be able to conduct rotary type drilling and the Down-the-Hole (DTH) drilling method to cope with unconsolidated formations and hard rock areas.

b. Accessories

Drill bits and standard tools

c. Supporting Vehicles -

| | |
|---|---|
| High pressure type compressors (1): | for DTH drilling; mountable on trucks |
| Medium size cargo truck (2): | 6 t, with crane (for drilling tools & materials) |
| Water tank lorry (1): | 4.5m³ (water for drilling) |
| Fuel tank truck (1): | 2m³ (fuel for rig and generator) |

d. Instruments for groundwater investigations -

| | |
|---|---|
| Geophysical logging equipment (1 set) : | resistivity,<br>spontaneous potential,<br>gamma-gamma,<br>temperature,<br>cable length (200m) |
| Submersible motor pump (2 set): | 50-100m pumping lift, 50-200 liters/min and 200-500 liters/min maximum discharge |
| Generator (1 set): | For the rig and compressor |

e. Welder, Bentonite and CMC

Welder (1) - for welding in the site, bentonite & CMC (1 set) - for drilling

f. Hand pumps (130 for deep wells, 2 for existing wells, and 13 reserves)

The type of hand pumps to be used shall be selected based on the operation and maintenance level of the villagers. The hand pumps should have a maximum pumping lift of 50m with a 15 -20 liters/min pumping discharge. They shall be procured locally or from a third country.

g. Casing and Screen

The construction of the deep wells is completed with the installation of a 5 inch PVC casing. A PVC screen pipe with an opening ratio ranging from 3 - 5% shall be used as well. Allowance is estimated at 3% (refer to Table 2-6).

| | |
|---|---|
| 5 inches, 5m long: | 1,712 pieces (total length of 4,849m) |
| 5 inches, 5m long: | 466 pieces (total length of 1,212m) |

The pipes shall be also procured from a third country.

2) Equipment for maintenance and education

The following equipment shall be required for maintenance operations and the training of the villagers, during the construction stage and operation and maintenance stage:

a. pick-up trucks (2)

To be stationed in the districts of Karagwe and Ngara; shall be used to transport people from one village to the other, as well as hand pump spares, pipes and other tools

b. motorcycles (4)

2 each shall be stationed in the districts of Karagwe and Ngara; shall be used as means of transport from village to village

c. wireless communication system (2 sets)

To establish communication with the DWE, the drilling team and maintenance team in the districts of Karagwe and Ngara, respectively

d. water analysis kit (2 sets)

To analyze water quality according to the established standards for drinking

e. standard tools

Tools for hand pump, pipe and vehicle maintenance

f. comruter (1 set)

To prepare deep well inventory and management

The spares for the above mentioned equipment shall be provided within 10% of the price.

Table 2-6 Data for well depth, casing length, screen length, etc.(1)

| Number | Village name | Well number in village | Drilling depth | Surface layer | Rotary method | | | Rotary method with DTH | Casing | | Screen | | Centralizer | Bottom plug | Well cap |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (m) | (m) | Classification | | | | Length | Unit | Length | Unit | | | |
| | | | | | A | B | C | D | (m) | (pcs) | (m) | (pcs) | pcs | pcs | pcs |
| 1 | Mukalinzi | 1 | 50 | 20 | 20 | | 30 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 2 | | 4 | 60 | 30 | | 30 | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 3 | | 5 | 65 | 35 | | 35 | 30 | | 52 | 18 | 13 | 5 | 7 | 1 | 1 |
| 4 | | 6 | 60 | 20 | | 20 | 40 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 5 | | 10 | 50 | 20 | 20 | | 30 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 6 | Mukubu | 9 | 80 | 10 | | 10 | 70 | | 64 | 23 | 16 | 6 | 8 | 1 | 1 |
| 7 | Mururama | 1 | 60 | 10 | | 10 | 50 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 8 | | 2 | 75 | 15 | | 15 | | 60 | 60 | 21 | 15 | 6 | 8 | 1 | 1 |
| 9 | | 3 | 55 | 15 | | 15 | | 40 | 44 | 16 | 11 | 4 | 6 | 1 | 1 |
| 10 | | 6 | 80 | 20 | | 20 | | 60 | 64 | 23 | 16 | 6 | 8 | 1 | 1 |
| 11 | Murubanga | 1 | 60 | 20 | 20 | | 40 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 12 | | 2 | 60 | 20 | 20 | | 40 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 13 | | 3 | 45 | 15 | 15 | | 30 | | 36 | 13 | 9 | 4 | 5 | 1 | 1 |
| 14 | | 4 | 50 | 20 | 20 | | 30 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 15 | | 5 | 45 | 15 | 15 | | 30 | | 36 | 13 | 9 | 4 | 5 | 1 | 1 |
| 16 | | 8 | 50 | 30 | 30 | | 20 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 17 | Kihinga | 2 | 65 | 15 | | 15 | | 50 | 52 | 18 | 13 | 5 | 7 | 1 | 1 |
| 18 | Kumubuga | 3 | 50 | 20 | 20 | | | 30 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 19 | | 4 | 60 | 30 | 30 | | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 20 | | 5 | 60 | 30 | 30 | | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 21 | Magamba | 1 | 60 | 20 | 20 | | | 40 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 22 | | 2 | 50 | 15 | 15 | | | 35 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 23 | | 3 | 50 | 20 | | 20 | | 30 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 24 | | 4 | 60 | 10 | | 10 | | 50 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 25 | | 8 | 55 | 15 | | 15 | | 40 | 44 | 16 | 11 | 4 | 6 | 1 | 1 |
| 26 | | 9 | 55 | 10 | | 10 | | 45 | 44 | 16 | 11 | 4 | 6 | 1 | 1 |
| 27 | Muganza | 1 | 50 | 10 | 10 | | 40 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 28 | | 2 | 50 | 10 | 10 | | 40 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 29 | | 3 | 48 | 8 | | 8 | 40 | | 38.4 | 14 | 9.6 | 4 | 5 | 1 | 1 |
| 30 | | 4 | 80 | 20 | 20 | | 60 | | 64 | 23 | 16 | 6 | 8 | 1 | 1 |
| 31 | | 5 | 82 | 12 | 12 | | 70 | | 65.6 | 23 | 16.4 | 6 | 9 | 1 | 1 |
| 32 | | 7 | 75 | 15 | 15 | | 60 | | 60 | 21 | 15 | 6 | 8 | 1 | 1 |
| 33 | Ntanga | 1 | 60 | 20 | 20 | | | 40 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 34 | | 2 | 45 | 15 | 15 | | | 30 | 36 | 13 | 9 | 4 | 5 | 1 | 1 |
| 35 | | 6 | 45 | 15 | 15 | | | 30 | 36 | 13 | 9 | 4 | 5 | 1 | 1 |
| 36 | | 7 | 70 | 10 | 10 | | | 60 | 56 | 20 | 14 | 5 | 7 | 1 | 1 |
| 37 | Nyabihanga | 1 | 45 | 15 | | 15 | | 30 | 36 | 13 | 9 | 4 | 5 | 1 | 1 |
| 38 | | 2 | 50 | 10 | | 10 | | 40 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 39 | | 5 | 40 | 10 | 10 | | | 30 | 32 | 12 | 8 | 3 | 4 | 1 | 1 |
| 40 | | 6 | 40 | 10 | 10 | | | 30 | 32 | 12 | 8 | 3 | 4 | 1 | 1 |
| | Total | | 2,290 | | 422 | 258 | 750 | 860 | 1,832 | 651 | 458 | 183 | 236 | 40 | 40 |
| | | | | | | 680 | | 1,610 | | | | | | | |
| | | | | | | | | 2,290 | | | | | | | |
| | Including 3% of spare ratio | | | | | | | | 1,887 | 671 | 472 | 188 | 243 | 41 | 41 |

Table 2-6 Data for well depth, casing length, screen length, etc.(2)

| Number | Village name | Well number in village | Drilling depth | Surfase layer | Rotary method | | Rotary method with | D.T.H. | Casing | | Screen | | Centralizer | Bottom plug | Well cap |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (m) | (m) | Classificaion | | | | Length | Unit | Length | Unit | | | |
| | | | | | A | B | C | D | (m) | (pcs) | (m) | (pcs) | (pcs) | (pcs) | (pcs) |
| 1 | Bugara | 1 | 100 | 10 | | 10 | | 90 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 2 | | 2 | 50 | 50 | 50 | | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 3 | | 3 | 50 | 50 | 50 | | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 4 | | 5 | 100 | 10 | | 10 | | 90 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 5 | Busindc | 2 | 50 | 50 | 50 | | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 6 | | 3 | 55 | 30 | 30 | | 25 | | 44 | 16 | 11 | 4 | 6 | 1 | 1 |
| 7 | | 4 | 55 | 50 | 50 | | 5 | | 44 | 16 | 11 | 4 | 6 | 1 | 1 |
| 8 | | 5 | 55 | 30 | 30 | | 25 | | 44 | 16 | 11 | 4 | 6 | 1 | 1 |
| 9 | Chanya | 1 | 50 | 10 | | 10 | 40 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 10 | Itera | 1 | 50 | 10 | | 10 | 40 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 11 | Kamuli | 1 | 90 | 20 | | 20 | | 70 | 72 | 25 | 18 | 7 | 9 | 1 | 1 |
| 12 | | 3 | 50 | 20 | | 20 | | 30 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 13 | | 5 | 50 | 10 | | 10 | 40 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 14 | Kayungu | 1 | 60 | 30 | | 30 | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 15 | | 2 | 70 | 30 | | 30 | | 40 | 56 | 20 | 14 | 5 | 7 | 1 | 1 |
| 16 | | 3 | 60 | 30 | | 30 | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 17 | | 4 | 50 | 20 | | 20 | | 30 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 18 | | 5 | 50 | 20 | | 20 | | 30 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 19 | | 6 | 50 | 40 | 40 | | 10 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 20 | Kibare | 3 | 70 | 50 | | 50 | | 20 | 56 | 20 | 14 | 5 | 7 | 1 | 1 |
| 21 | | 4 | 60 | 40 | | 40 | | 20 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| | Kibona | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | Kibondo | 1 | 70 | 30 | | 30 | | 40 | 56 | 20 | 14 | 5 | 7 | 1 | 1 |
| 23 | | 2 | 70 | 60 | | 60 | | 10 | 56 | 20 | 14 | 5 | 7 | 1 | 1 |
| 24 | | 4 | 70 | 30 | | 30 | | 40 | 56 | 20 | 14 | 5 | 7 | 1 | 1 |
| 25 | | 5 | 80 | 30 | | 30 | | 50 | 64 | 23 | 16 | 6 | 8 | 1 | 1 |
| 26 | Kitwe | 1 | 50 | 50 | | 50 | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 27 | | 2 | 50 | 50 | | 50 | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 28 | | 3 | 50 | 50 | 50 | | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 29 | | 5 | 80 | 50 | 50 | | 30 | | 64 | 23 | 16 | 6 | 8 | 1 | 1 |
| 30 | | 6 | 80 | 50 | | 50 | | 30 | 64 | 23 | 16 | 6 | 8 | 1 | 1 |
| 31 | Mashcshe | 1 | 60 | 15 | 15 | | 45 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 32 | | 2 | 60 | 15 | 15 | | 45 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 33 | | 3 | 60 | 15 | 15 | | 45 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| | Nyabwegira | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | Nyakabanga | 2 | 60 | 15 | | 15 | | 45 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 35 | | 3 | 60 | 40 | | 40 | | 20 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 36 | | 4 | 50 | 40 | | 40 | | 10 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 37 | | 5 | 60 | 30 | | 30 | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 38 | | 6 | 60 | 40 | | 40 | | 20 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 39 | Nyakatuntu | 1 | 50 | 30 | | 30 | 20 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 40 | | 2 | 60 | 40 | | 40 | | 20 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |

Table 2-6 Data for well depth, casing length, screen length, etc.(3)

| Number | Village name | Well number in village | Drilling depth | Surfase layer | Rotary method | | Rotary method with D.T.H. | | Casing | | Screen | | Centralizer | Bottom plug | Well cap |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (m) | (m) | Classificaion | | | | Length | Unit | Length | Unit | | | |
| | | | | | A | B | C | D | (m) | (pcs) | (m) | (pcs) | (pcs) | (pcs) | (pcs) |
| 41 | Nyamiyaga | 5 | 50 | 30 | | 30 | 20 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 42 | | 6 | 50 | 30 | | 30 | 20 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 43 | | 7 | 70 | 40 | 40 | | 30 | | 56 | 20 | 14 | 5 | 7 | 1 | 1 |
| 44 | | 8 | 70 | 40 | 40 | | 30 | | 56 | 20 | 14 | 5 | 7 | 1 | 1 |
| 45 | Kagenyi | 1 | 60 | 10 | 10 | | 50 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 46 | | 2 | 50 | 20 | 20 | | 30 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 47 | | 3 | 50 | 10 | 10 | | 40 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 48 | | 4 | 60 | 15 | 15 | | 45 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 49 | Kitweche- | 1 | 60 | 40 | 40 | | | 20 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 50 | nkula | 3 | 60 | 30 | 30 | | 30 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 51 | | 4 | 60 | 20 | 20 | | 40 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 52 | | 5 | 60 | 40 | 40 | | 20 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 53 | Murongo | 1 | 60 | 40 | | 40 | | 20 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 54 | | 3 | 40 | 20 | | 20 | | 20 | 32 | 12 | 8 | 3 | 4 | 1 | 1 |
| 55 | | 4 | 40 | 20 | | 20 | | 20 | 32 | 12 | 8 | 3 | 4 | 1 | 1 |
| 56 | | 5 | 50 | 30 | 30 | | 20 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 57 | Nkwenda | 1 | 50 | 40 | | 40 | 10 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 58 | | 2 | 50 | 50 | | 50 | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 59 | | 3 | 50 | 50 | | 50 | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 60 | | 4 | 50 | 50 | | 50 | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 61 | | 5 | 50 | 50 | | 50 | | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 62 | | 6 | 60 | 60 | | 60 | | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 63 | Nyakasimbi | 1 | 100 | 40 | | 40 | | 60 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 64 | | 2 | 80 | 40 | 40 | | 40 | | 64 | 23 | 16 | 6 | 8 | 1 | 1 |
| 65 | | 5 | 80 | 20 | | 20 | | 60 | 64 | 23 | 16 | 6 | 8 | 1 | 1 |
| 66 | Songambele | 1 | 50 | 40 | | 40 | 10 | | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 67 | | 2 | 60 | 30 | 30 | | 30 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 68 | | 3 | 60 | 30 | 30 | | 30 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 69 | | 4 | 60 | 30 | 30 | | 30 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 70 | | 5 | 60 | 30 | 30 | | 30 | | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 71 | Bukangara | 1 | 100 | 30 | | 30 | | 70 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 72 | | 2 | 100 | 30 | | 30 | | 70 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 75 | Kabundwe | 1 | 100 | 30 | 30 | | 70 | | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 76 | | 2 | 100 | 30 | 30 | | 70 | | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 77 | | 3 | 100 | 30 | 30 | | 70 | | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 78 | | 4 | 100 | 30 | 30 | | 70 | | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 79 | Kashanda | 1 | 100 | 30 | 30 | | 70 | | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 80 | | 2 | 100 | 30 | 30 | | 70 | | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 81 | | 3 | 100 | 30 | 30 | | 70 | | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 82 | Katera | 1 | 60 | 30 | | 30 | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 83 | | 2 | 60 | 30 | | 30 | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |
| 84 | | 3 | 60 | 30 | | 30 | | 30 | 48 | 17 | 12 | 5 | 6 | 1 | 1 |

Table 2-6 Data for well depth, casing length, screen length, etc.(4)

| Number | Village name | Well number in village | Drilling depth (m) | Surfase layer (m) | Rotary method | | Rotary method with D.T.H. | | Casing | | Screen | | Centralizer | Bottom plug | Well cap |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Classificaion | | | | Length | Unit | Length | Unit | | | |
| | | | | | A | B | C | D | (m) | (pcs) | (m) | (pcs) | (pcs) | (pcs) | (pcs) |
| 85 | Nyakahite | 1 | 100 | 30 | | 30 | | 70 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 86 | | 2 | 100 | 30 | | 30 | | 70 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 87 | | 3 | 100 | 30 | | 30 | | 70 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 88 | | 4 | 100 | 30 | | 30 | | 70 | 80 | 28 | 20 | 7 | 10 | 1 | 1 |
| 89 | Ruhita | 1 | 50 | 30 | | 30 | | 20 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 90 | | 2 | 50 | 30 | | 30 | | 20 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 91 | | 3 | 50 | 30 | | 30 | | 20 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| 92 | | 4 | 50 | 30 | | 30 | | 20 | 40 | 14 | 10 | 4 | 5 | 1 | 1 |
| | Rugera | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | | 5,885 | | 1,110 | 1,775 | 1,415 | 1,585 | 4,708 | 1,662 | 1,177 | 452 | 590 | 90 | 90 |
| | | | | | | 2,885 | | 3,000 | | | | | | | |
| | | | | | | | | 5,885 | | | | | | | |
| Including 3% of spare ratio | | | | | | | | | 4,849 | 1,712 | 1,212 | 466 | 608 | 93 | 93 |

| | | |
|---|---|---|
| Screen installation retio | □F | One fifth(1/5) of well depth |
| Centralizer installation retio | □F | one for 10 meter |
| Unit length of casing and scre | □F | 2.9 meter per unit |
| Classification A | □F | Sand, sandy clay formation |
| Classification B | □F | Gravel formation |
| Classification C | □F | Soft rock formation |
| Classification D | □F | Hard rock formation |

3) Medical instruments

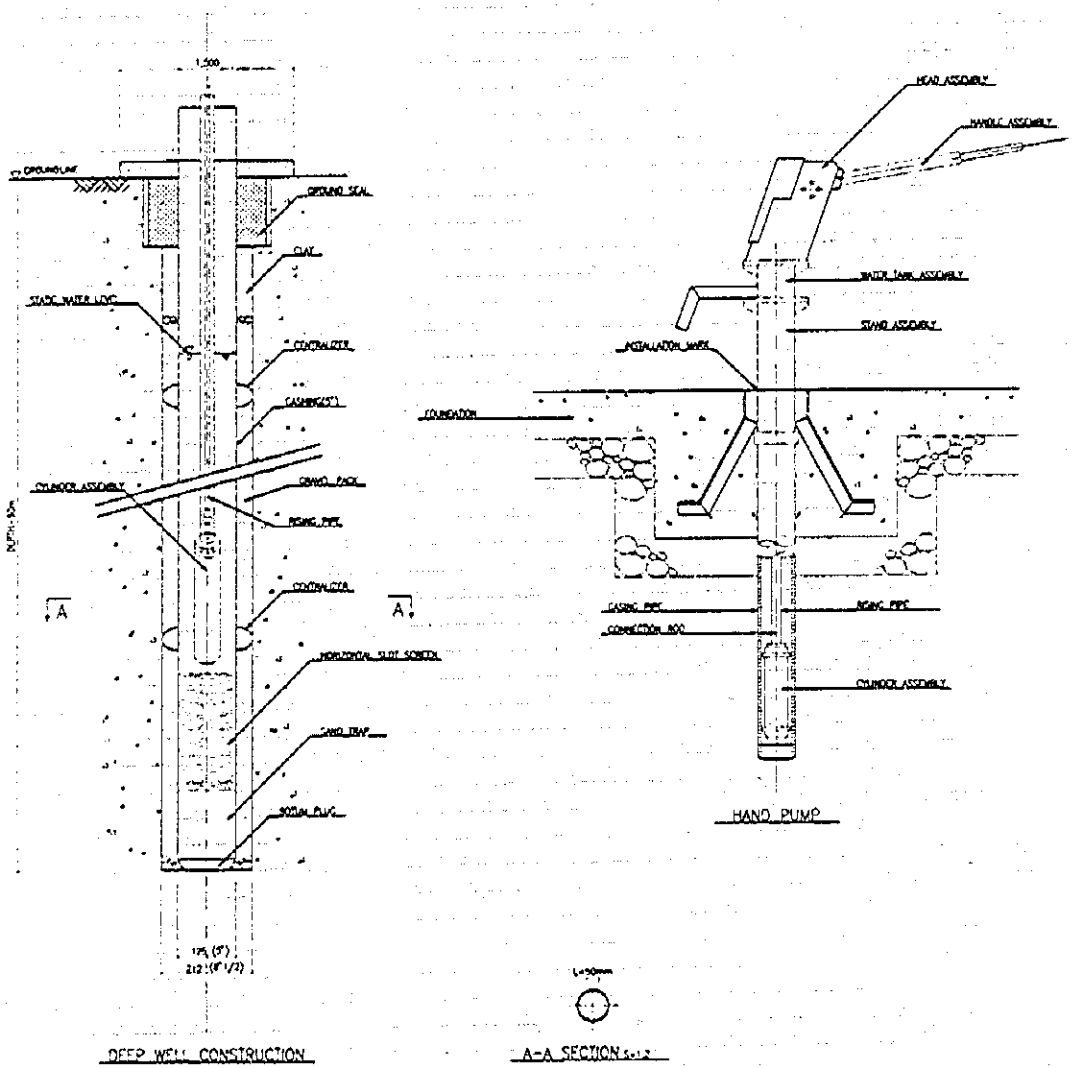
The medical instruments shall meet the baic requirement at the primary medical services and consist of 43 items which can be operated manually.
Table 2.7 shows the list of the public health center and clinics where the medical instruments shall be procured.

Table 2.7 List of clinics and public health center
(Karagwe and Ngara district)

| Karagwe | | | | Ngara | | | |
|---|---|---|---|---|---|---|---|
| No. | Place | No. | Place | No. | Place | No. | Place |
| 1 | Nyakahanga | 11 | Kikukuru | 1 | Bukiriro | 11 | Rwinbogo |
| 2 | Murongo | 12 | Kimuli | 2 | Rusumo | 12 | Kasolo |
| 3 | Kayanga | 13 | Kamaganbo | 3 | Kirushya | 13 | Muganza |
| 4 | Rwenkende | 14 | Chamchuzi | 4 | Kanazi | 14 | Murubanga |
| 5 | Nyaishozi | 15 | Kishoji | 5 | Djululigwa | 15 | Mukarche |
| 6 | Kibungo | 16 | Kitengule | 6 | Mbuma | 16 | Ruganzo |
| 7 | Kaisho | 17 | Chanika | 7 | Kanyinya | 17 | Nyakisasa |
| 8 | Kyerwa | 18 | Kiruruma | 8 | Nyarulama | 18 | Nyamahwa |
| 9 | Nyakatuntu | | | 9 | Bugarama | 19 | Muyenzi |
| 10 | Mabira | | | 10 | Murusagmba | 20 | Munjebwe |

4) Basic Design Drawings

| | |
|---|---|
| No.1 | Deep Well Construction and Hand pump Structure |
| No.2 | Typical Design For Spring Protection |
| No.3 | Typical Design for Collection Ditch |
| No.4 | Rehabilitation of Gravity Water Supply System (Plan) |
| No.5 | Rehabilitation of Gravity Water Supply System (Intake) |
| No.6 | New Gravity Water Supply System (Plan) |
| No.7 | New Gravity Water Supply System (Intake) |
| No.8 | New Gravity Water Supply System (Longitudinal Section-1) |
| No.9 | New Gravity Water Supply System (Longitudinal Section-2) |
| No.10 | New Gravity Water Supply System (Longitudinal Section-3) |
| No.11 | Typical Design for Road Crossing and River Crossing |
| No.12 | Typical Design for Communal |
| No.13 | Layout Plan for Temporary Office Yard |
| No.14 | Layout Plan for Temporary Office Building |
| No.15 | Typical Design for Operation and Maintenance Road |




| PHASE | KAPACHE | NGARA | ADVANTAGE% | TOTAL |
|---|---|---|---|---|
| 1PHASE | 70 | 0 | 14 | 84 |
| 2PHASE | 20 | – | 4 | 24 |
| | – | 40 | 8 | 48 |
| TOTAL | 90 | 40 | 26 | 156 |

THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE AFFECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA

DWG No.: | SHEET No.: | DESIGNED BY: | DATE:

DRAWING TITLE: No.1 Deep Well Construction And Hand Pump Structure

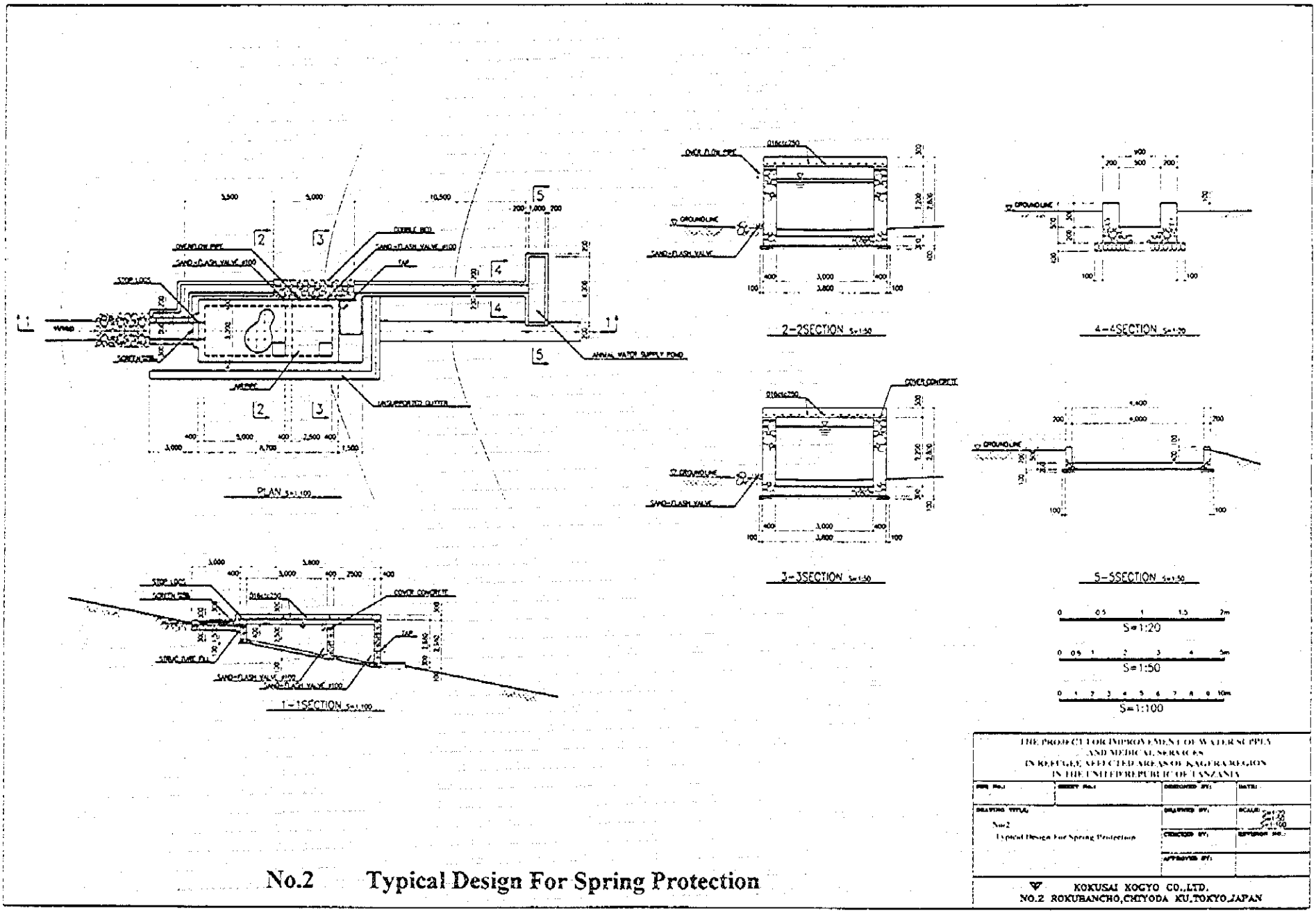
DRAWN BY: | SCALE: NON SCALE

CHECKED BY: | REVISION No.:

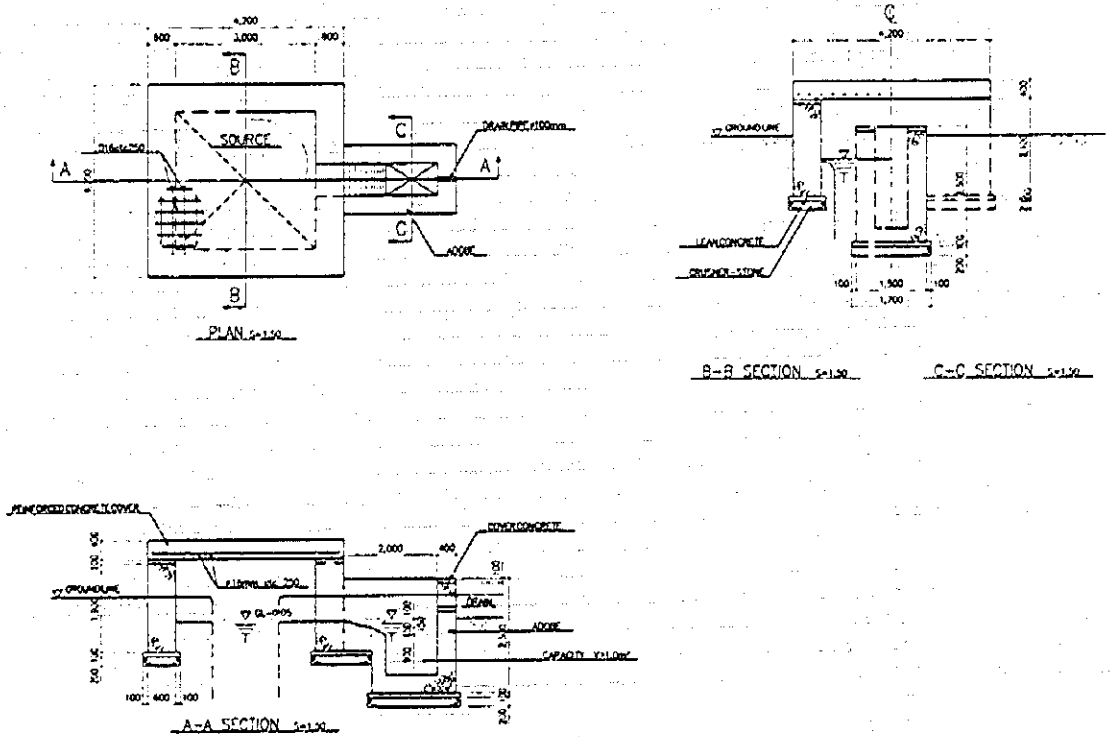
APPROVED BY:

KOKUSAI KOGYO CO.,LTD.
NO.2 ROKUBANCHO,CHIYODA KU,TOKYO,JAPAN

**No.1 Deep Well Construction and Hand pump Structure**




**No.2 Typical Design For Spring Protection**

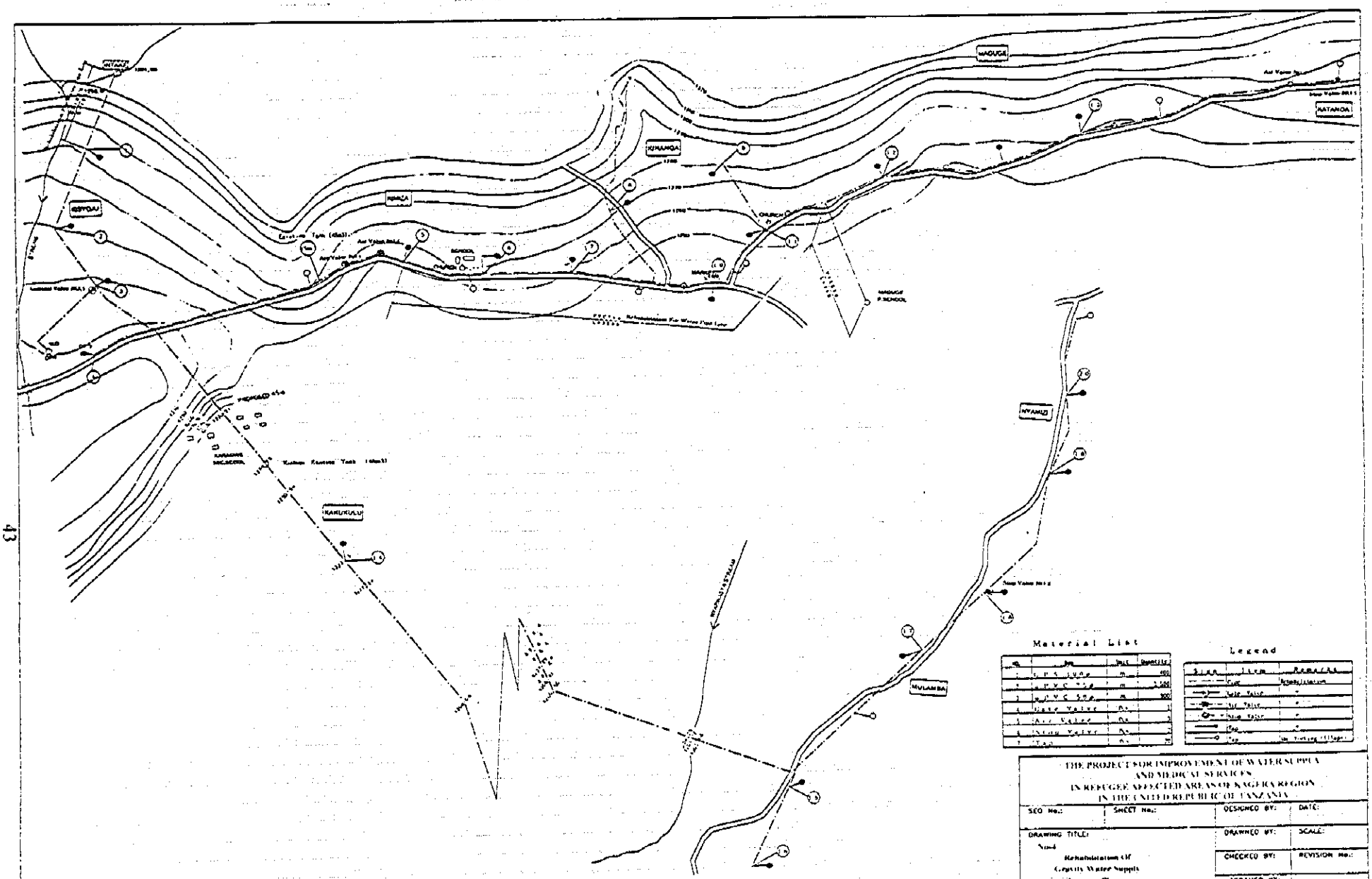



THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE AFFECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA

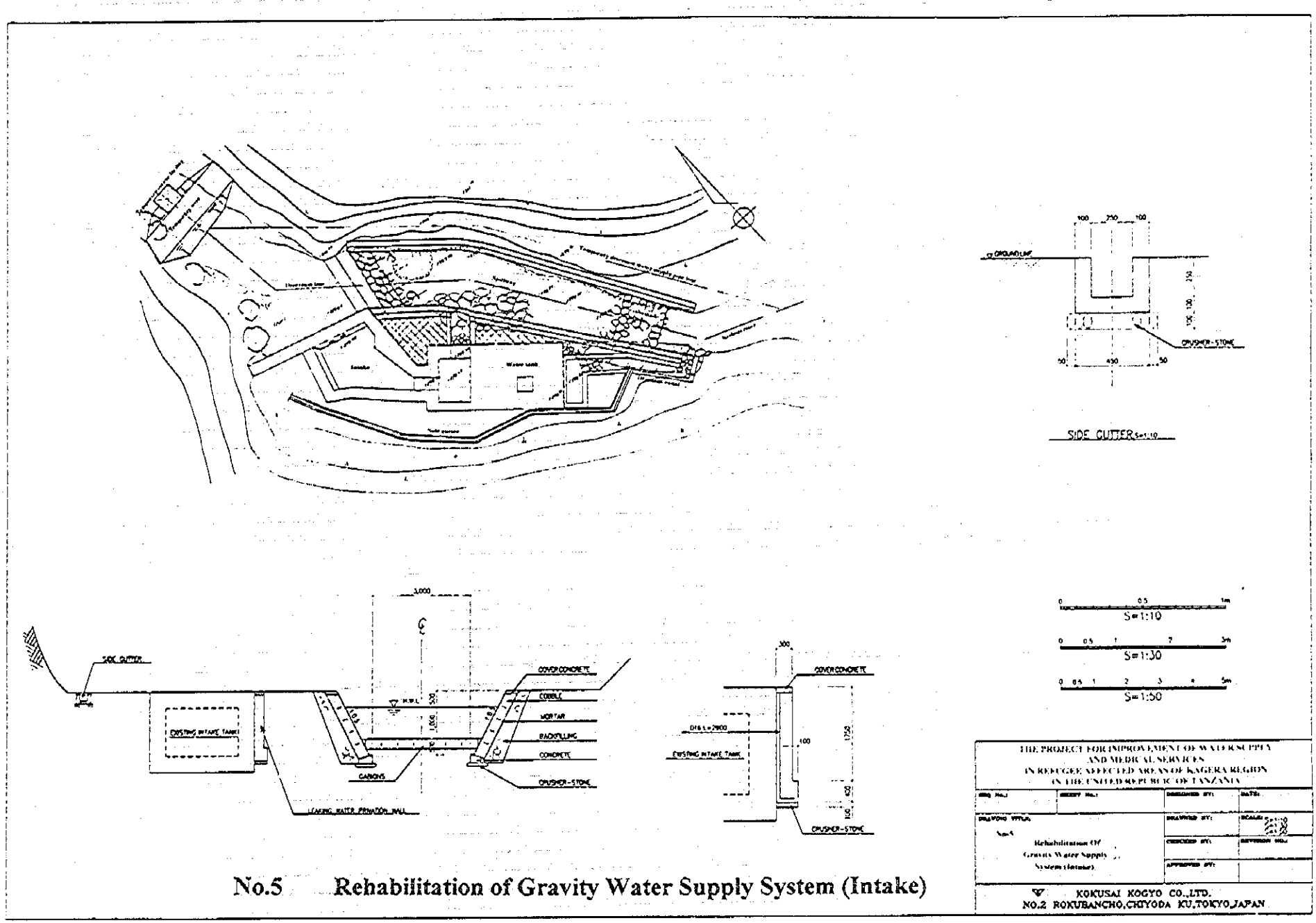
| | | | |
|---|---|---|---|
| DWG. No.: | SHEET No.: | DESIGNED BY: | DATE: |
| DRAWING TITLE: No.3 Typical Design For Collection Ditch | | DRAWN BY: | SCALE: 1:50 |
| | | CHECKED BY: | REVISION No.: |
| | | APPROVED BY: | |

KOKUSAI KOGYO CO.,LTD.
NO.2 ROKUBANCHO,CHIYODA KU,TOKYO,JAPAN

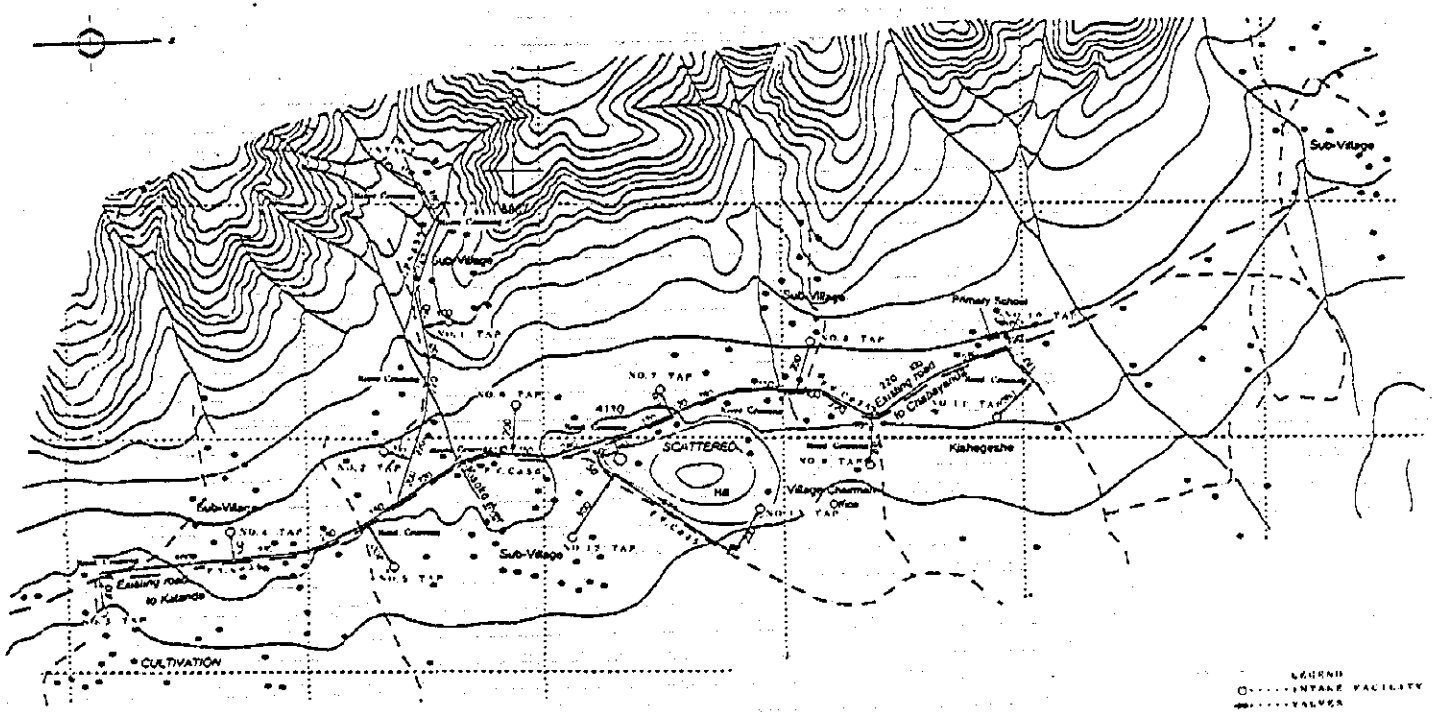
## No.3 Typical Design for Collection Ditch




**No.4 Rehabilitation of Gravity Water Supply System (Plan)**




**No.5 Rehabilitation of Gravity Water Supply System (Intake)**




LEGEND

- INTAKE FACILITY
- VALVES
- TAPS
- G.P.S. GALVANIZE PIPE
- P.V.C. POLY VINYL PIPE
- V.P.V.C. VINYL PIPE

QUANTITY LIST

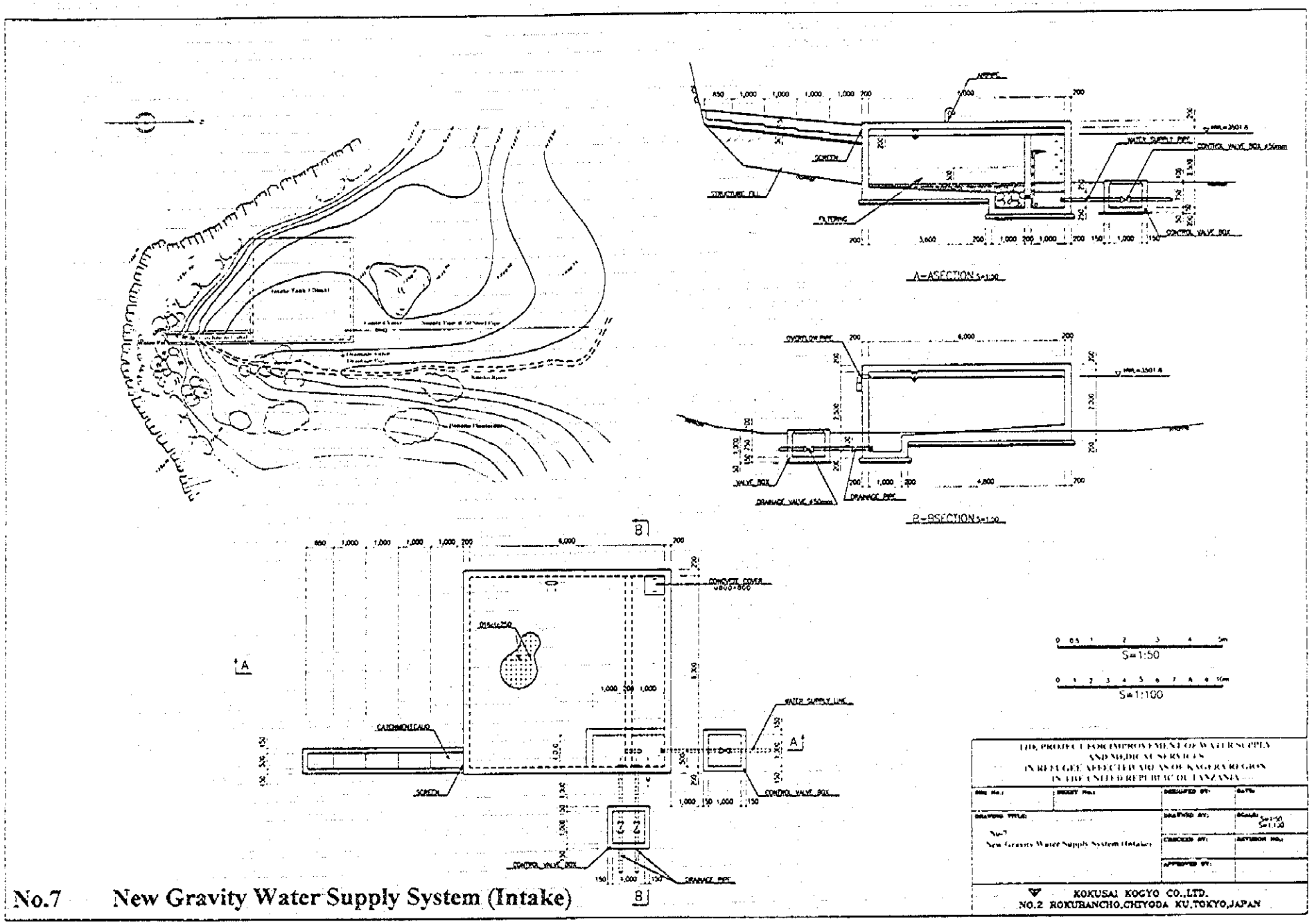
| | | | | |
|---|---|---|---|---|
| Pipe | | | | |
| Valve | | | | |
| Tap | | | | |
| Intake Facility | | | | |
| Others | | | | |

THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE AFFECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA

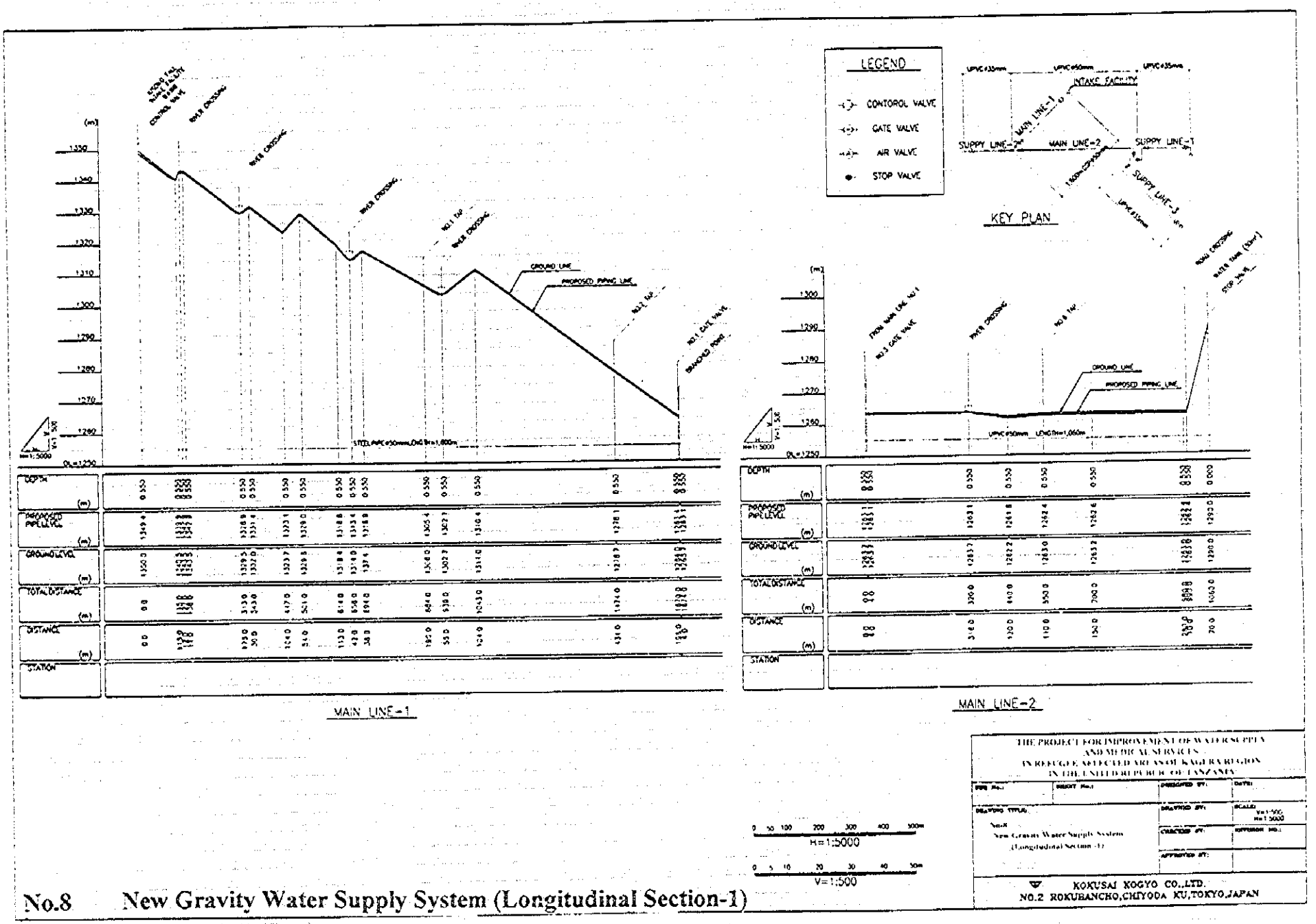
| | | | |
|---|---|---|---|
| SEQ No.: | SHEET No.: | DESIGNED BY: | DATE: |
| DRAWING TITLE: New Gravity Water Supply System (Plan) | | DRAWN BY: | SCALE: 1:10000 |
| | | CHECKED BY: | REVISION No.: |
| | | APPROVED BY: | |

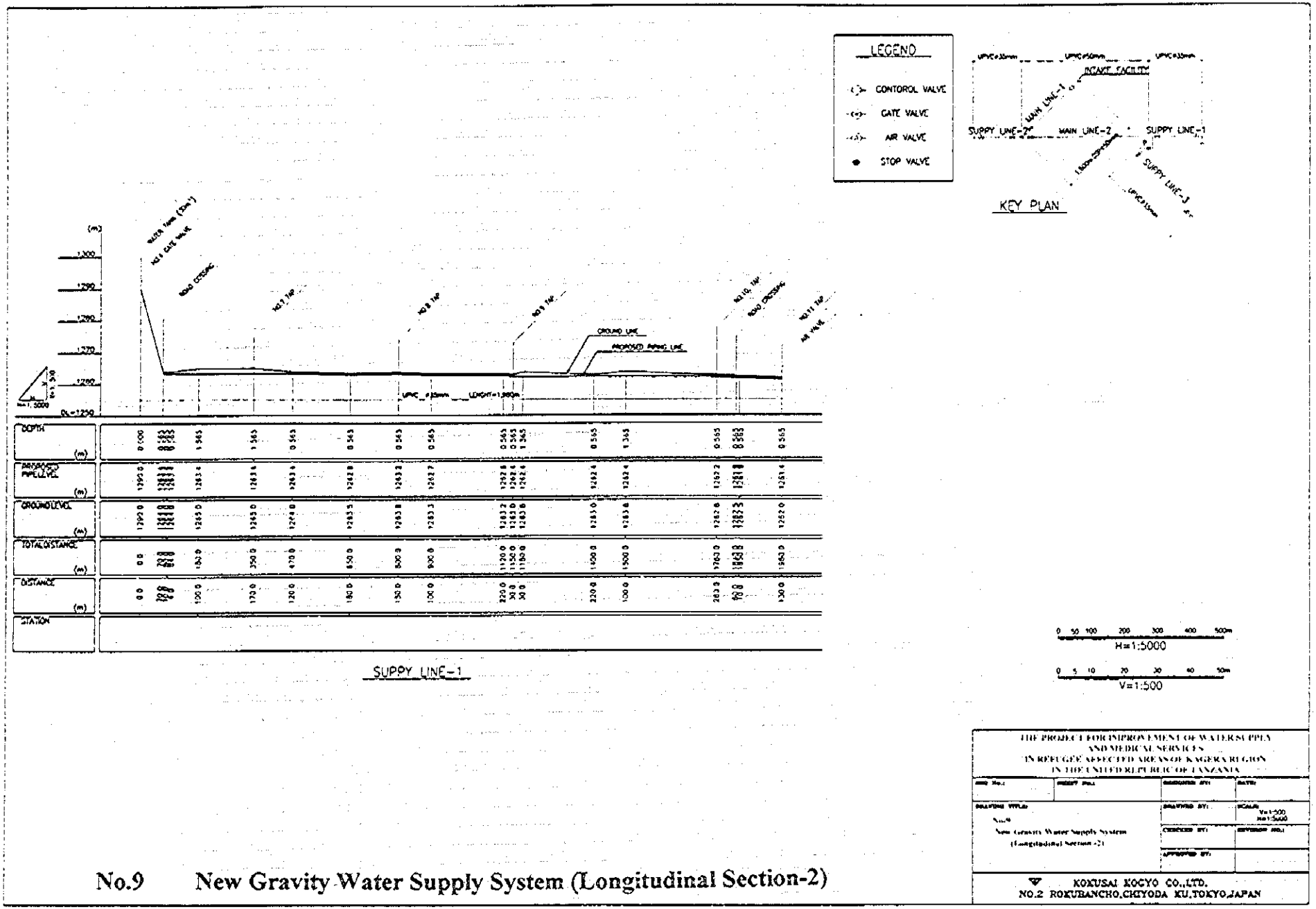
KOKUSAI KOGYO CO.,LTD.
NO.2 ROKUBANCHO,CHIYODA KU,TOKYO,JAPAN

**No.6 New Gravity Water Supply System (Plan)**

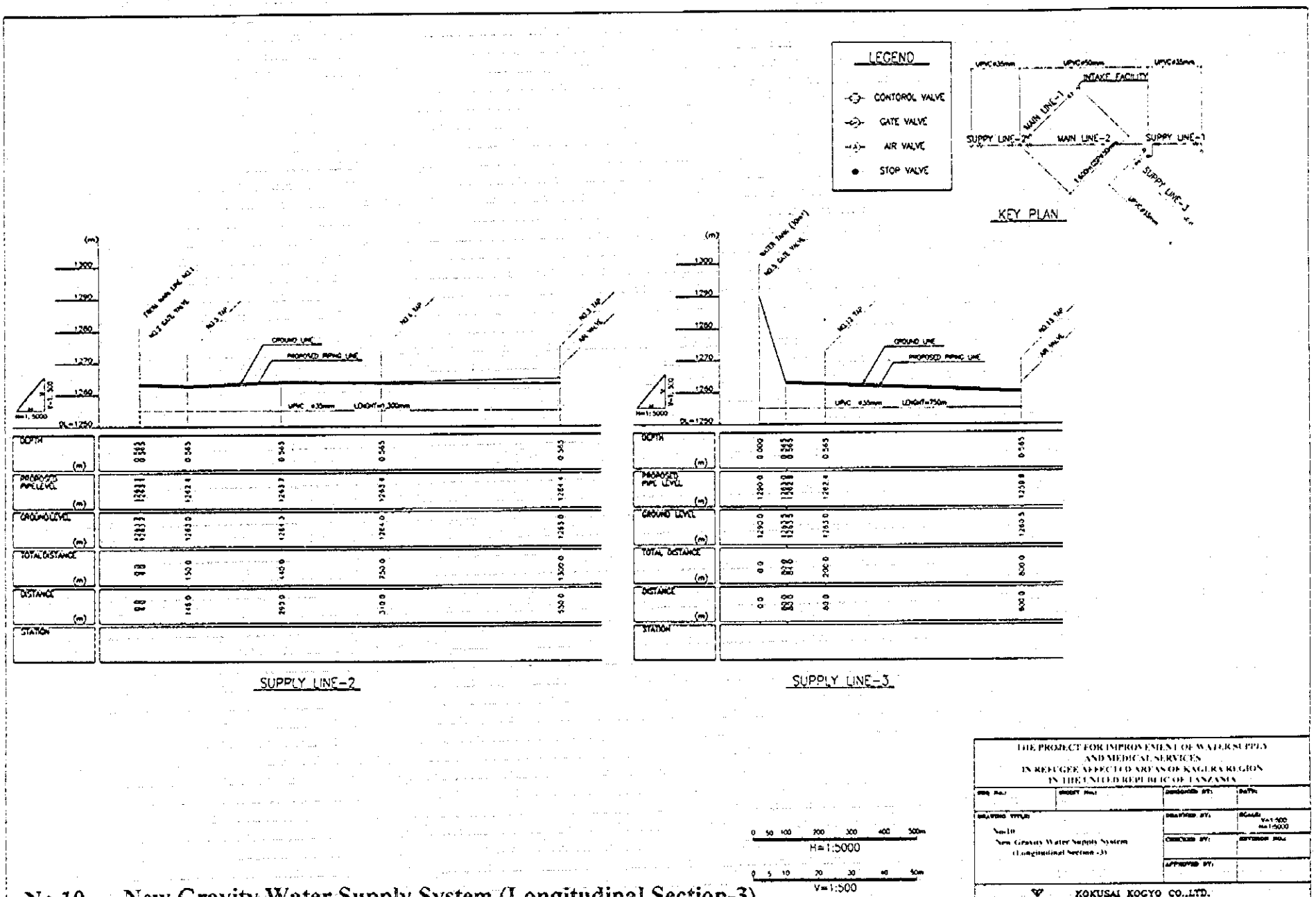



**No.7 New Gravity Water Supply System (Intake)**

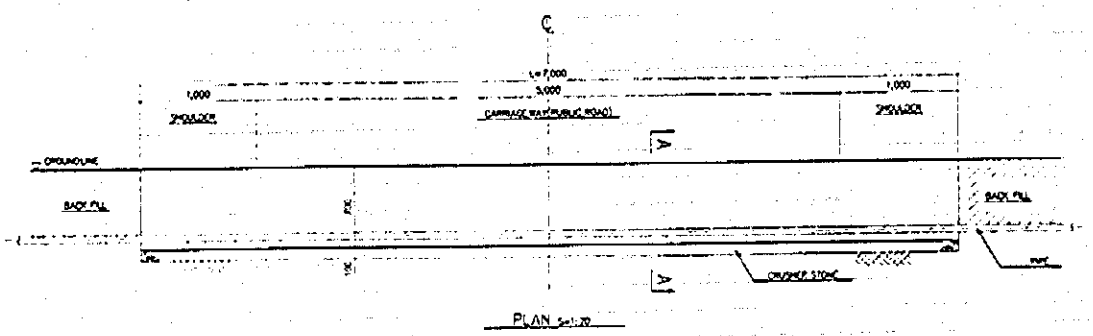

LEGEND
CONTOROL VALVE
GATE VALVE
AIR VALVE
STOP VALVE
KEY PLAN
INTAKE FACILITY
MAIN LINE-1
MAIN LINE-2
SUPPLY LINE-1
SUPPLY LINE-2
SUPPLY LINE-3
RIVER CROSSING
GROUND LINE
PROPOSED PIPING LINE
DEPTH
PROPOSED PIPE LEVEL
GROUND LEVEL
TOTAL DISTANCE
DISTANCE
STATION
MAIN LINE-1
MAIN LINE-2
H=1:5000
V=1:500
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE SELECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA
No.8 New Gravity Water Supply System (Longitudinal Section-1)
KOKUSAI KOGYO CO.,LTD.
NO.2 ROKUBANCHO,CHIYODA KU,TOKYO,JAPAN




**No.9 New Gravity Water Supply System (Longitudinal Section-2)**



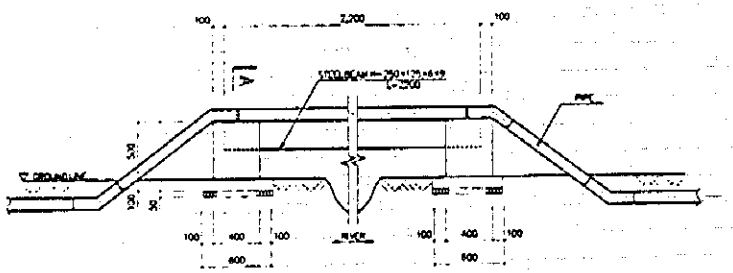

**No.10 New Gravity Water Supply System (Longitudinal Section-3)**



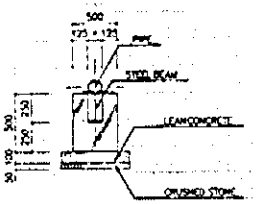

PLAN S=1:20


A-A SECTION S=1:20

TYPICAL DESING FOR EXITING ROAD CROSSING




PLAN S=1:20




A-A SECTION S=1:20

TYPICAL DESING FOR RIVER CROSSING

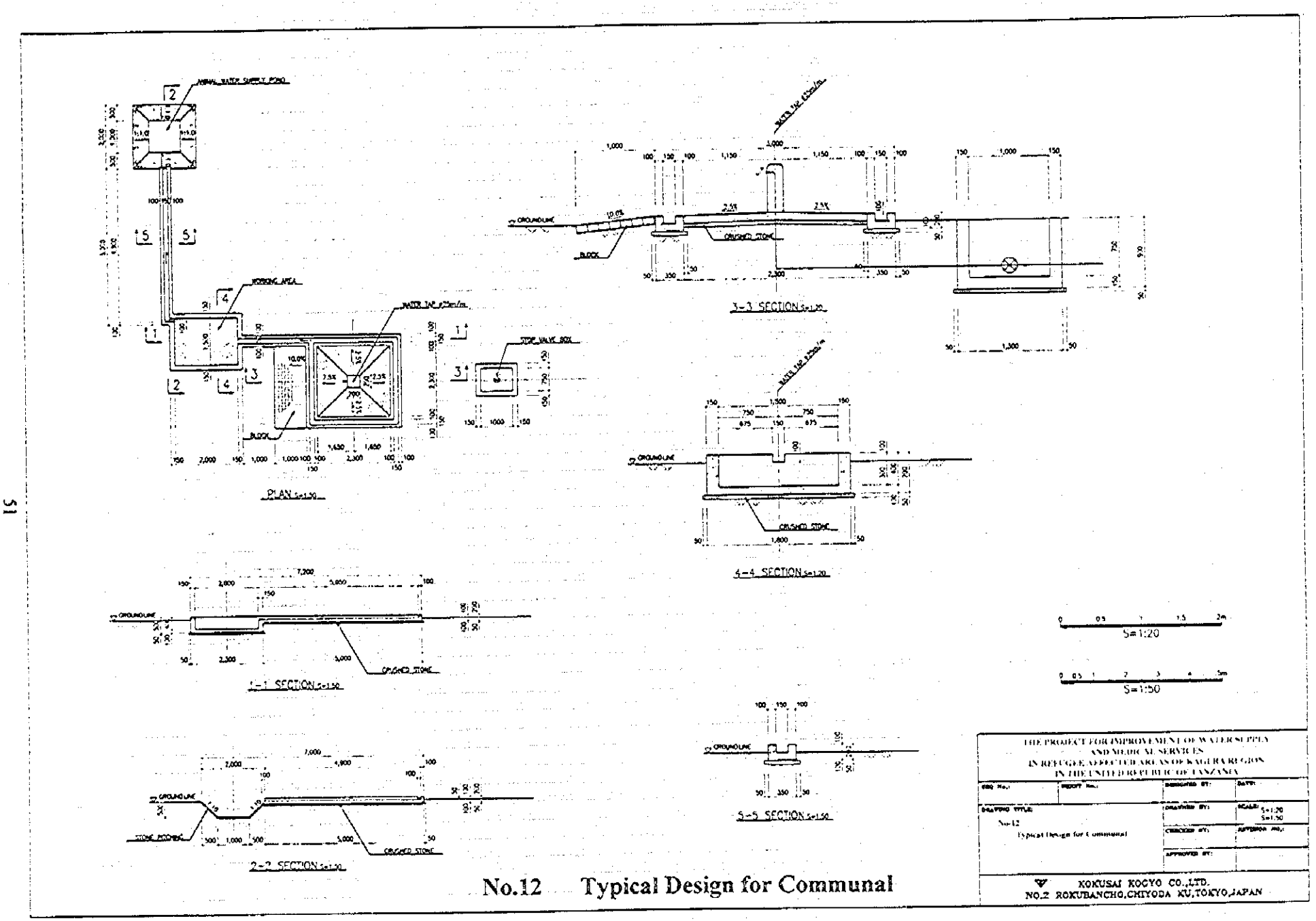
0 0.5 1 1.5 2m
S=1:20

THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE AFFECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA

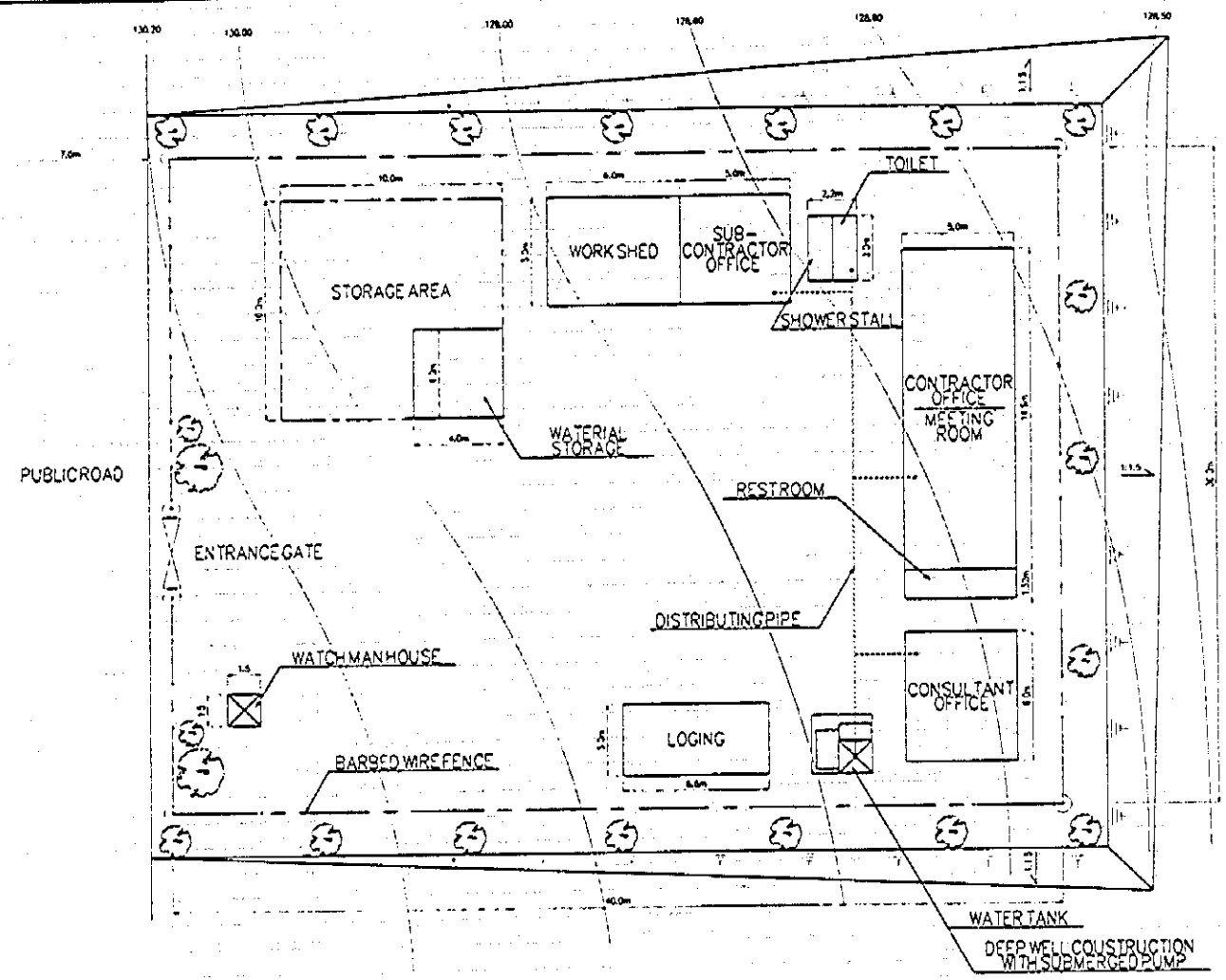
| | | | |
|---|---|---|---|
| DRG No.: | SHEET No.: | DESIGNED BY: | DATE: |
| DRAWING TITLE: No.11 Typical Design For Road Crossing And River Crossing | | DRAWNED BY: | SCALE: S=1:20 |
| | | CHECKED BY: | REVISION NO.: |
| | | APPROVED BY: | |

KOKUSAI KOGYO CO.,LTD.
NO.2 ROKUBANCHO,CHIYODA KU,TOKYO,JAPAN

# No.11 Typical Design for Road Crossing and River Crossing




**No.12 Typical Design for Communal**




AREA OF TEMPORARY OFFICE AND FACILTIES

(m²)

| | KARAGWE | NGARA |
|---|---|---|
| CONSULTANT OFFICE | 30 | 10 |
| CONTRACTOR OFFICE (MEETINGROOM) | 73 | 39 |
| STORAGE AREA | 100 | 100 |
| WORK SHED | 30 | 30 |
| SUB-CONTRACTOR OFFICE | 25.0 | 15 |
| WATERIAL STORAGE | 16 | 16 |
| LOGING | 33 | 8.5 |
| TOILET | 3.3 | 3.3 |
| SHOWER STALL | 3.3 | 3.3 |
| REST ROOM | 6.6 | 6.6 |
| WATCHMAN HOUSE | 2.25 | 2.25 |

0 1 2 3 4 5 6 7 8 9 10m
S=1:100

NOTE: THE LAY OUT FOR TEMPORARY OFFICE IS INDICATED KARAGWE OFFICE

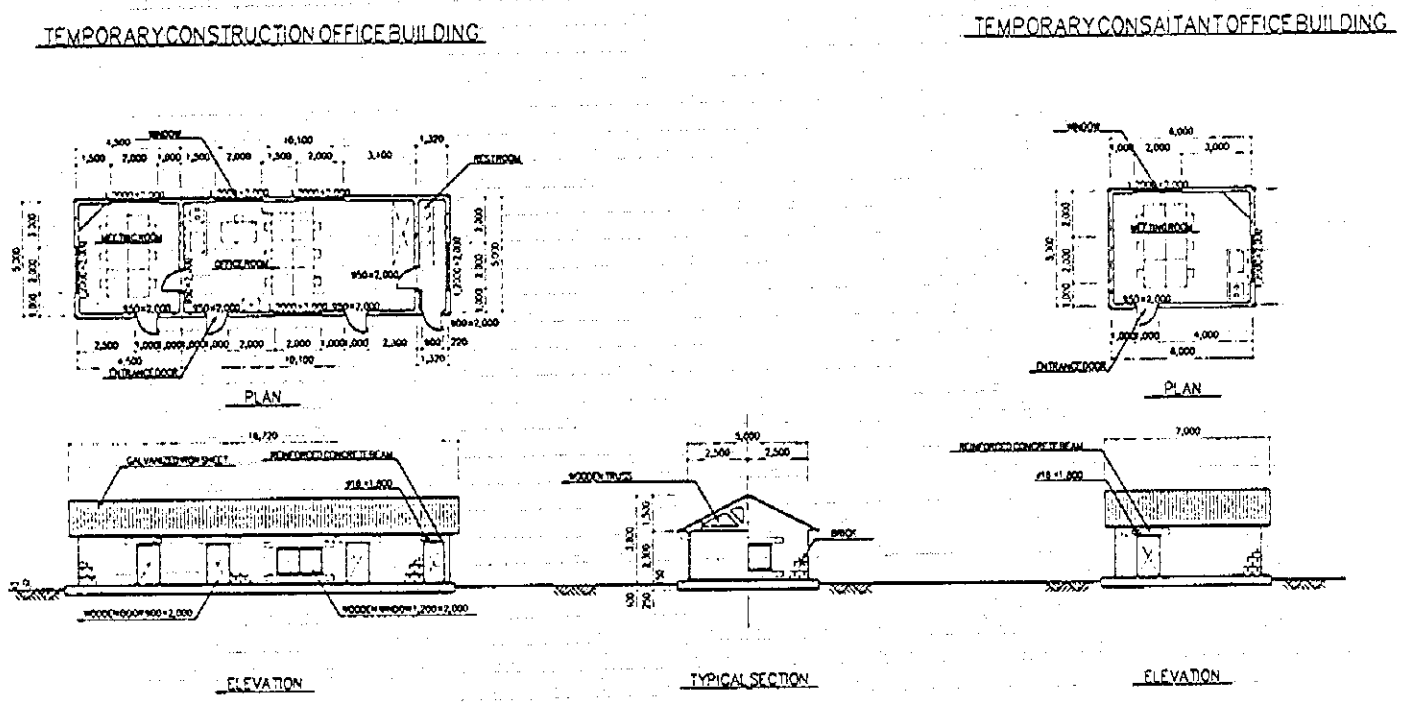
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE AFFECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA

DRAWING TITLE: No.14 Layout Plan for Temporary Office Yard

SCALE: S=1:100

KOKUSAI KOGYO CO.,LTD.
NO.2 ROKUBANCHO,CHIYODA KU,TOKYO,JAPAN

## No.13 Layout Plan for Temporary Office Yard



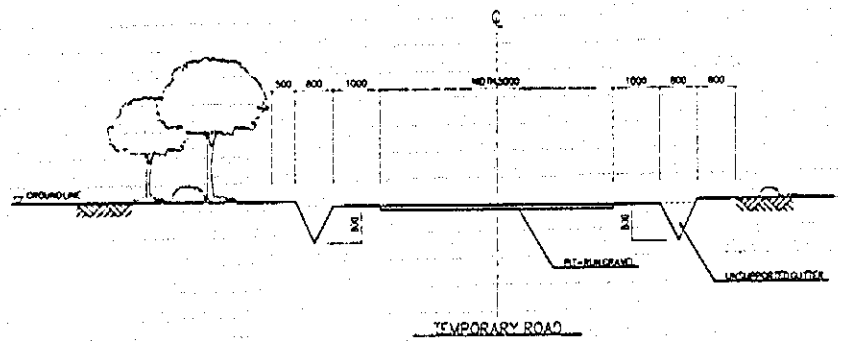

S=1:100

THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE AFFECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA

Layout Plan for Temporary Office Building

KOKUSAI KOGYO CO.,LTD.
NO.2 ROKUBANCHO,CHIYODA KU,TOKYO,JAPAN

## No.14 Layout Plan for Temporary Office Building




NOTE 1.
TO MAINTENANCE DETERIORATING EXISTING PUBLIC ROAD.

0 0.5 1 2 3 4 5m
S=1:50

THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY AND MEDICAL SERVICES IN REFUGEE AFFECTED AREAS OF KAGERA REGION IN THE UNITED REPUBLIC OF TANZANIA

| | | | |
|---|---|---|---|
| DWG No.: | SHEET No.: | DESIGNED BY: | DATE: |
| DRAWING TITLE: No.16 Typical Design For Operation And Maintenance Road | | DRAWN BY: | SCALE: S=1:50 |
| | | CHECKED BY: | REVISION NO.: |
| | | APPROVED BY: | |

KOKUSAI KOGYO CO.,LTD.
NO.2 ROKUBANCHO,CHIYODA KU,TOKYO,JAPAN

## No.15 Typical Design for Operation and Maintenance Road