5-5 Borehole Construction Method

The process of borehole construction using the provided machines, equipment and materials is summarised below.

(1) The drilling diameter at the borehole mouth will be 10 5/8", muddy water drilling will be conduted upto a depth of 6m and a conductor pipe with an inside diameter of 10" will be inserted.

(2) In the case of the sediment or strongly weathered rock layers (10 - 20m in depth), muddy water drilling will be conducted with a drilling diameter of 8 1/2" and a guide pipe with an inside diameter of 7" will be inserted. Electric logging will be conducted when deemed necessary to confirm the existence of an aquifer before the insertion of the guide pipe.

(3) In the case of the hard rock layer below (2) above, drilling will be conducted using the air hammer method with a drilling diameter of 6 1/2". When groundwater is found, a blowing agent will be used to facilitate the discharge of mud.

(4) When the predetermined depth is reached, the existence of an aquifer will be confirmed by electric logging and a screen and casing, both with an inside diameter of 4", will be installed.

(5) Gravel of a predetermined size and clay will be firmly packed around the screen and casing respectively.

(6) The borehole will be cleaned using the air lift equipemnt until clean water is obtained.

(7) Pumping and water quality tests will be conducted to determine the available water volume and water quality respectively and the usability of the borehoel will then be decided. With

regard to test pumping, the phased pumping test and/or recovery test will be carried out when deemed necessary.

(8) When a borehole is judged to be usable on the basis of the test rusults of (7) above, a foot pump will be installed and the work concerning such auxiliary facilities as the water receiving apron, drainage channel and washing area will be implemented to complete the borehole construction process.

The structures of the borehole and auxiliary facilities are shown in Figs. 5-1 and 5-2.

The work described in (1) - (5) avove will be conducted by the borehole construction teams (2) and the standard composition of the machines and equipment to be used is as follows.

- o Truck-Mounted Drilling Rig
- o Air Compressor
- o Station Wagon
- o Cargo Truck with Crane

The work described in (6) and (7) above will be conducted by the test pumping equipment teams (2) and the standard composition of the machines and equipment to be used is as follows.

- o Truck-Mounted Test Pumping Equipment
- o Pick-Up
- o Cargo Truck with Crane

In order for 80 boreholes to be sucessfully constructed by the above 2 types of teams within the first year, it will be of crucial importance for the access roads to be repaired by the Government of the Republic of Malawi and for the cooperaiton of the local inhabitants to be enlisted prior to the commencement of the construction work so that vehicle traffic is not hindered.

Fig. 5-1 Structure of Borehole

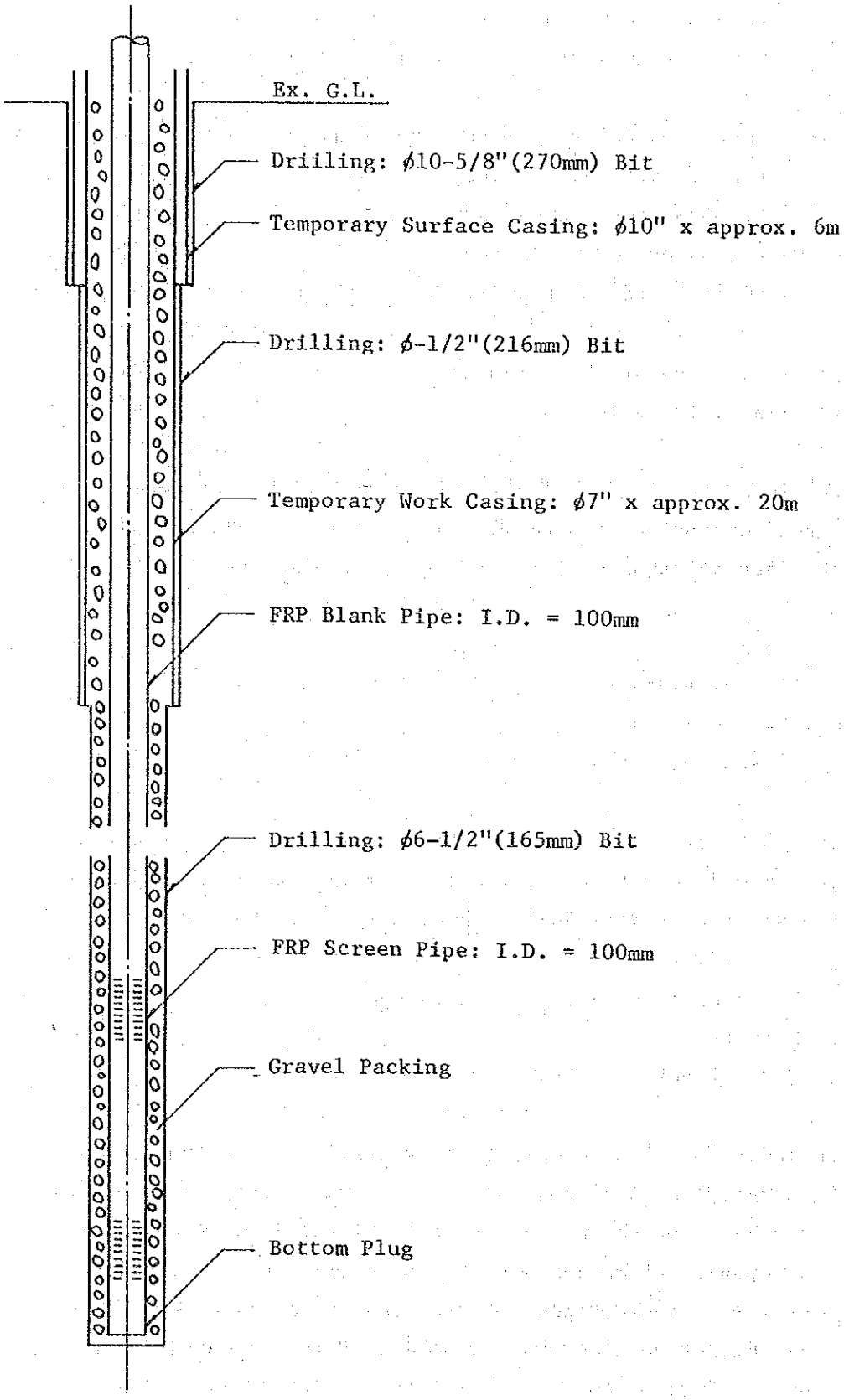
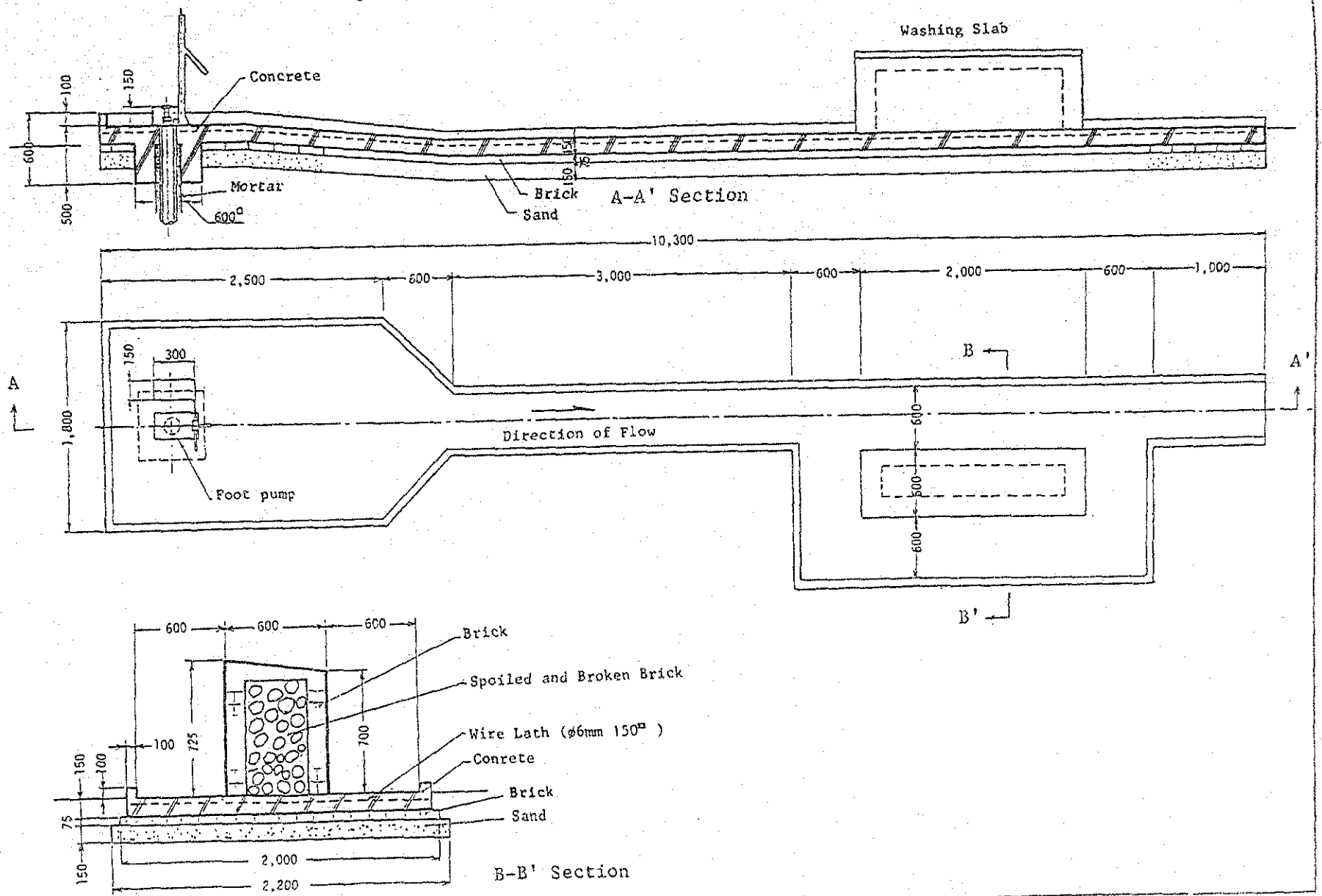


Fig. 5-2 Plan and Section of Auxiliary Facilities



CHAPTER 6 PROJECT IMPLEMENTATION SYSTEM

6-1 Implementing Agency

(1) Project Implementing Agency

The implementing agency of this Project is the Ministry of Works and Supplies which is responsible for the promotion of Groundwater Development Programmes of the Republic of Malawi. The Department of Water of the Ministry of Works and Supplies will assume overall responsibility for this Project, operate the machines, equipment and materials to be provided in the first phase as a grant aid of the Government of Japan and implement construction of 80 boreholes each in the first and second years of the second phase through a contractor of Japanese nationality. Thereafter, the Department of Water will undertake the construction of 79 boreholes and the rehabilitation of existing boreholes in the third year of the second phase by itself. The Department of Water will also administer the Project, maintain the completed boreholes in good condition and offer the inhabitants public health education and other guidance.

(2) Consultant

Procurement of machines, equipment and materials for constructing the boreholes, as well as design work and supervision of the construction of boreholes will be performed by a Japanese consultant firm to be selected according to the grant aid system of the Government of Japan.

The portion of this Project to be undertaken and paid for by the Japanese side will be divided into: 1) the first phase: granting of machines, equipment and materials for construction of boreholes, 2) the first and second years of the second phase: construction of boreholes. Accordingly, the consultancy

services will also be divided into the following two portions. The consultancy service contract for each portion will be concluded after siging and exhchanging of Notes for each respective year.

1) Consultancy services (in the first phase)

   a) Preparation of tender documents for procurement of machines, equipment and materials necessary for the construction of boreholes (including preparation of technical specifications)

   b) Execution of tender on behalf of the implementing agency and analysis and evaluation of tender

   c) Offering advice and counsel in negotiation the contract between the Government of the Republic of Malawi and the successful tenderer

   d) Withnessing the inspection of machines, equipment and materials during their manufacturing process and at the time of their delivery.

   e) Electric prospecting to select the locations for constructing boreholes (for the first and second years of the second phase)

2) Consultancy services (in the first and second years of the second phase)

   a) Preparation of tender documents for construction of boreholes (including preparation of technical specifications)

   b) Execution of tender on behalf of the implementing agency, and analysis and evaluation of tender

c) Offering advice and counsel in negotiation the contract between the Government of the Republic of Malawi and the successful tenderer

d) Supervision of the construction of boreholes

(3) Construction Contractor

Delivery of machines, equipment and materials and construction of boreholes will be executed by a contractor of Japanese nationality selected in accordance with the grant aid system of the Government of Japan. Government of the Republic of Malawi will execute the tender with the aid of the consultancy services stated in 2) above and conclude a contract with the contractor. Works to be performed by the contractor will be as follows.

1) Delivery of machines, equipment and materials (in the first phase)

The contractor will deliver the machines, equipment and materials stipulated in the contract to the Department of Water by the delivery date. Explanation and guidance on their assembly, operation, inspection and maintenance, and routine management will be rendered by the contractor. The materials that will be provided will be for the first and second years of the second phase.

2) Borehole construction work (in the first and second years of the second phase)

The borehole construction work will be contracted with a contractor of Japanese nationality in accordance with the grant aid system of the Government of Japan, who will complete the stipulated number of boreholes within the stipulated construction period. On-the-job training will be provided

during the construction period in order to effect technology transfer on operation of drilling rig and drilling methods.

The contract will be a blanket contract to cover all work from start to completion based on the turn-key system. Sub-contractors will be selected from among juridical persons of Mawawi and Japan by the construction contractor subject to screening and approval by the consultant.

6-2 Implementation Plan

(1) Implementation plan

The portion of this Project to be undertaken and paid for by the Japanese side will be implemented in accordance with the grant aid system of the Government of Japan. Since the said portion is divided into the provision of machines, equipment and materials and the construction of boreholes, it will be implemented according to the following steps.

First phase: 1) Selection of suppliers of machines, equipment and materials through public notice, 2) tender, 3) determination of tenderer, 4) ordering of machines, equipment and materials, 5) manufacturing of machines and equipment, 6) transportation, inspection for acceptance, and 7) delivery

First and second years of the second phase: 1) Selection of contractors through public notice, 2) tender, 3) determination of contractor, and 4) construction of a boreholes

For this Project to be successfully implemented, it is indispensable that the Malawi side shall have completed the following works prior to delivery of the machines, equipment and materials for the construction of boreholes.

1) Upon discussion with local inhabitants, determine the locations for drilling of 160 boreholes based on hydrogeological data which were obtained by means of electric prospecting and submitted by the consultant.

2) As soon as the locations for drilling of the abovementioned boreholes have been determined, construct or repair the access roads (including bridges) to the drilling sites.

3) Secure competent and experienced local staff (to organize two teams) to participate in on-the-job training.

4) Obtain permission of concerned government authorities for the use of the frequency stipulated for the whireless communication equipment which is scheduled to be provided.

5) Conduct a publicity campaign to enlighten the inhabitants on public health, the significance of this Project, its maintenance and other aspects.

The time of starting consutruction of the boreholes will be two months after arrival of the machines, equipment and materials at the port of unloading, assuming that it will take one month for inland transport from Dar es Salaam (in Tanzania), the port of unloading, to Ntaja, and another month for inspection for acceptance and delivery.

Two borehole construction teams will be organized based on the machines, equipment and materials to be provided under the grant aid of the Government of Japan by the construction contractor of Japanese nationality with a plan to construct 160 boreholes in the Project Area.

The construction of new boreholes and rehabilitation of existing boreholes in the third year of the second phase will be undertaken by the Malawi side.

(2) Labour plan

There are several well drilling contractors in the Republic of Malawi, but all of them work mainly with the percussion type of drilling rig, so that although they may be experienced in the work flow of well drilling, it is unlikely that it would be easy to recuit anyone who can operate the new type of drilling rigs which are scheduled to be proveded. In veiw of

this condition, although labours, as a principle, will be procured locally this will not apply where special technical skill is required. The technical staff who will perform the pivotal function in technical control and process control will be dispatched from Japan due to the following reason.

1) As the main work of drilling boreholes must be implemented with the use of the new type of drilling rigs to be provided, and the quantity contracted must be drilled within the specified period, it would be difficult for the technical worker who has had no experience with the equipment to implement the work.

2) Transfer of technical knowhow necessary for operating the new type of drilling rigs to the technical staff of the Department of Water must be effected during the construction period.

6-3 Procurement Plan for Machines, Equipment and Materials

As a result of a market survey of equipment and materials necessary for constructing boreholes conducted in the Republic of Malawi, it was found that cement, gravel, sand, filtering material, brick and reinforcing bar are locally procurable. However, as demand fluctuates wildly, their supply is instable. If the Project is to be completed within the stipulated period, it would be necessary for the implementing agency to make arrangements to supply itself with the necessary quantities of the necessary materials on a priority basis according to the project schedule. Machines, equipment and materials other than the above would have to be imported.

The Procurement plan for machines, equipment and materials of this Project was determined as follows upon a comparative study of the financial conditions of the Government of the Republic of Malawi, costs, quality and other factors.

(1) Materials to be locally procured

1) Cement, gravel, etc.

Malawi has cement mills so that cement is locally procurable. As sand and gravel is easily procurable within the drilling sites, they will be locally procured. Filter materials can be collected from the collecting site of the Department of Water on the bank of Lake Malawi. As they pose no problem in terms of both quantity and quality they will be locally procured here.

2) Brick

Bricks, being a typical building material and easily available as there are comparatively many brickworks, will be procured locally. Both wooden mould and steel mould bricks are available.

3) Gasoline and automotive diesel oil

Gasoline and diesel oil are imported from the Republic of South Africa. As there seems to be no shortage of supply in Malawi, these will be procured in Malawi.

4) Reinforcing bar

Like 3) above, reinforcing steel bars are imported. They occasionally run short of supply but not as serious as to have them transported all the way from Japan. Products of Zimbabwe will be locally procured.

(2) Imported machines, equipment and materials

1) Machines and materials for constructing boreholes

These must be imported from Japan as it is difficult to procure them locally.

2) Survey and prospecting equipment

These must be imported from Japan as it is difficult to procure them locally.

6-4 Scope of Work

The scope of work to be borne by the Japanese side under the grant aid of the Government of Japan as set forth in the basic design is as follows.

(1) Provision of machines, equipment and materials necessary for the two borehole consturction teams

(2) A complete job of constructing (including on-the-job traning) 160 boreholes in the first and second years of the second phase.

(3) Marine transport of machines, equipment and materials from Japan to the port of unloading and customs clearance

(4) Inland transport from the port of unloading to Ntaja and inspection for acceptance and delivery

(5) Consultancy services for procurement of machines, equipment and materials

(6) Electric prospecting to determine the locations of drilling site for 160 boreholes to be constructed in the first and second years of the second phase

(7) Implementation and supervision of borehole construction work

The scope of work to be borne by the Government of the Republic of Malawi has been confirmed as follows in the Minute of Discussions agreed upon by and between the Government of the Republic of Malawi and the basic design study team. (Refer to Appendix - I)

1) Provision of land;

To secure the land for drilling work and fixing the pump

2) Clearance of land;

To clear, level and reclaim the land where pump is proposed to fix

3) Access road;

To construct the access road to the drilling site, if some pumps are proposed to be fixed at the site where drilling rig can not have access

4) Payment of bank commission to Japanese Bank;

To bear commissions to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement

5) Tax exemption and customs clearance for machinery and equipment;

To exempt taxes and to take necessary measures for customs clearance of the materials and equipment brought for the project C.I.F. Ntaja.

6) Provision of facilities to Japanese Nationals who serve in the project;

To accord Japanese Nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into Malawi and stay therein for the performance of their work

7) Proper utilization and maintenance;

To maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant

8) Expenses which is boren by the Malawi Government;

To bear all the expenses other than those to be borene by the Grant (including various expenses in curred by the trainees of on-the-job training during the construction period) necessary for construction of the facilities as well as for the transportation and the installation of the equipment

6-5 Implementation Schedule

(1) First phase

After signing and exchanging of Notes by and between the Government of Japan and the Government of the Republic of Malawi, the Ministry of Works and Supplied will conclude a service contract for procurement of machines, equipment and materials with a consultant of Japanese nationality.

The consultant will prepare the tender documents after concluding said contract, and upon obtaining the approval of both the Government of Japan and the Government of the Republic of Malawi, will invite tenders from Japanese suppliers of machines, equipment and materials, and witness the contracting procedure between the successful tenderer and the Government of the Republic of Malawi.

The supplier contracted will manufacture, procure and transport (both sea and inland) the machines, equipment and materials which the consultant will locally inspect for acceptance, whereupon they will be delivered to the Government of the Republic of Malawi.

The consultant will also conduct during this period electric prospecting in order to obtain basic data necessary for selecting the locations for construction of the boreholes to be executed in the first and second years of the second phase, and submit said data to the Government of the Republic of Malawi.

(2) First and second years of the second phase

After signing and exchanging of Notes by and between the Government of Japan and the Government of the Republic of Malawi for each year, the Ministry of Works and Supplies will conclude a contract with a consultant of Japanese nationality

for his consultancy services for the construction of 80 boreholes for each year.

After consummation of said contrat, the consultant will prepare contract documents for construction, and with the approval of both the Government of Japan and Government of the Republic of Malawi, will invite Japanese contractors to submit tenders, and will witness the contracting procedure, between the successful tenderer and the Government of the Republic of Malawi. Under the supervision of the consultant, the contractor will organize two borehole construction teams on the basis of the machines, euipment and materials provided, and construct 80 boreholes in each year.

(3) Third year of the second phase

The construction of 79 boreholes and rehabilitation of 16 existing boreholes in the third year of the second phase, including advance survey for selecting the locations of the boreholes, will be executed by the Malawi side.

6-6 Rough Estimate of the Project Cost

The rough cost estimate of items to be undertaken by the Government of the Republic of Malawi is as shown below:

1) All the expenses of the engineers of the development of water who will be participated in the on-the-job training (for the first and second years of the second phase) K 40,000

2) Construction cost in the third year of the second phase (Whole construction cost)

a)	Cost for procuring equipment and materials	K 2,634,000
	. Spare parts and tools for constructing 79 boreholes	
	. Casing for 100 boreholes	
	. Pumps for 120 boreholes	
	. Muddy water agent and blowing agent for 79 boreholes	
b)	Drilling cost of 79 boreholes	K 400,000
c)	Pumping test cost of 79 boreholes	K 232,000
d)	Auxiliary facilities cost	K 115,000
e)	Rehabilitating cost of 16 existing borehole	K 70,000
f)	Preparatory expenses	K 16,000
g)	Common temporary work expenses	K 100,000
	sub-total	K 3,567,000

3) Total [1) + 2)] K 3,607,000

CHAPTER 7 MAINTENANCE SYSTEM

7-1 Maintenance System

The maintenance system for this Project may be divided into maintenance of boreholes as the water supplying facilities and maintenance of machines, equipment and materials for constructing those boreholes. The maintenance system is the supporting system that becomes necessary immediately with the start of the Project and is most important for successfully operating and maintaining the water supplying facilities. Since the Government of the Republic of Malawi has established a basic maintenance system through its national groundwater supply projects such as the Livulezi Project, Dowa West Project and Lilongwe N.E. Project, all of which have already been completed, the policy is to apply said system to this Project.

(1) Boreholes for supplying water must be periodically inspected for maintenance, and guidance must be provided in order to develop a sanitary environment so that sanitary groundwater may be stably supplied to the inhabitants at all times. Until the aforementioned Livulezi Project was completed and the new maintenance system was adopted with it in 1983, the Government of the Republic of Malawi had been adopting the time-consuming system of maintaining its boreholes by first having the District Development Committee (DDC) study the need for repairing and maintaining the boreholes upon request of the inhabitants involved and discuss the order of priority for repairing those boreholes and the method of raising the necessary funds before submitting a request for repairs to the Department of Water of the Ministry of Works and Supplies. As a result, the actual situation was that many boreholes were left choked if DDC were unable to raise the necessary funds, and with the limited capability of the maintenance team of the Department of Water it was not possible to adequately maintain the widely scattered boreholes.

Ever since the Livulezi Project, however, the system of all national groundwater supply projects, calls for the establishment of a borehole management committee for each borehole and to have it autonomously manage its operation and maintenance.

The existing potable water supply sources such as surface water, spring water and open-type dugwells which had so far been used by most of the inhabitants in the Project Area have become exposed to man-made secondary water pollution due to the inhabitants' ignorance of public health and are the sources of water-borne infection of diseases. The development of a sanitary environment in the villages is therefore a basic problem which cannot be ignored in the management of boreholes.

Under the above circumstances, the following are also considered key points in operating the new maintenance system on the part of the Government of the Republic of Malawi.

1) Select a competent person from among the villagers to oversee the maintenance of the borehole. He or she shall be provided with basic training in maintenance to become an inspector.

2) Offer the villagers education in public health in order to make them more public health conscious.

3) Launch a publicity campaign in order to let the inhabitants fully understand the significance of this Project and also to implant in their minds a feeling of attachment to the borehole.

4) Conduct periodical inspection and maintenance and offer guidance to inhabitants on water quality, water supplying facilities and sanitation.

(2) Maintenance of machines, equipment and materials

The machines, equipment and materials which will be provided as a grant will be received by the Department of Water of the Ministry of Works and Supplies who in turn will let them to the contractor of Japanese nationality who will undertake construction of the boreholes.

The Department of Water has a Regional Workhop in Zomba which is equipped with a minimum of machines necessary for repairs of pumps. The repair shop of Blantyre (PVHO: Plant and Vehicle Hire Organization) which belongs to the Ministry of Works and Supplies and which is equipped with the basic maintenance system necessary for the implementation of this Project will be responsible for the repair of machines and vehicles.

Since the drilling rigs which perform the main tasks in constructing the boreholes will have the serviceable life of more than 10 years if provided with a system of replenishing expendable supplies and with adequate inspection and maintenance services, and can be used for constructing other boreholes after the completion of this Project, it is necessary to establish a maintenance system that will allow the machines, equipment and materials to be autonomously operated on the part of the Government of the Republic of Malawi.

Based on the foregoing reasons, we made the following recommendations with respect to the maintenance system for the machines, equipment and materials.

1) If the machines and vehicles are to be operated effectively, they must be periodically inspected and maintained and they must not be operated or handled in any way beyond their functional capability.

2) Materials and spare parts must be stored neatly by item in the storage. Stacking them in the open field must be prohibited. Data on usage status of materials and spare parts, their degree of wear and tear and rate of consumption, and their problems shall be systematically compiled for used as the basic data for the replenishment system to be organized two years later.

3) Since the maintenance of machines, equipment and materials to be provided under this Project is considered to be relatively simple and can be taken care of by the Malawi side alone, it is desirable that the Malawi side master the operating system in as short a time as possible.

7-2 Maintenance Plan

In order to use the boreholes in the best of condition for as long a period as possible as water supplying facilities, a borehole keeper will be selected from among the members of the borehole management committee stated in Paragraph 7-1 above and he or she will conduct routine inspection of the borehole and take care of simple repairs. However, repairs of choked boreholes which are likely to require much technical knowhow and entail a large financial burden will be undertaken jointly by the maintenance engineers who will be dispatched from the Department of Water at the rate of one engineer for every 100 boreholes to provide their technical knowhow and the borehole management committee who will provide the labor. In this case, spare parts will be supplied by the Government of the Republic of Malawi.

7-3 Rough Estimate of Maintenance Cost

(1) Personnel cost

As stated in Paragraph 7-2 above, borehole maintenance engineers are planned to be assigned at the rate of one engineer per every 100 boreholes, and as the number of boreholes will become 255 upon completion of this Project, three borehole maintenance engineers will become necessary. Accordingly, the required annual personnel cost will be as follows.

Unit: K (Malawi Kwacha)

	Monthly basic salaries	Annual basic salaries
One Borehole Maintenance Engineer	K 88	K 1,056
- do -	- do -	- do -
- do -	- do -	- do -
Total	K 264	K 3,168

(2) Maintenance cost of water supplying facilities

1) Maintenance cost of vehicles K 3,100/year

2) Maintenance cost of pumps, etc. K 9,200/year

CHAPTER 8 PROJECT EVALUATION

8-1 Effects of Implementing the Project

The following effects can be expected by implementing this Project.

(1) Securing of sanitary domestic water

The Project Area has difficulty in securing domestic water during the dry season when many of its rivers and traditional dugwells dry up. And, as the existing dugwells have been exposed to man-caused secondary water pollution due to a lack of public health awareness on the part of the inhabitants, it has become fairly difficult to secure sanitary domestic water for the inhabitants of the Project Area excepting some from the present water supply facilities.

Since the water source of the boreholes that will be constructed under this Project is clean groundwater, it will become possible, with the aid of public health education for the inhabitants and the provision of water supply facilities not easily susceptible to water pollution, to stably supply the inhabitants with sanitary domestic water and thus assuage the inhabitants' sense of insecurity arising from the shortage of water and improve their living standard.

As a result of the above, it will become possible to reduce the incidence of water-borne infectious diseases originating from the use of insanitary drinking water.

(2) Reduction in required work load

In the Project Area, it is the daily job of women and children to draw and carry water to their homes. Their living environment is such that especially during the dry season,

many of them have to go for their supply of domestic water to a water intake site more than 5 km away from their homes.

The construction of the boreholes at locations convenient for the settlement and where sanitary water will be available even during the dry season will not only liberate the women and children from their unproductive heavy labor, but the reduction in their labor hours will allow them to divert the surplus hours to agricultural production, which is the basis of living, and will have the effect of greatly contributing to the economic development of Malawi.

(3) Permanent settlement of rural inhabitants

There is a tendency for the inhabitants to leave their villages in the Project Area due to their inability to maintain a stable family life in a living environment where sanitary domestic water is difficult to obtain. This tendency constitutes a hindrance to the plan of increasing the production of farm crops.

It is expected that the securing of a stable supply of sanitary domestic water by constructing boreholes will contribute to promoting permanent settlement of the rural inhabitants as it will improve the living environment, reduce unproductive labor hours and promote highly productive agriculture.

8-2 Propriety of Implementing the Project

(1) Implementation of a borehole construction project in the target area is expected to bring about the aforementioned socioeconomic effects. However, since it is difficult for the Government of the Republic of Malawi to implement this Project by itself due to financial difficulties, it is judged appropriate for the Government of Japan to extend its grant aid for this Project.

(2) Provision of machines, equipment and materials

The Department of Water, having organized 13 drilling teams and assigned repair shops and storage houses, is organizationally well equipped to carry out the construction of the boreholes and the necessary maintenance system. The drilling rigs owned by the Department of Water, however, are mostly of the percussion type which is poor in working efficiency on hard rockbeds and tend to break down frequently due to aging and which, as a result, is delaying the Groundwater Development Programme being advanced by the Government of the Republic of Malawi. The provision of machines, equipment and materials including rotary and air hammer types of drilling rigs (along with technology transfers) under this Project will better equip the Malawi side for construction of the boreholes and thus greatly contribute to the development of the groundwater supply in that country.

CHAPTER 9 CONCLUSION AND RECOMMENDATION

9-1 Conclusion

In North Kawinga, the project area, where water supply facilities have not been developed yet, the inhabitants have no other recourse but to use the existing dugwells spring water and river water, all of which are unsuitable for drinking (except for the few boreholes), and which are the cause of the water-borne infectious diseases. During the dry season, the people are compelled to walk more than 5 km for water and are subjected to the hard, unproductive labor of carrying water back to their homes. This is causing a delay in implementation of the National Rural Development Programme (NRDP) of the Government of the Republic of Malawi for the purpose of developing agriculture, which is the basis of its national economy. The stable supply of sanitary water, therefore, is a major problem for Malawi.

If, by implementing this Project, the water supplying facilities (boreholes) utilizing groundwater are constructed in the Project Area, and sanitary water is stably supplied to the inhabitants of the Project Area throughout the year, it is certain not only to improve the living environment of this area but manifest the area's high potential for agricultural development and thus contribute greatly to a further development and improvement of agriculture which is the main theme of the development plan of the Government of the Republic of Malawi.

As stated above, this Project will improve the living environment of the local inhabitants and promote their permanent settlement and thus establish the foundation for rural development. It is therefore considered significant and appropriate for the Government of Japan to extend its grant aid cooperation to this Project.

9-2 Recommendation

This Project is expected to have a major effect on improving the very basis of life in North Kawinga and developing an environment suitable for permanent settlement of the farmers. The water supply condition in the Republic of Malawi, however, is such that the ratio of the rural population supplied with water is only 33%, so that there is an impending need to raise the water supply ratio by taking future population growth into account. The demand for groundwater development in particular is of crucial importance. In order to solve this problem, it is necessary for the Government of the Repblic of Malawi to back up the groundwater development function of the Department of Water through budgetary measures, and expand its organization so as to enlarge its capacity to tackle groundwater supply projects.

APPENDICES

APPENDIX I MINUTES OF DISCUSSIONS

MINUTES OF DISCUSSIONS

ON

THE PROJECT FOR

NORTH KAWINGA GROUND WATER SUPPLY

IN

THE REPUBLIC OF MALAWI

In response to the request of the Government of the Republic of Malawi for the Grant Assistance for the Project of North Kawinga Ground Water Supply (hereinafter referred to as "the Project"), the Government of Japan decided to conduct a basic design study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to MALAWI the team headed by Mr Takeshi NARUSE, Official, First Basic Design Study Div., Grant Aid Cooperation Planning and Survey Dept., JICA from 12 July, 1987 to 19 August, 1987.

The team had a series of discussions on the Project with the concerned officials of the Government of the Republic of Malawi and conducted a field survey in the project area.

As a result of the study, both sides agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

24 July, 1987

Leader of Team
Basic Design Study , JICA

Ministry of Works and Supplies

Ministry of Finance

1. Objectives of the Project;
Supply of safe drinking water from boreholes with handpumps in rural areas by provision of drilling rigs and equipment and construction of new boreholes and rehabilitation of the existing boreholes.

2. Project Site;
The site of the Project is North Kawinga which is in the northern part of Machinga District, Southern region of Malawi.
(Site map is attached as Annex -1-)

3. Project Components requested by the Malawi Side;
See the attached Annex -2-

4. Responsible Organization;
Ministry of Works and Supplies, Water Department.

5. Measures taken by the Japanese Side;
The Japanese Study Team will convey to the Government of Japan the desire of Malawi Government that the former takes necessary measures to cooperate by providing machinery and construction and rehabilitation of new and existing boreholes within the scope of Japanese economic cooperation programme in Grant form.

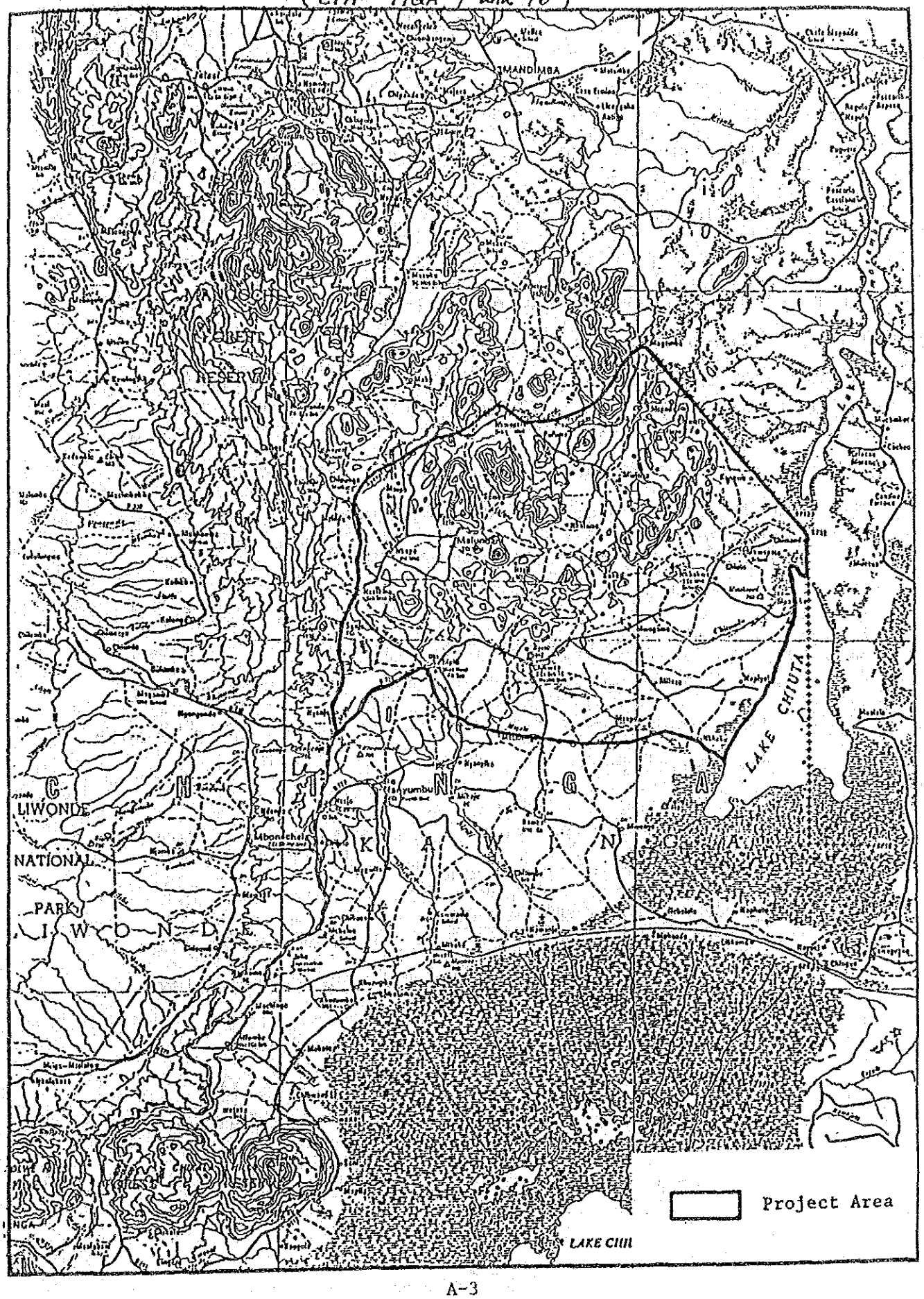
6. Understanding of Japanese Grant Aid System;
The Malawi side has understood Japanese Grant Aid System explained by the Team which includes a principle of use of a Japanese Consultant Firm and Japanese General Contractor for the construction.

7. Measures taken by Malawi Side;
See the attached Annex -3-

Annex [1]

MAP OF THE PROJECT AREA

(EPA - MGA 9 and 10)



Annex -2-

1. Required Machines, Equipment and Materials (Subject to review)

(1)	Truck mounted drilling rig (rotary/air hammer type)	2 units
(2)	Truck mounted test pumping equipment	2 units
(3)	Truck mounted borehole servicing machine	1 unit
(4)	Mobile workshop truck	1 unit
(5)	Geophysical survey equipment	2 sets
(6)	Borehole logging equipment	2 sets
(7)	Transportation equipment	
	-4WD station wagon	2 nos
	-4WD pick up	2 nos
	-8 ton cargo truck with crane	2 nos
	-4 cu.m water tank lorry	1 no
	-Motorcycle	4 nos
(8)	Communication equipment	1 set
(9)	Casing and screen	for 280 B/H
(10)	Hand pump	300 sets
(11)	Spare parts	1 lot

2. Rehabilitation of existing boreholes 24 B/H

3. Construction of new borehole 236 B/H

Specifications of Borehole

(1) Depth of borehole : 60 meters on average

(2) Diameter of borehole (casing size) : 4 inch as PVC or FRP

(3) Pumping unit : Hand pump

Annex -3-

MEASURES WHICH SHALL BE TAKEN BY MALAWI SIDE

1. Provision of land;
To secure the land for drilling work and fixing the pump.

2. Clearance of land;
To clear, level and reclaim the land where pump is proposed to fix

3. Access road;
To construct the access road to the drilling site, if some pump are proposed to be fixed at the site where drilling rig can not have access

4. Payment of bank commission to Japanese Bank;
To bear commissions to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement

5. Tax exemption and customs clearance for machinery and equipment;
To exempt taxes and to take necessary measures for customs clearance of the materials and equipment brought for the project C.I.F. Lilongwe

5. Provision of facilities to Japanese Nationals who serve in the project;
To accord Japanese Nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into Malawi and stay therein for the performance of their work

7. Proper utilization and maintenance:
To maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant

8. Expenses which is borne by recipient;
To bear all the expenses other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and the installation of the equipment

APPENDIX I-(2) MINUTES ON DISCUSSIONS
(DRAFT FINAL REPORT EXPLANATION)

MINUTES OF DISCUSSIONS
ON
THE PROJECT
FOR
NORTH KAWINGA GROUNDWATER SUPPLY
IN
THE REPUBLIC OF MALAWI

Date: 22nd October, 1987

In response to the request made by the Government of Republic of Malawi, the Government of Japan decided to conduct a basic design study on the Project for North Kawinga Groundwater Supply, (hereinafter reffered to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Republic of Malawi the study team from July 12 to August 19, 1987.

As a result of the study, JICA prepared a draft report and dispatched a mission, headed by Mr. Yoshikatsu Nakamura, First Basic Design Study Division, Grant Aid Planning and Survey Department, JICA, to explain and discuss it from October 15 to October 26, 1987.

Both parties had a series of discussions on the Report and, after clarifying its contents, agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Yoshikatsu Nakamura
Leader
Draft Report Team of Basic Study
Japan International Cooperation Agency

T.A.V. Chande
Under Secretary
Ministry of Finance

S.M.N. Mainala
Principal Hydrogeologist
Ministry of Works and Supplies

Major Points of Understanding:

1. The Malawi side principally agreed to the basic design proposed in the Draft Final Report.

2. The Malawi side understood the system of Japan's Grant Aid Programme and confirmed the measures to be taken by the Malawi side towards the realization of the Project, particularly, the provision of land, clearance of Land, construction of access roads when necessary, and other related activities required before the start of the actual construction.

3. The Malawi side requested that the Government of Japan consider undertaking the cost of construction and materials for boreholes of 79 nos. as shown in the Draft Final Report in the fourth year, 1991, of the Project period.

   The Malawi side also requested to change CIF Lilongwe to CIF Ntaja.

   The mission recognized the requests done by the Malawi side and confirmed to convey them to the Government of Japan.

4. The Final Report (10 copies in English) on the Project will be submitted to the Republic of Malawi in November, 1987.

APPENDIX II ITINERARY OF THE STUDY AND LIST OF THE STUDY TEAM MEMBERS

APPENDIX II-(1) ITINERARY OF THE STUDY AND LIST OF THE STUDY TEAM MEMBERS (BASIC DESIGN STUDY)

Itenerary of the Study

No.	Date/Day	Schedule	Contents of the Study
1	Jul.12 Sun	TYO - LDN	Transmission
2	13 Mon	Lv. LDN	- do -
3	14 Tue	Ar. NBO	Courtesy Visit to and Meeting with Embassy of Japan and JICA Office
4	15 Wed	NBO - LLW	Transmission
5	16 Thu		Courtesy Visit to and Meeting with MOWS and MOF
6	17 Fri		Explanation of Inception Report to DW, Data Collection
7	18 Sat		Data Collection
8	19 Sun		Meeting in Team
9	20 Mon	LLW - LWD	Transmission, Site Survey
10	21 Tue		Site Survey
11	22 Wed	LWD - LLW	- do -, Transmission
12	23 Thu		Discussion on Minutes with DW and MOF
13	24 Fri		Meeting in Team, Signing of Minutes, Discussion with DW
14	25 Sat		Data Collection (Naruse; Lv. LLW for TYO)
15	26 Sun		Data Collection, Meeting in Team
16	27 Mon		- do -, Preparation for Site Survey
17	28 Tue		Data Collection (Takaku & Imai; Lv. LLW for Site)
18	29 Wed		Site Survey, Data Collection
19	30 Thu		- do - (Nakamura; Lv. LLW for Site)
20	31 Fri		- do -
21	Aug. 1 Sat		- do -

No.	Date/Day	Schedule	Contents of the Study
22	Aug. 2 Sun		Arrangement of Survey Result and Collected Data
23	3 Mon		Site Survey
24	4 Tue		- do - (Takaku & Nakamura; Lv. Site for LLW)
25	5 Wed		- do -, Discussion with DW
26	6 Thu		- do -, - do -, Data Collection
27	7 Fri		- do -, - do -, Data Collection
28	8 Sat		Arrangement of Survey Result and Collected Data (Imai; Lv. Site for LLW)
29	9 Sun		Arrangement of Survey Result, Study on Collected Data
30	10 Mon		Arrangement of Survey Result, Discussion with DW, Data Collection
31	11 Tue		Study and Examination of the Plan Data Collection
32	12 Wed		Study and Examination of the Plan Data Collection
33	13 Thu		- do -, Discussion with DW, Interview to Private Company
34	14 Fri		Final Discussion with MOWS and MOF
35	15 Sat	LLW - NBO	Arrangement of Collected Data and Survey Result, Transmission
36	16 Sun		Arrangement of Collected Data and Survey Result
37	17 Mon		Report to Embassy of Japan and JICA Office Visit to the World Bank
38	18 Tue	NBO - LDN	Transmission
39	19 Wed	Ar. TYO	Transmission

Abbreviaion:

TYO; Tokyo
LDN; London
NBO; Nairobi
LLW; Lilongwe
LWD; Liwonde

MOWS; Ministry of Works and Supplies
MOF; Ministry of Finance
DW; Department of Water

List of the Study Team Members

Leader	Takeshi NARUSE	Japan International Cooperation Agency
Water Supply Planning	Akinori TAKAKU	Japan Engineering Consultants Co., Ltd.
Hydrology	Ryoji IMAI	Japan Engineering Consultants Co., Ltd.
Machinery Planning	Sakae NAKAMURA	Japan Engineering Consultants Co., Ltd.

APPENDIX II-(2) ITINERARY OF THE STUDY AND LIST OF THE STUDY TEAM MEMBERS (DRAFT FINAL REPORT EXPLANATION)

Itinerary of the Study

No.	Date/Day	Schedule	Contents of the Study
1	Oct.15 Thu	Lv. TYO	Transmission
2	16 Fri	Ar. LDN Lv. LDN	- do -
3	17 Sat	Ar. LLW	- do -
4	18 Sun		Meeting in Team
5	19 Mon		Explanation of Draft Report on Basic Design Study to DW
6	20 Tue		Courtesy Visit to and Discussion with MOF
7	21 Wed		Discussion on Minutes with DW and MOF
8	22 Thu		Signing on Minutes, Meeting with DW
9	23 Fri		Meeting with DW and MOWS
10	24 Sat	Lv. LLW	Transmission
11	25 Sun	Ar. LDN Lv. LDN	- do -
12	26 Mon	Ar. TYO	- do -

List of the Study Team Members

Leader	Yoshikatsu NAKAMURA	Japan International Cooperation Agency
Water Supply Planning	Akinori TAKAKU	Japan Engineering Consultants Co., Ltd.
Machinery Planning	Sakae NAKAMURA	Japan Engineering Consultants Co., Ltd.

APPENDIX III GENERAL DATA (TABLES AND FIGURES)

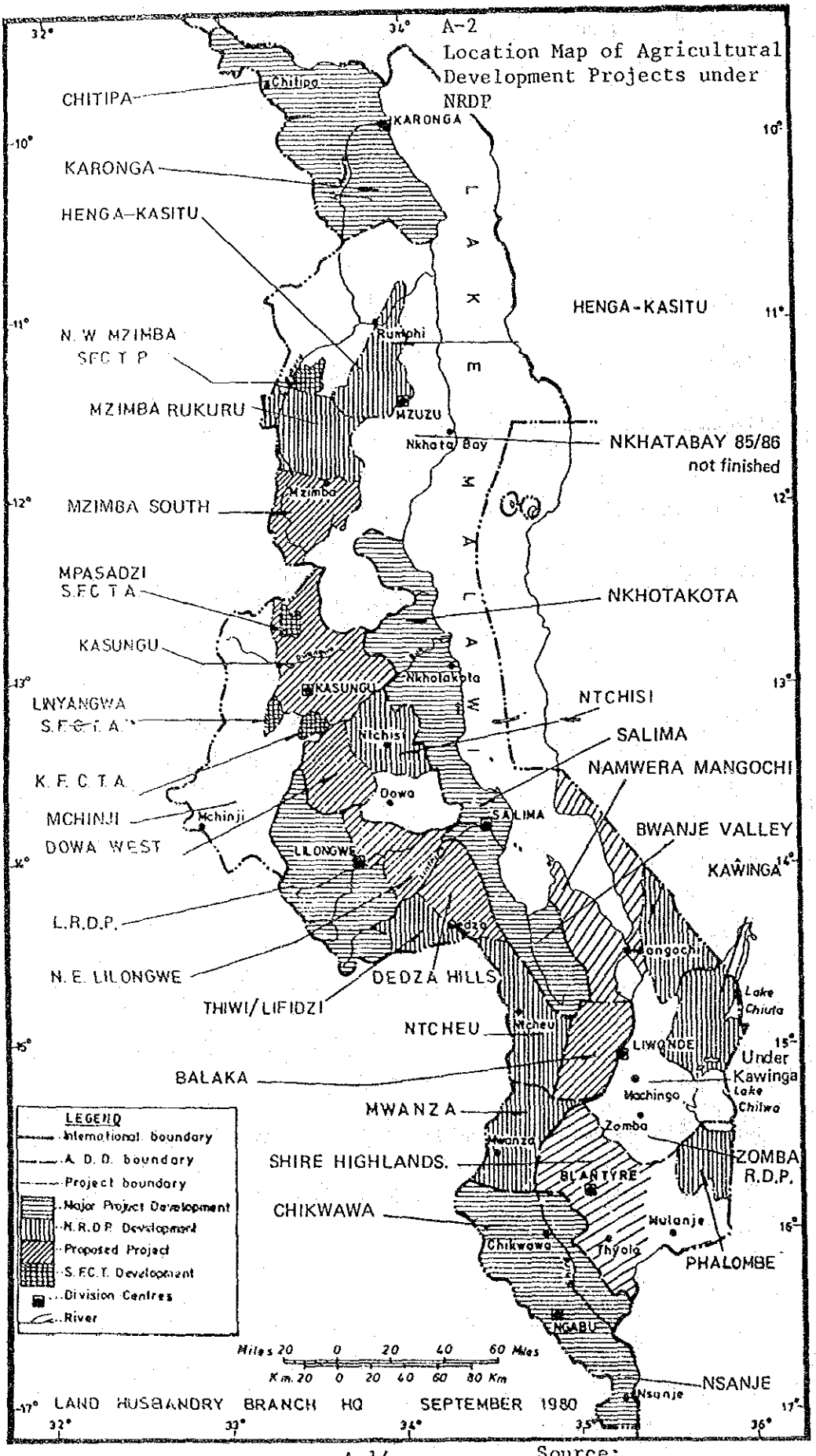
APPENDIX III GENERAL DATA (TABLES AND FIGURES)

A-1 Country Data on Malawi

Name of the Country:	The Republic of Malawi
Country Area:	118,484 km^2
Capital:	Lilongwe
Population: (estimated in 1985)	7.06 million people
Population Growth Rate:	2.9 %
Races:	Chewa tribe, Nyanja tribe, Lomwe tribe, Ngoni tribe, etc.
Languages:	English (official language), Chichewa
Currency:	Malawi Kwacha (MK) Exchange Rate (July 1987); MK 1.00 = US$ 0.437 = ¥ 65.79
GDP (1985):	MK 862.4 million (US$ 504 million)
GNP (1984):	MK1,695.3 million (US$ 991 million)
Independence Year, Ex-suzerian Country:	1964, Britain
Government Type, Sovereign:	Presidencial Type of Government President H. Kamuzu Banda
Expenditure, Revenue (1985):	MK542.3 million, MK382.6 million
Exports, Imports (1985):	MK455.4 million, MK438.1 million

A-2

Location Map of Agricultural Development Projects under NRDP



Source:
Ministry of Agriculture

A-3 Completed Rural Piped Water Projects

(AS ON JUNE 1986)

	PROJECT	DISTRICT	REGION	POPULATION INVOLVED	LENGTH OF PIPING (KM)	NUMBER OF TAPS	COST OF MATERIALS (K)	YEAR COMPLETED
1	Chingale	Zomba	South	5 000	40	60	6 000	1969
2	Chambe	Mulanje	South	30 000	96	180	64 000	1970
3	Migowi	Mulanje	South	6 000	24	45	12 000	1971
4	Chilinga	Mulanje	South	2 000	10	14	4 000	1972
5	Ng'onga	Rumphi	North	2 000	17	20	6 000	1972
6	Muhuju	Rumphi	North	1 000	19	21	7 000	1973
7	Chinkwezulu	Machinga	South	700	2	9	1 000	1974
8	Ighembe	Karonga	North	4 000	17	36	7 000	1974
9	Mulanje West	Mulanje	South	90 000	237	460	170 000	1975
10	Luzi	Mzimba/Rumphi	North	8 000	59	44	24 000	1975
11	Chinunka	Chitipa	North	4 000	25	51	12 000	1975
12	Chilumba	Karonga	North	4 000	17	29	8 000	1975
13	Chilobwe	Ntcheu	Central	1 200	6	14	2 000	1975
14	Dedza	Dedza	Central	1 400	8	10	5 000	1976
15	Mchinji	Mchinji	Central	20 000	136	215	52 000	1976
16	Chagwa	Machinga	South	7 000	80	110	15 000	1976
17	Phalombe	Mulanje	South	140 000	400	660	500 000	1977
18	Kalitsilo	Ntcheu	Central	1 000	6	13	3 000	1977
19	Lifani	Zomba/Machinga	South	20 000	100	152	72 000	1977
20	Hewe	Rumphi	North	8 000	42	42	30 000	1977
21	Nkhamanga	Rumphi	North	12 000	75	120	134 000	1978
22	Lizulu	Ntcheu	Central	6 000	24	34	20 000	1978
23	Namitambo	Chiradzulu/Mulanje	South	60 000	290	360	480 000	1979
24	Sombani	Mulanje	South	40 000	184	300	240 000	1979
25	Ntonda	Ntcheu	Central	25 000	120	194	120 000	1980

Note: Cost pertains to the year when the project was completed.

(Continued)

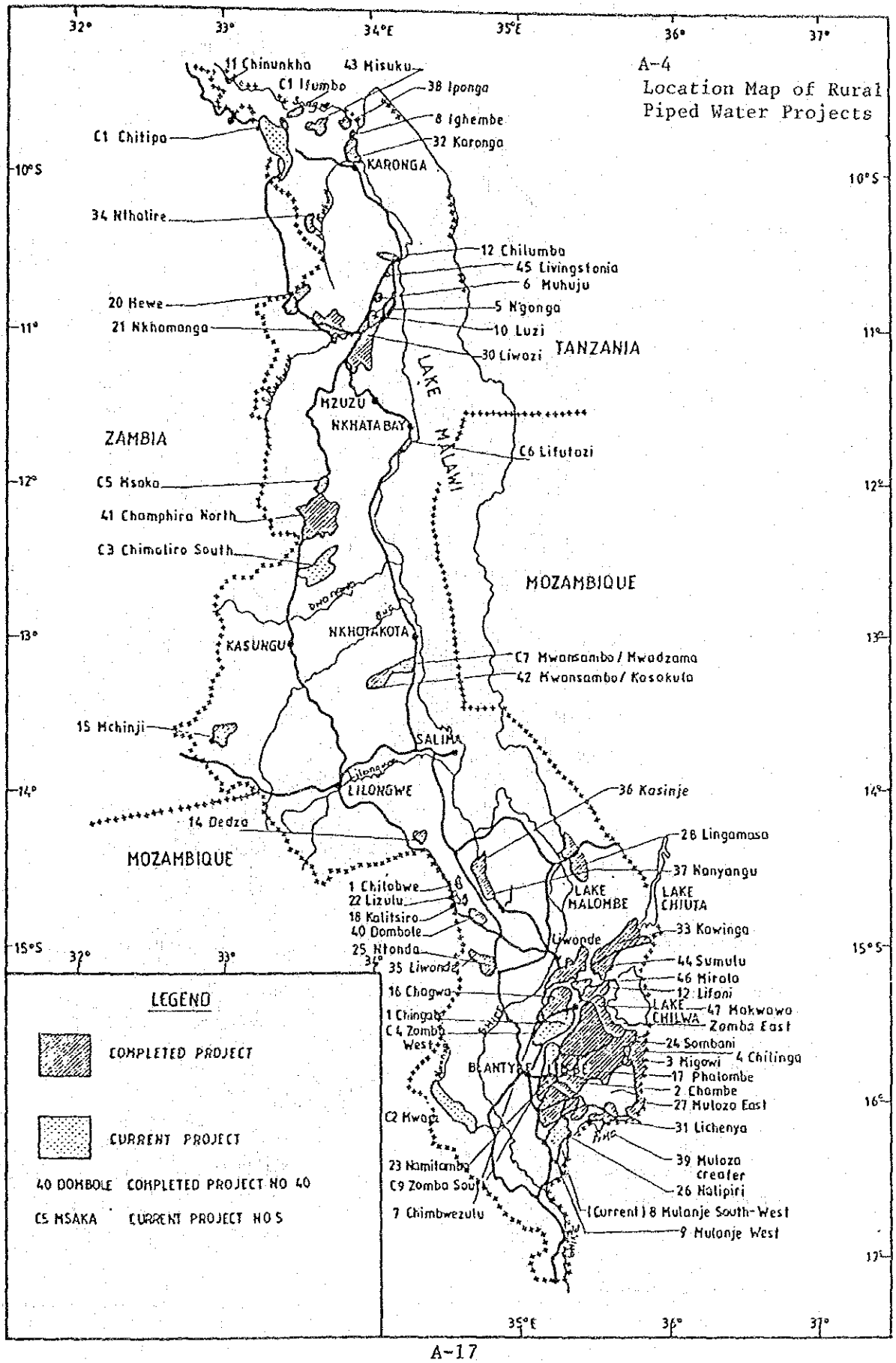
Source: National Water Resources Master Plan, 1986, Department of Water/UNDP

(AS ON JUNE 1986)

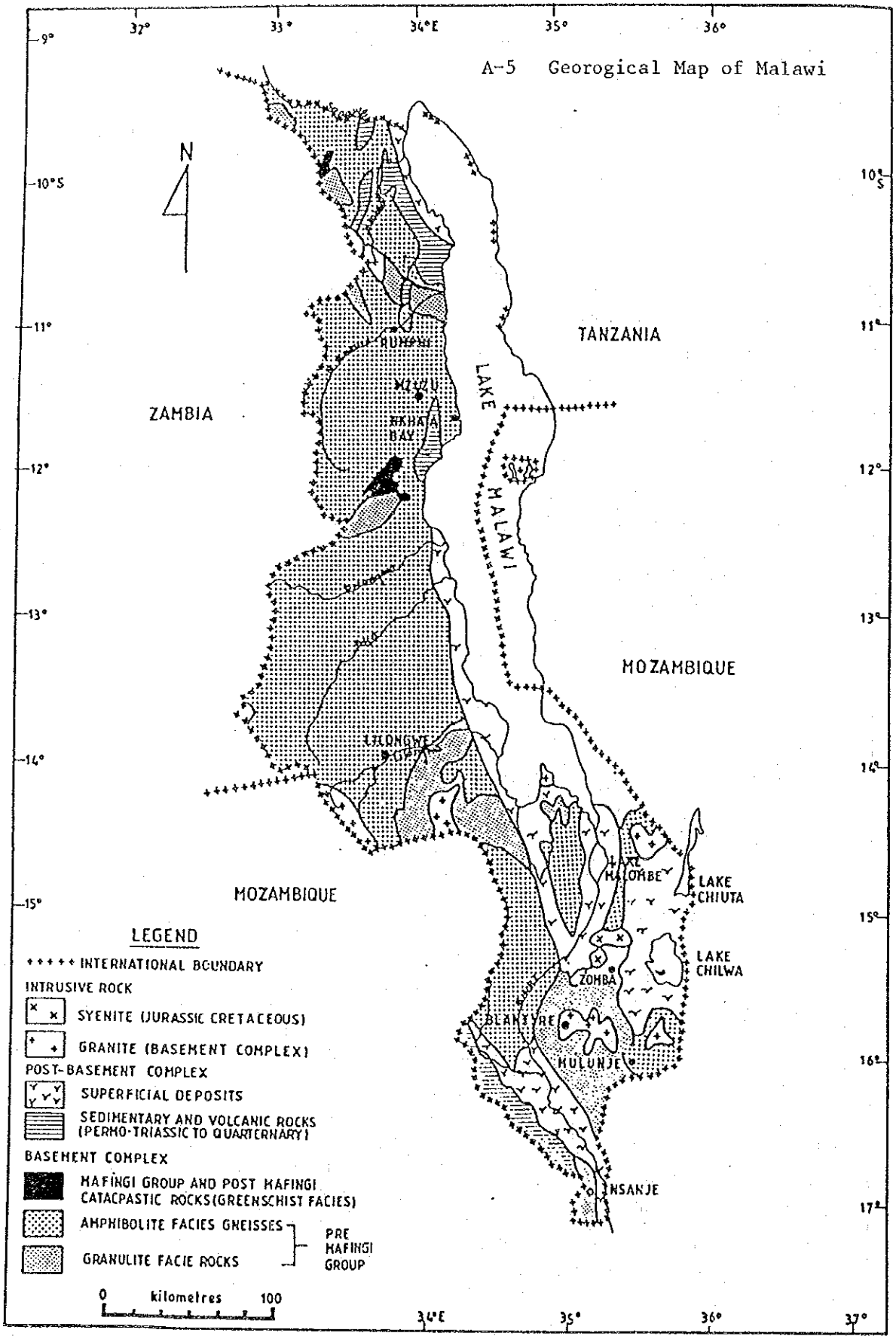
	PROJECT	DISTRICT	REGION	POPULATION INVOLVED	LENGTH OF PIPING (KM)	NUMBER OF TAPS	COST OF MATERIALS (K)	YEAR COMPLETED
26	Nalipiri	Mulanje	South	9 000	27	55	40 000	1980
27	Muloza East	Mulanje	South	32 000	150	180	120 000	1980
28	Lingamasa	Mangochi	South	12 000	43	118	50 000	1981
29	Zomba(Domasi)	Zomba	South	100 000	448	813	711 000	1981
30	Luwazi	Mzimba	North	8 000	80	54	79 400	1981
31	Luchenya	Mulanje	South	46 000	168	270	180 000	1982
32	Karonga	Karonga	North	30 000	195	250	290 300	1983
33	Kawinga	Machinga	South	70 000	571	450	926 600	1983
34	Nthalire	Chitipa	North	3 000	21	46	66 500	1983
35	Liwonde	Machinga	South	23 000	110	130	198 000	1983
36	Kasinje	Ntcheu	Central	14 000	32	95	60 000	1983
37	Nanyungu	Ntcheu	Central	20 000	53	131	150 000	1983
38	Iponga	Karonga	North	5 600	24	35	40 000	1983
39	Muloza Crater	Mulanje	South	8 000	22	45	40 000	1983
40	Dombole	Ntcheu	Central	22 000	107	140	286 700	1984
41	Champhira/ North	Mzimba	North	24 000	167	154	236 000	1984
42	Mwansambo/ Kasakula	Nkhotakota/Nchisi	Central	25 000	60	145	157 300	1984
43	Misuku	Chitipa	North	3 700	17	70	40 900	1984
44	Sumulu	Machinga	South	23 500	80	100	261 000	1984
45	Livingstonia	Rumphi	North	3 000	15	21	9 600	1984
46	Mirala	Machinga	South	13 000	56	81	108 000	1985
47	Kakwawa	Zomba	South	16 000	68	101	93 000	1985
				1 009 100	4 548	6 677	6 138 300	

A-4

Location Map of Rural Piped Water Projects



A-5 Georogical Map of Malawi



A-6 (1) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
8		KWILASYA	Mitomoni	53	72	125	180	1		1	
			Ntopa	76	130	206	290	1		1	
			Total (2)	129	202	331	470	2	0	2	0
MAG-8 Total			(2)	129	202	331	470	2	0	2	0

A-6 (2) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
9	160	UMBWA	Chiwaro	139	165	304	470	2		2	1
			Umbwa	212	245	457	640	2		2	1
			Nyanje								
			Mkambili	122	121	243	340	1		1	1
			Mtimpu	206	265	471	660	2		2	1
			Magwede	21	28	49	70	1		1	
			Thom	211	285	496	700	2		2	1
			Phunyu	159	198	357	500	2		2	1
			Kaidi	29	32	61	90				
			Chigwaja	250	337	587	830	3		3	2
			Mapalio	53	60	113	160				
			Mdala Malungwa	12	24	36	50				
			Mwandima	117	139	256	360	1		1	1
			Total (12)	1,531	1,899	3,430	4,830	16	0	16	9
	161	KAPOLOMA	Nselema	175	236	411	580	1	1	2	
			Mwitiya	77	109	186	260	1		1	
			Mbambaya	65	87	152	210	1		1	
			Lim	20	33	53	75				
			Kapoloma(A)	181	202	383	540	1	1	2	
			Kapoloma(B)	113	164	277	390	1		1	
			Mofolo	39	55	94	130				
			Nangwale	37	51	88	120	1		1	
			Salima	26	41	67	100				
			Makata	133	202	335	470	1		1	1
			Rafaelo	117	146	263	370	1	1	2	
			Mkweya	45	60	105	150	1		1	
			Mota	47	60	107	150	1		1	
			Chiwalo	9	11	20	28				
			Paulo Palasi	43	45	88	120	1		1	
			Total (15)	1,127	1,502	2,629	3,690	11	3	14	1

A-6 (3) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
9	162	NKAPA	Napwanga	3	2	5	10				
			Mkanje	285	372	657	930	3		3	2
			Majaja	213	287	500	710	3		3	2
			Chimombo	17	22	39	60				
			Nkapa	293	341	634	890	1	2	3	
			Mlung	156	185	341	480	2		2	1
			Makoka	125	149	274	390	1		1	1
			Chimala	171	216	387	550	2		2	1
			Ulongwe Estate	45	29	74	100				
			Mtenjela	44	65	109	150	1		1	
			Mkanje	31	23	54	80				
			Malango	35	51	86	120	1		1	
			Mitomoni	79	75	154	220	1		1	
			Total (13)	1,497	1,817	3,314	4,690	15	2	17	7
	163	NYAMBI	Puluma	45	55	100	140	1		1	
			Mchimbo(A)	125	180	305	430	2		2	1
			Mchimbo(B)	109	31	140	200	1		1	
			Mlamba	118	126	244	340	1		1	1
			Likoswe	114	168	282	400	2		2	1
			Nyambi	201	284	485	680	3		3	1
			Mtopola	77	142	219	310	1		1	
			Chisisa	67	87	154	220	1		1	
			Chitaganya	170	178	348	490	1		1	1
			Kaukuta	96	162	258	360	1		1	1
			Chikojo	76	105	181	260	1		1	
			Mtapa	135	171	306	430	2		2	1
			Mchika	191	231	422	560	2		2	1
			Pasakele	89	73	162	230	1		1	
			Nikwakwa	35	44	79	110				
			Nantwe	187	227	414	580	2		2	1
			Nansola	180	220	400	560	2		2	1

A-6 (4) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
9	163		Sombo	228	267	495	700	2		2	1
			Total (18)	2.243	2.751	4.994	7000	26	0	26	11
	164	MKWEPELE	Yaya	47	50	97	140	1		1	
			Juma	13	22	35	50				
			Kanene	246	296	542	760	3		3	2
			Mkwepele	202	211	413	580	1	1	2	
			Namanjonjori	166	170	336	470	2		2	1
			Mbwabwa	45	47	92	130	1		1	
			Msapila	22	35	57	80				
			Mwinjilani	47	67	114	160	1		1	
			Mkumbeni	66	42	108	150		1	1	
			Mbalwe	225	243	468	660	2		2	1
			Total (10)	1.079	1.183	2.262	3.180	11	2	13	4
	165	NTALI	Kalambo	14	23	37	50				
			Chamba	40	75	115	160	1		1	
			Sawanje-meso	38	34	72	100				
			Mlima	189	125	314	440	2		2	1
			Ntali	96	97	193	270	1		1	
			Mlanda	36	42	78	110				
			Bakali	91	94	185	260	1		1	
			Mlawa	15	13	28	40				
			Mkwinda	256	282	538	760	3		3	2
			Mlenje	81	101	182	260	1		1	
			Maisi	140	195	335	470	2		2	1
			Mole pingo	27	30	57	80				
			Mlanje	106	106	212	300	2		2	
			Mthiniwa	331	376	707	1000	4		4	2
			Jelasi	14	16	30	40				
			Mongola	93	126	219	310		1	1	

A-6 (5) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
9	165		Mphipha	33	36	69	100				
			Msamala	29	38	67	100	1		1	
			Total (18)	1,629	1,809	3,438	4,850	18	1	19	6
	166	MWITIYA	Ngalama	42	65	107	150	1		1	
			Mtonda	112	102	214	300	2		2	
			Mwitiya	152	133	285	400	2		2	1
			Mkoman Khani Estate No.II	1	3	4	10				
			Mlinde Estate	45	23	68	100				
			Khama Estate	85	25	110	160				
			Nawanga	42	60	102	140	1		1	
			Mkwepu	38	33	71	100				
			Limamu Sinja	0	14	14	20				
			Puluma II	6	13	19	30				
			Kalimele	90	108	198	280	1		1	
			Chalawe	121	97	218	310	1		1	
			Total (12)	734	676	1,410	2,000	8	0	8	1
	167	CHIMBILA	Chimbila	96	132	228	320	1		1	1
			Salanje	88	97	185	260	1		1	
			Katulo	34	43	77	110				
			Mkwetemba	27	29	56	80	1		1	
			Mataka	3	2	5	10				
			Chinyenye	18	28	46	70				
			Total (6)	226	331	597	850	3	0	3	1
MGA-9 Total			(104)	10,106	11,968	22,074	31,090	108	8	116	40

A-6 (6) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
10	168	Mwepeta	M'njete	31	45	76	110				
			Ntoko	72	29	101	140	1		1	
			Mtungwi	102	115	217	310	2		2	
			Mwepetha	37	42	79	110				
			Kungwa	112	134	246	350	1		1	1
			Bitiya	66	81	147	210	1		1	
			Total (6)	496	446	866	1,230	5	0	5	1
	169	BAKALI	Chilonga	52	132	228	320	1		1	1
			Chamba	59	65	117	170	1		1	
			Mteuka	39	83	142	200	1		1	
			Mpinda	39	45	84	120				
			Lipuputa	49	60	109	150	1		1	
			Chimanda	96	87	183	260	1		1	
			Total (6)	391	472	863	1,220	5	0	5	1
	170	MUWAWA	Mchiwa	183	229	412	580	2		2	1
			Muwawa	205	259	464	650	2		2	1
			Naituli	149	174	323	460	2		2	1
			Sulumba	14	16	30	40				
			Mkhowa	11	25	36	50				
			Mpakaka	98	98	196	280	2		2	
			Nankondwa	13	13	26	40				
			M'meta	78	130	208	290	1		1	
			Peheliya	86	116	202	290	1		1	
			Mponda	44	61	105	150	1		1	
			Nachanje	32	31	63	90				
			Mbaso	50	59	109	150	1		1	
			Makuku	326	372	698	980	3		3	2
			Tukuta	22	27	49	70				
			Sinja(Duwa)	33	43	76	110	1		1	

A-6 (7) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
10	170		Mtenjela	14	28	42	60				
			Total (16)	1,358	1,681	3,039	4,290	16	0	16	5
	171	CHIKUMBA	Nkhokwe	133	164	297	420	2		2	1
			Makanjila	70	117	187	260	1		1	
			Mwala	50	87	137	190		1	1	
			Mlungu	63	80	143	200	1		1	
			Namaja	7	14	21	30				
			Mwikawa	25	24	49	70				
			Total (6)	348	486	834	1,170	4	1	5	1
	172	MAKANALIA	Machina	242	277	519	730	3		3	2
			Muhatele	16	19	35	50				
			Makuteya	58	70	128	180	1		1	
			Selemani	54	69	123	170	1		1	
			Mbisa	66	96	162	230	1		1	
			Kokoti	57	88	145	210	1		1	
			Mwegawa	52	50	102	140		1	1	
			Likoloma	41	66	107	150				
			Makuche (Makala)	21	30	51	70				
			Total (9)	607	765	1,372	1,930	7	1	8	2
	173	KONDONI	Nyama	61	82	143	200	1		1	
			Maonga	116	137	253	360	2		2	1
			Mchingama	80	88	168	240	1		1	
			Ungwe	29	29	58	80	1		1	
			Kambwiri	58	67	125	180	1		1	
			Welewela	66	63	129	180	1		1	
			Mwenyali	31	30	61	90				

A-6 (8) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS (1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
10	173		Tupula	14	19	33	50				
			Matipa	29	48	77	110				
			Makawa	31	36	67	100				
			Nsangula	19	19	38	50				
			Mapanje	97	144	241	340	1	1	2	
			Katolokosu	44	40	84	120				
			Makacha	21	29	50	70				
			Total (14)	696	831	1,527	2,170	8	1	9	1
	174	CHISAWA	Chisawa	177	228	405	570	2		2	1
			Ngalawango	119	108	227	320	1		1	
			Isa	127	178	305	430	2		2	1
			Mowele	275	333	608	860	2	1	3	1
			Mosiya	93	121	214	300	1		1	
			Nambuta	45	61	106	150	1		1	
			Michesi	117	147	264	370	2		2	1
			Mwamuthu	50	68	118	170	1		1	
			Mbele	197	240	437	620	2		2	1
			Total (9)	1,200	1,484	2,684	3,790	14	1	15	5
	175	NTAJA	Phwiti	403	510	913	1,290	5		5	2
			Chiganga	121	163	284	400	2		2	1
			Total (2)	524	673	1,197	1,690	7	0	7	3
	176	CHIKWEO	Salanje	22	22	44	60				
			Saite	67	82	149	210	1		1	
			Lulanga	103	124	227	320	2		2	1
			Manja	50	51	101	140	1		1	
			Mtepa	124	144	268	380	1		1	1
			Kwisanjala	110	126	236	330		1	1	

A-6 (9) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
10	176		Nkolimbo	83	125	208	290	1		1	
			Lipagani	61	60	121	170	1		1	
			Chikweo	114	186	300	420	1	1	2	
			Chisumbi	58	80	138	200	1		1	
			Msisi	64	75	139	200	1		1	
			Mlowe	35	41	76	110				
			Mwanje	23	30	53	80				
			Kusani	24	48	72	100				
			Kondoni	201	279	480	690	3		3	1
			Total (15)	1,139	1,473	2,612	3,700	13	2	15	3
MAG-10 Total			(83)	6,683	8,311	14,994	21,190	79	6	85	22

A-6 (10) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
11	179	LIKHOMO	Mpili-Mission	42	58	100	140	1		1	
			MpiliT.C.	35	36	71	100				
			Chikumba	166	232	398	560	2		2	1
			Likhomo	99	101	200	280		1	1	
			Mahuta	150	163	313	440	1	1	2	
			Chipala	107	151	258	360	1		1	1
			Lipende	102	124	226	320	2		2	1
			Jon Makoka	181	262	443	630	2		2	1
			Njenjema	249	64	113	160	1		1	
			Mpunga	190	297	487	690	3		3	1
			Nsamu	205	281	487	690	2		2	1
			Nachuma	117	108	225	320	2		2	
			Muhipela	180	226	406	570	2		2	1
			Total (13)	1,623	2,103	3,726	5,260	19	2	21	7
	180	CHIUJA	Makome	82	133	215	300	1		1	
			Idi	37	64	101	140	1		1	
			Mulakala	128	194	322	450	1		1	1
			Kaumbwe	43	58	101	140	1		1	
			M'meta	83	117	200	280	1		1	
			Kachere	43	70	113	160	1		1	
			Kasambwe	65	69	134	190	1		1	
			Namwini	238	323	561	790	4		4	2
			Nanganga	202	288	490	690	2		2	1
			Mlemba	30	34	64	90				
			Chiuja	441	604	1,045	1,470	6		6	2
			Nchokola	117	187	304	430	1		1	1
			Total (12)	1,509	2,141	3,650	5,130	20	0	20	7
	181	NYENJE	Nyenje	203	258	461	650	3		3	1
			Nyenje(B)	84	109	193	270	1		1	

A-6 (11) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		Village	CENSUS(1977)			Estimated Population (1990)	Construction Plan			
	No.	Section Name		M	F	Total		New	Rehab.	Total	First Year
11	181		Chipili	65	79	144	200	1		1	
			Mtembo	157	160	317	450	1		1	1
			Total (4)	509	606	1,115	1,570	6	0	6	2
	182	CHINDAMBA	Msume	37	64	101	140	1		1	
			Mkomela	110	140	250	350	1		1	1
			Mbosongwe	72	122	194	270	1		1	
			M'malisye	6	12	18	30				
			Chipowo	140	169	309	440	2		2	1
			Total (5)	365	507	872	1,230	5	0	5	2
MAG-11 Total			(34)	4,006	5,357	9,363	13,190	50	2	52	18

A-6 (12) Population Sheet and Construction Plan at Village Level

MAG	EXT. Section		No. of Village	CENSUS (1977)			Estimated Population (1990)	Construction Plan			
	No.	No. of Section		M	F	Total		New	Rehab.	Total	First Year
8		1	2	129	202	331	470	2	0	2	0
9		8	104	10,106	11,968	22,074	31,090	108	8	116	40
10		9	83	6,683	8,311	14,944	21,190	79	6	85	22
11		4	34	4,006	5,357	9,363	13,190	50	2	52	18
Total		22	223	20,924	25,838	46,762	65,940	239	16	255	80

A-7 Meteorological Data

1. Monthly Rainfall (unit: mm)

Station Name: Ntaja Height: 731 metres

Years	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total
1975							124.7	243.3	86.6	46.5	1.8	1.3	
1975/76	10.2	1.0	0.5	62.5	58.2	69.1	204.0	293.1	196.1	125.2	16.3	8.4	1044.6
1976/77	5.6	0.0	0.0	14.7	7.6	166.4	269.2	74.4	155.4	5.1	0.0	0.0	698.4
1977/78	0.0	0.0	0.0	5.1	61.0	197.6	378.2	165.4	478.5	57.9	3.8	0.0	1347.5
1978/79	11.7	0.0	0.0	16.8	47.8	256.3	174.2	170.9	230.6	26.9	0.0	7.6	942.8
1979/80	0.0	0.0	1.3	1.3	146.6	212.6	64.0	308.4	37.6	84.1	0.0	3.0	858.9
1980/81	1.4	10.4	0.0	29.8	2.8	421.6	79.3	226.7	83.3	22.8	14.0	1.4	893.5
1981/82	0.0	0.0	1.6	39.2	36.2	41.9	297.5	222.5	74.6	71.5	4.8	0.0	789.8
1982/83	13.6	6.8	0.0	66.4	121.4	135.3	202.1	112.9	134.0	82.5	2.1	5.5	882.6
1983/84	20.5	1.1	0.0	5.9	63.1	100.9	162.0	241.2	182.2	8.8	3.8	1.7	791.2
1984/85	0.0	0.0	1.5	1.6	62.8	185.0	265.0	165.9	119.6	49.8	2.3	3.8	857.3
1985/86	0.0	7.7	1.1	7.0	111.8	326.1	250.7	180.8	162.1	42.2	2.6	0.3	1092.4

Station Name: Chikweo Height: 717 metres

Years	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total
1982							164.7	317.7	44.1	47.1	17.5	0.5	
1982/83	14.0	16.9	2.6	34.0	99.0	244.4	128.8	116.7	111.7	36.1	1.6	0.6	806.4
1983/84	17.7	0.0	0.0	3.4	74.5	163.0	110.0	339.8	194.2	15.7	2.9	3.8	924.9
1984/85	0.3	0.0	9.6	0.4	74.4	168.2	268.7	154.5	243.4	67.4	0.8	2.2	989.9
1985/86	0.1	1.6	10.7	3.9	74.7	338.0	261.8	214.5	171.5	40.4	2.2	2.2	1121.6

Station Name: Nyambi Height: 853 metres

Years	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total
1975							228.6	269.0	120.1	88.1	4.6	4.1	
1975/76	4.1	0.0	0.0	25.9	55.9	259.8	256.3	317.2	469.1	282.4	26.9	16.5	1714.1
1976/77	5.8	0.0	0.0	19.6	10.2	260.6	326.9	121.2	227.8	5.1	0.0	0.0	977.2
1977/78	4.3	0.0	2.3	0.0	90.7	179.3	294.1	144.5	234.4	8.9	4.3	7.4	970.2
1978/79	19.1	0.0	0.0	30.0	56.6	456.9	294.1	144.5	234.4	8.9	0.0	7.4	1251.9
1979/80	14.2	0.0	1.0	4.6	94.2	277.9	139.4	137.7	102.9	103.6	15.0	3.0	893.5
1980/81	38.1	0.0	0.0	64.7	6.3	458.3	142.3	292.4	101.6	38.3	20.3	1.4	1163.7
1981/82	3.5	0.0	0.0	11.8	30.3	67.9	182.2	281.2	99.9	108.0	6.7	0.0	791.5
1982/83	27.7	19.6	1.3	43.5	75.2	206.1	169.4	156.7	137.0	42.2	0.8	0.4	879.9
1983/84	23.2	0.0	0.0	4.3	25.0	160.7	114.6	250.3	224.0	31.1	6.5	3.2	842.9
1984/85	6.2	0.0	0.0	39.5	73.5	194.2	241.2	131.1	256.5	108.1	5.0	6.8	1062.1
1985/86	0.6	2.1	5.4	10.8	57.6	222.5	374.9	284.1	347.9	48.7	40.2	7.6	1402.4

Station Name: Nkhokwe Height: 655 metres

Years	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total
1975							118.6	193.8	84.1	75.7	0.0	0.0	
1975/76	0.0	0.0	0.0	41.9	60.5	237.0	195.3	238.8	354.3	232.2	10.9	3.6	1374.5
1976/77	3.6	0.0	10.7	31.5	5.1	219.7	379.2	64.8	226.6	16.3	0.0	0.0	957.5
1977/78	1.8	0.0	10.7	0.0	84.8	178.3	400.3	269.5	400.8	113.0	0.0	1.8	1461.0
1978/79	3.0	0.0	0.0	53.3	29.0	258.6	114.8	122.7	218.4	27.9	0.0	17.5	845.2
1979/80	10.2	0.0	0.0	6.6	141.2	209.3	77.2	140.2	93.2	94.5	0.0	0.0	772.4
1980/81													
1981/82					28.0	100.0	215.6	280.3	46.8		14.0	0.0	
1982/83	14.0	3.0	1.0	48.0	151.2	180.0	125.2	184.2	116.9	38.8	0.0	2.0	864.3
1983/84	10.5	0.0	0.0	11.3	49.0	157.5	235.3	131.5	164.6	15.0	1.3	5.2	781.2
1984/85	3.8	0.0	4.2	2.0	111.2	164.5	241.2	131.8	198.9	40.1	0.0	0.9	898.6
1985/86	1.2	2.3	0.1	1.1	92.3	345.4	298.6	93.1	143.7	69.1	0.0	0.4	1047.3

Station Name: Nsanama Height: 675 metres

Years	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total
1983							224.6	287.4	50.5	47.3	38.0	0.0	
1983/84	0.0	0.0	0.0	6.9	41.8	159.7	164.2	86.3	136.5	7.3	2.0	0.2	604.9
1984/85	0.0	0.0	1.0	0.0	51.1	183.3	303.2	203.7	133.5	35.0	0.1	2.3	913.2
1985/86	0.0	3.1	0.0	10.8	140.7	305.1	308.7	213.2	234.5	16.6	0.0	2.4	1235.1

Station Name: Kankhomba Height: 640 metres

Years	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total
1975							87.4	205.5	106.2	49.5	0.0	4.6	
1975/76	13.2	2.0	1.3	8.6	54.1	131.8	243.6	154.7	176.0	98.8	13.0	4.1	899.2
1976/77	9.1	0.0	0.0	0.0	4.3	270.8	332.7	103.6	155.4	15.0	0.0	0.0	890.9
1977/78	1.3	0.0	5.6	0.0	84.1	278.9	392.7	186.9	352.8	56.6	6.9	3.0	1368.8
1978/79	13.5	0.0	0.0	58.4	38.9	120.7	126.7	258.3	181.4	42.9	0.0	9.9	850.7
1979/80	1.3	2.3	2.0	7.9	138.4	243.6	169.2	173.0	75.7	139.2	2.0	1.0	955.6
1980/81	0.0	22.7	0.0	65.0	6.0	148.0	123.1	87.9	86.8	17.6	26.3	0.0	583.4
1981/82	4.7	0.0	0.0	46.0	38.0	146.0	323.5	203.7	76.0	124.5	4.7	0.0	967.1
1982/83	12.4	6.0	0.0	36.2	87.6	243.2	217.3	185.4	121.0	70.5	3.7	0.0	983.3
1983/84	40.8	0.0	0.0	18.0	30.1	94.5	189.0	230.9	220.5	5.0	2.0	0.1	830.9
1984/85	2.5	0.0	13.0	23.0	67.0	168.5	177.8	189.2	180.7	41.2	3.0	5.0	870.9
1985/86	0.0	2.1	10.0	5.7	85.5	247.5	204.0	225.0	171.7	15.4	1.3	0.9	969.1

Station Name: Masuku Height: 838 metres

Years	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total
1975							134.9	273.1	75.2	106.7	2.8	1.3	
1975/76	0.0	0.0	0.0	50.0	70.4	252.5	456.4	299.0	264.7	174.2	7.4	3.0	1577.6
1976/77	1.3	0.0	0.0	11.2	1.3	207.0	282.2	93.2	198.4	6.1	0.0	0.0	800.7
1977/78	0.5	0.0	7.4	0.0	99.8	92.7	437.9	284.0	301.8	71.6	0.0	1.3	1297.0
1978/79	6.1	0.0	0.0	18.5	59.2	215.1	177.3	204.5	413.0	68.6	10.7	0.0	1173.0
1979/80	0.0	0.0	0.0	11.9	259.6	241.8	127.8	81.8	99.6	186.2	0.0	0.0	1008.7
1980/81	0.0	5.2	0.0	127.8	31.7	553.2	151.3	307.8	101.0	66.5	12.7	0.0	1357.2
1981/82	0.0	0.0	0.0	93.9	89.2	49.9	184.1	277.1	45.9	137.1	5.8	0.0	883.0
1982/83	3.6	0.0	0.0	55.5	120.3	161.4	203.5	255.2	210.6	25.0	0.0	0.0	1035.1
1983/84	0.0	0.0	0.0	7.1	44.3	201.7	89.7	302.4	332.8	15.6	10.5	9.2	1013.3
1984/85	0.0	0.0	6.8	1.1	82.3	287.9	223.8	127.8	308.2	62.9	0.4	1.8	1103.0
1985/86	0.0	1.3	0.5	3.2	116.9	355.1	428.0	230.3	326.3	21.4	0.0	8.6	1491.6

2. Monthly and Annual Total of Rainy Days

Station Name: Ntaja

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
1974	29	24	24	12	9	4	1	0	0	0	8	14	125
1975	11	15	10	6	3	1	3	1	0	0	4	21	75
1976	17	21	15	11	7	4	1	1	1	3	8	13	102
1977	12	8	15	2	0	0	1	0	0	5	1	14	58
1978	22	13	23	7	1	0	0	0	0	1	6	12	85
1979	13	12	17	5	0	0	1	0	0	2	7	20	76
1980	8	15	5	7	0	1	0	0	0	5	1	22	64
1981	17	14	8	3	1	0	2	2	0	2	7	9	65
1982	17	14	5	7	3	0	2	1	0	3	6	10	68
1983	15	8	9	3	2	1	4	1	0	2	6	14	65
1984	10	16	21	5	3	4	0	0	1	1	11	18	90

Station Name: Chikwewo

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
1981	20	15	5	9	3	3	4	2	2	3	7	14	87
1982	19	19	21	11	0	0	0	1	0	1	10	19	101
1983	15	9	13	7	2	1	0	0	0	1	0	0	48
1984	18	20	15	8	3	0	0	0	0	0	10	20	94

Station Name: Nyambi

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
1974	23	22	20	9	9	4	1	0	0	1	7	18	114
1975	17	18	11	7	2	2	5	1	1	1	7	16	88
1976	17	18	16	14	8	6	1	0	0	6	5	18	109
1977	18	8	15	3	0	0	2	0	0	4	4	16	70
1978	11	11	17	2	0	3	1	0	1	0	13	19	78
1979	22	21	26	13	1	5	3	0	1	2	4	22	120
1980	12	11	13	10	1	1	0	0	1	2	12	12	75
1981	8	18	13	5	2	3	2	0	0	4	1	21	77

Station Name: Kankhomba

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
1974	9	11	8	6	0	3	0	0	1	1	3	12	54
1975	17	19	17	7	8	3	1	1	1	4	5	15	98
1976	16	13	16	10	4	3	0	0	0	0	1	12	75
1977	21	8	14	4	0	0	2	0	4	0	8	12	73
1978	25	22	25	12	2	4	1	1	1	2	10	11	116
1979	11	12	7	12	1	1	0	0	1	3	11	20	79
1980	8	13	14	2									

Station Name: Mbonechela

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
1974	19	17	18	9	7	3	0	0	0	0	7	11	91
1975	10	13	6	3	1	0	0	0	0	0	2	17	52
1976	14	16	13	7	2	2	1	0	0	3	5	13	76
1977	16	7	11	1	0	0	0	0	0	2	2	16	55
1978	19	14	23	9	0	0	1	0	0	0	8	15	89

3. Mean Monthly and Annual Daily Temperature and Relative Humidity

Station Name: Chikkieo

1) Temperature (°C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean annual
1984								21.7	24.3	26.4	24.9	24.3	
1985	24.2	23.5	23.7	22.1	20.6	18.6	19.2	20.3	23.8	24.1	24.2	23.7	22.3
1986	24.0	23.5	23.4	23.1	21.0	18.4	18.6	20.9	24.1	25.2	24.7	23.9	22.6
1987	24.0	24.7	24.7	23.0	21.8	18.3							

Station Name: Nsanama

1) Temperature (°C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean Annual
1983									22.4	23.2	27.1	24.3	
1984	23.9		22.1	21.0	18.2	18.4	23.8						
1985					20.1	18.2	18.4	19.2	22.9	24.5	24.0	23.5	
1986	23.5	23.4	24.0	22.3	21.4	19.7	18.8	19.5	22.3	24.3	24.0	23.7	22.2
1978	23.6	24.8	25.0	22.9	21.1								

2) Humidity (%)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean Annual
1983									60	62	57	78	
1984	81		78	76	77	79	61						
1985					81	74	75	71	59	60	70	85	
1986	87	86	83	79	74	71	70	69	60	66	72	80	74.8
1987	83	80	77	79	75								

Station Name: Masuku

1) Temperatures (°C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean Annual
1983									21.5	22.7	25.6	23.2	
1984	23.2	22.6	21.7	21.5	19.9	17.5	17.5	17.7	21.2	23.4	22.7	22.5	21.0
1985	22.8	22.3	22.0	21.4	19.4	16.7	17.4	18.9	21.5	23.1	22.3	22.8	20.9
1986	22.2	22.9	22.9	21.8	20.7	17.4	17.4	18.5	20.9	23.3	22.6	22.8	21.1
1987	22.6	23.3	23.5	21.9	21.2								

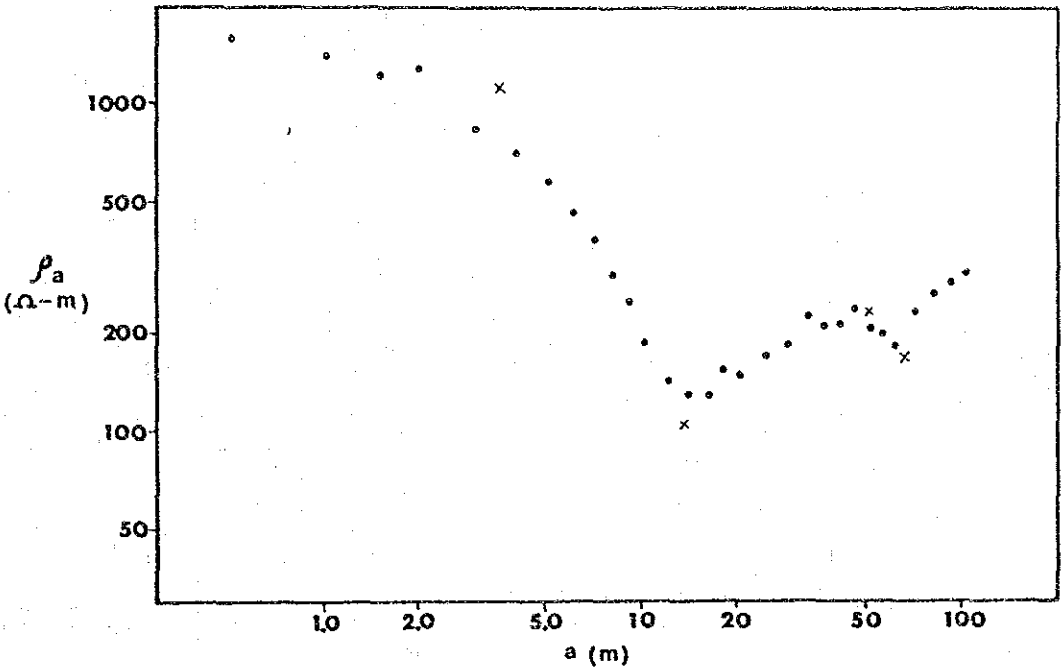
2) Humidity (%)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean Annual
1983									58	61	59	78	
1984	81	81	85	75	80	77	77	70	60	59	75	95	76.3
1985	83	83	87	78	75	77	72	71	63	61	75	88	76.1
1986	87	80	80	84	70	73	76	69	60	64	77	82	75.2
1987	84	83	80	76	75								

NYAMBI

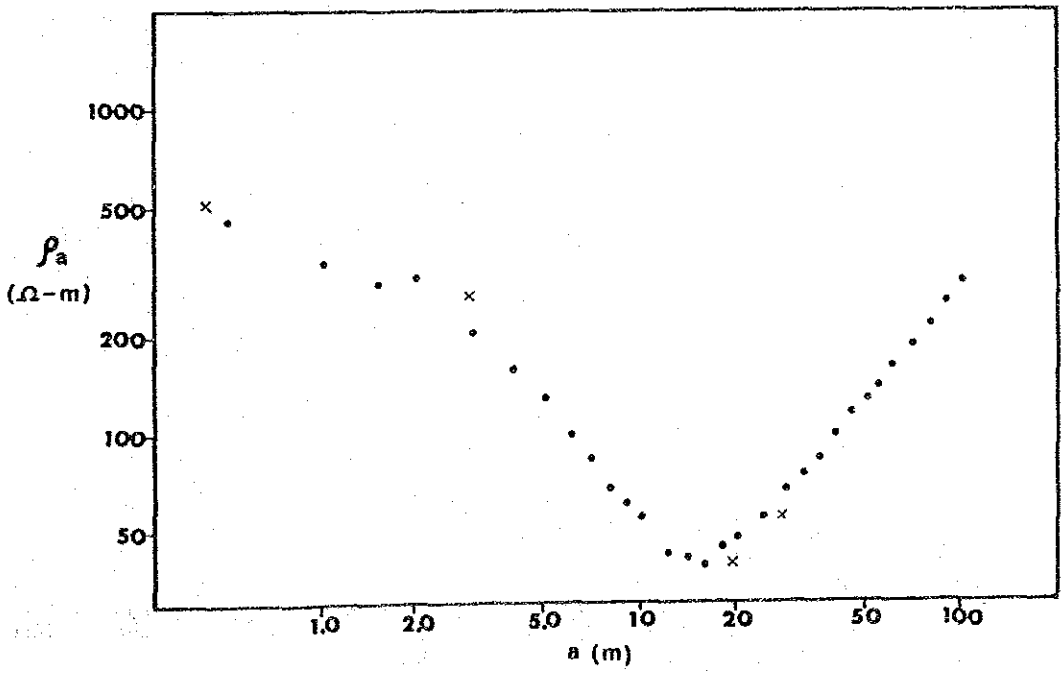
A-8 (1) ρ - a Curve (Electric Prospecting)

No. 1



1150	77	420	92	1750

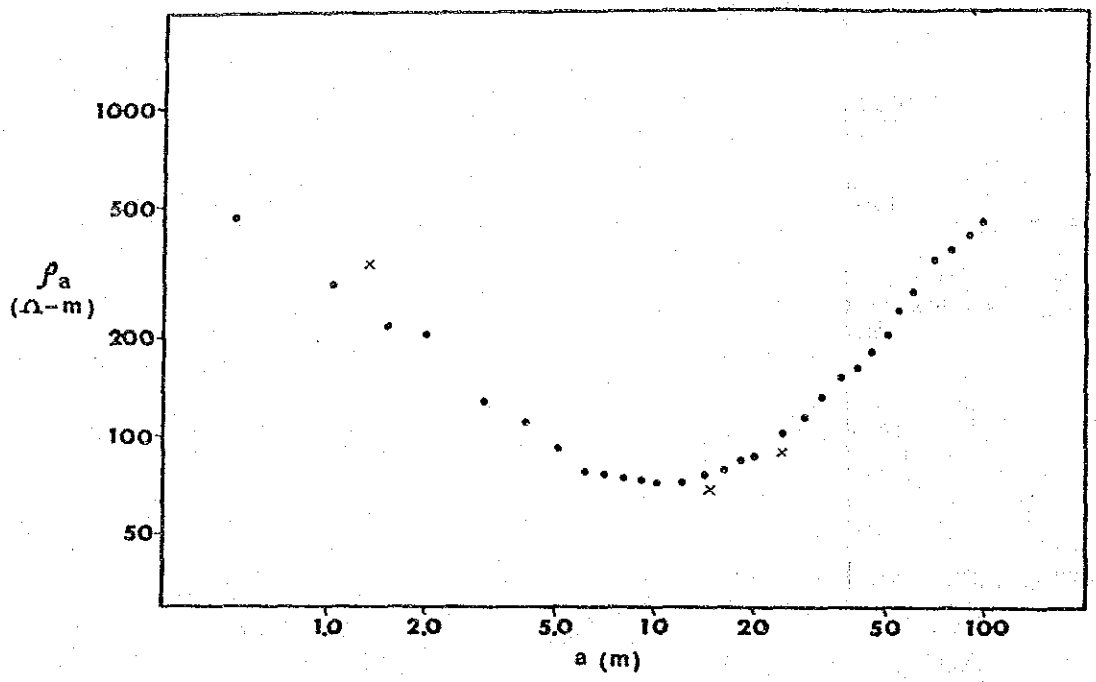
No. 2



500	250	35	200	3000 <

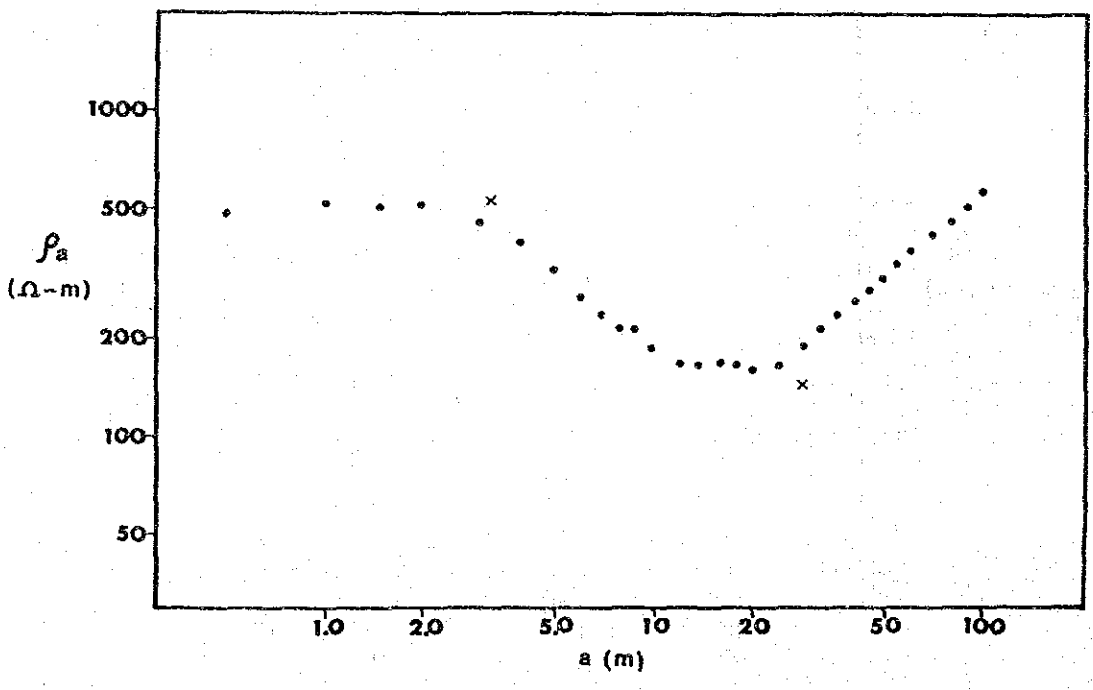
A-8 (2) ρ - a Curve (Electric Prospecting)

No. 3



340	68	175	4500

No. 4

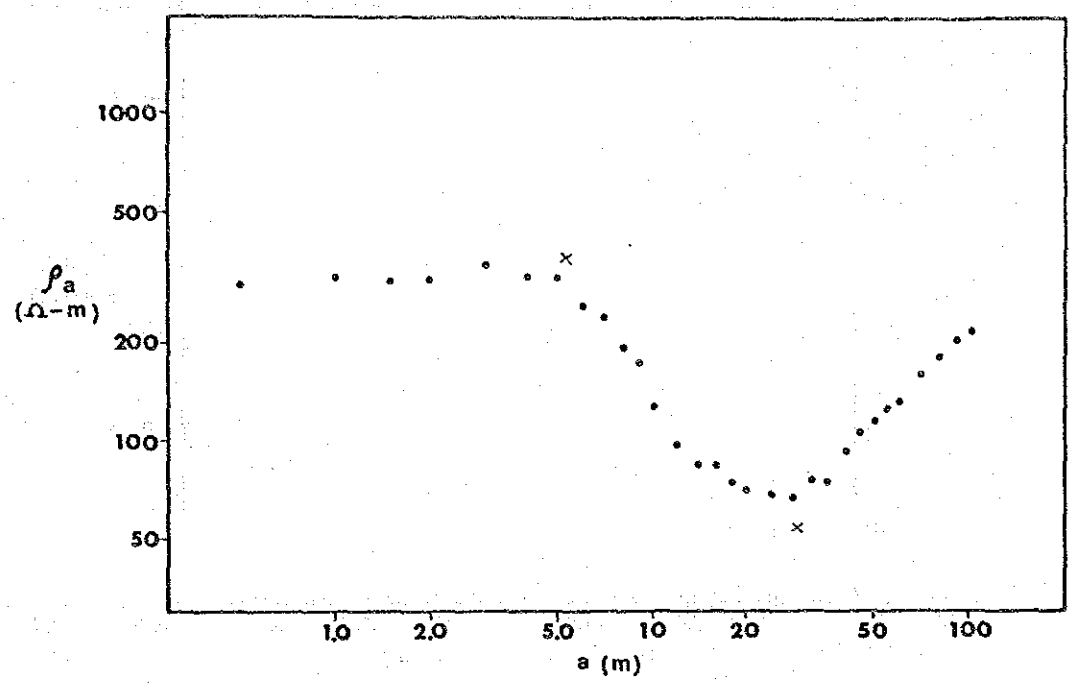


530	133	3000

A-8 (3) ρ – a Curve (Electric Prospecting)

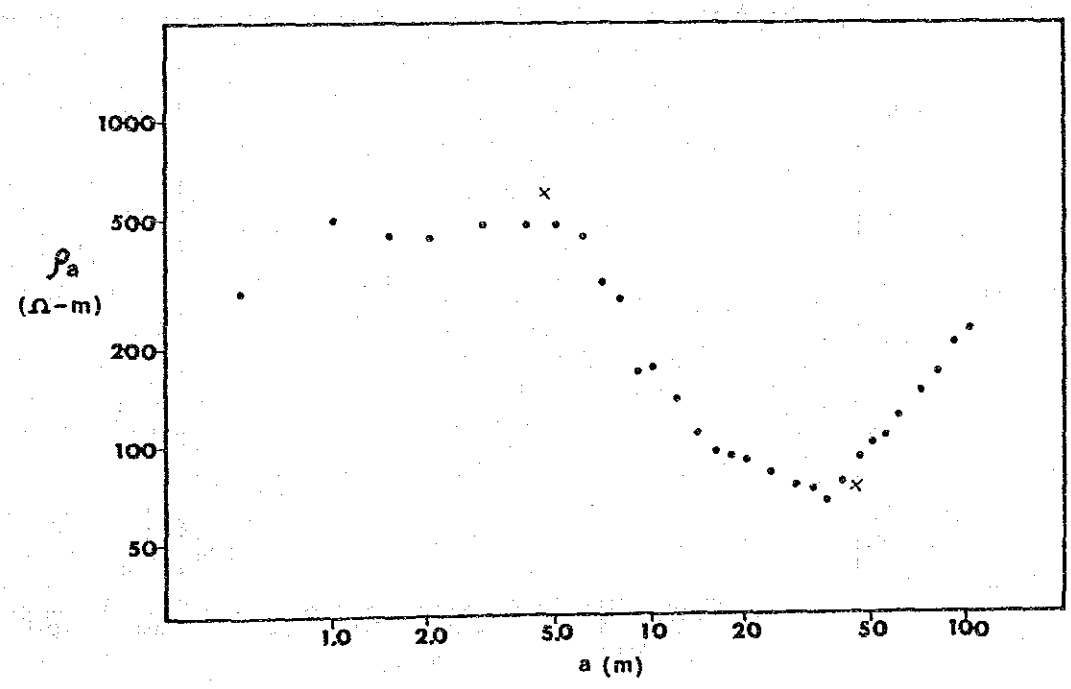
MKWEPELE

No. 1



360	45	2700

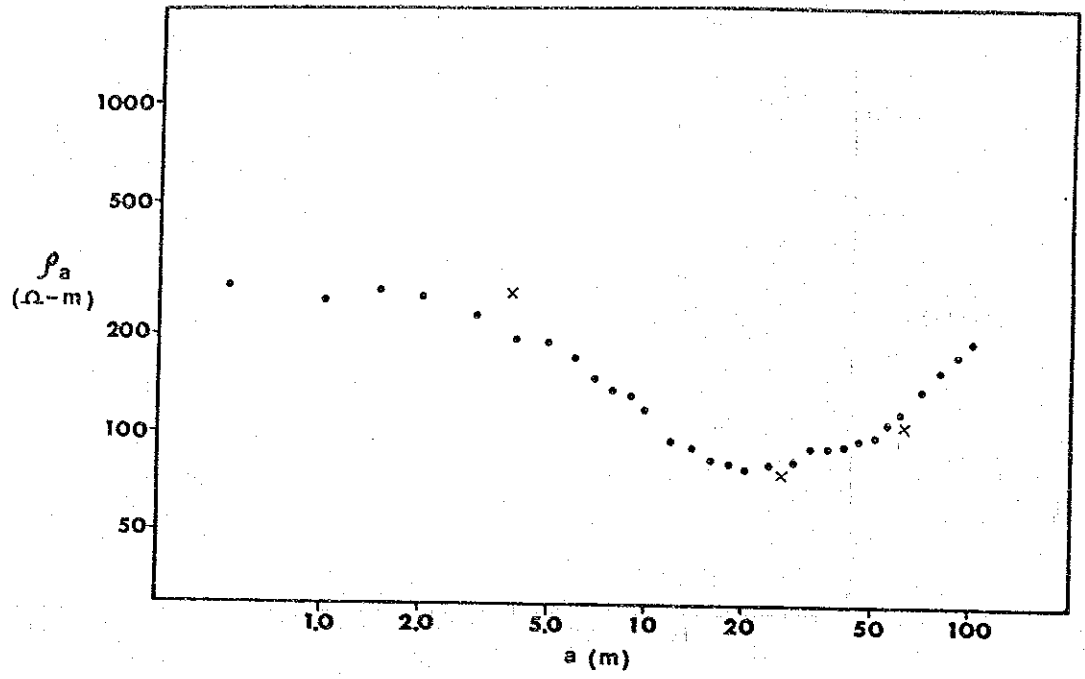
No. 2



600	67	3500 <

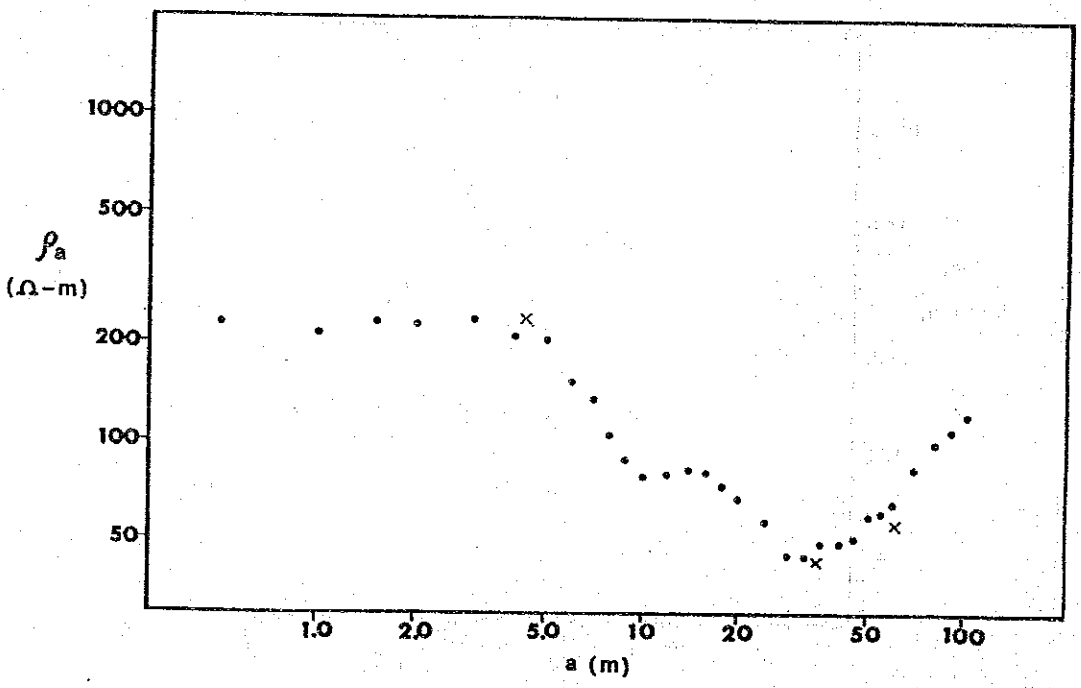
A-8 (4)　ρ - a Curve (Electric Prospecting)

No. 3



260	65	150	1000

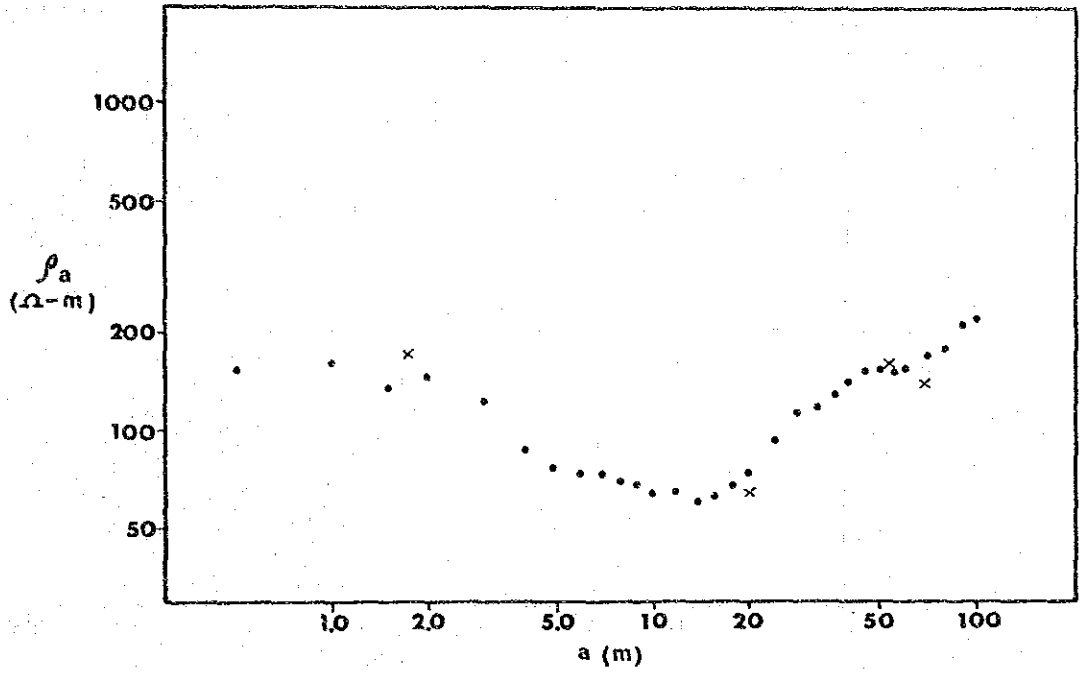
No. 4



240	40	110	2750

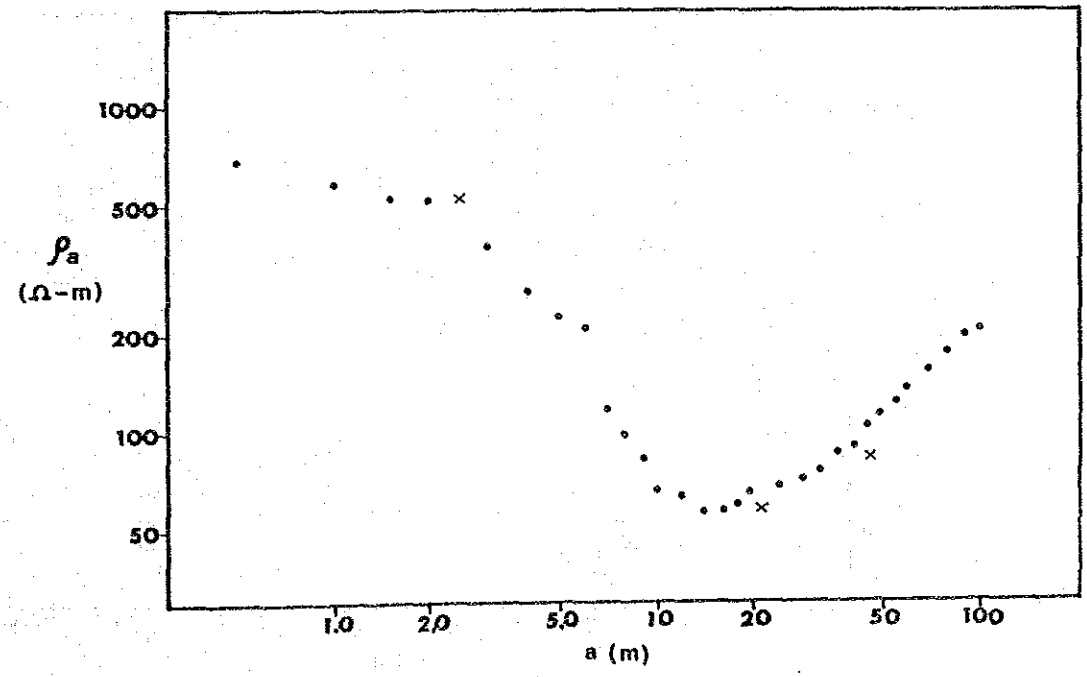
MWITIYA A-8 (5) ρ - a Curve (Electric Prospecting)

No. 1



170	57	620	100	980

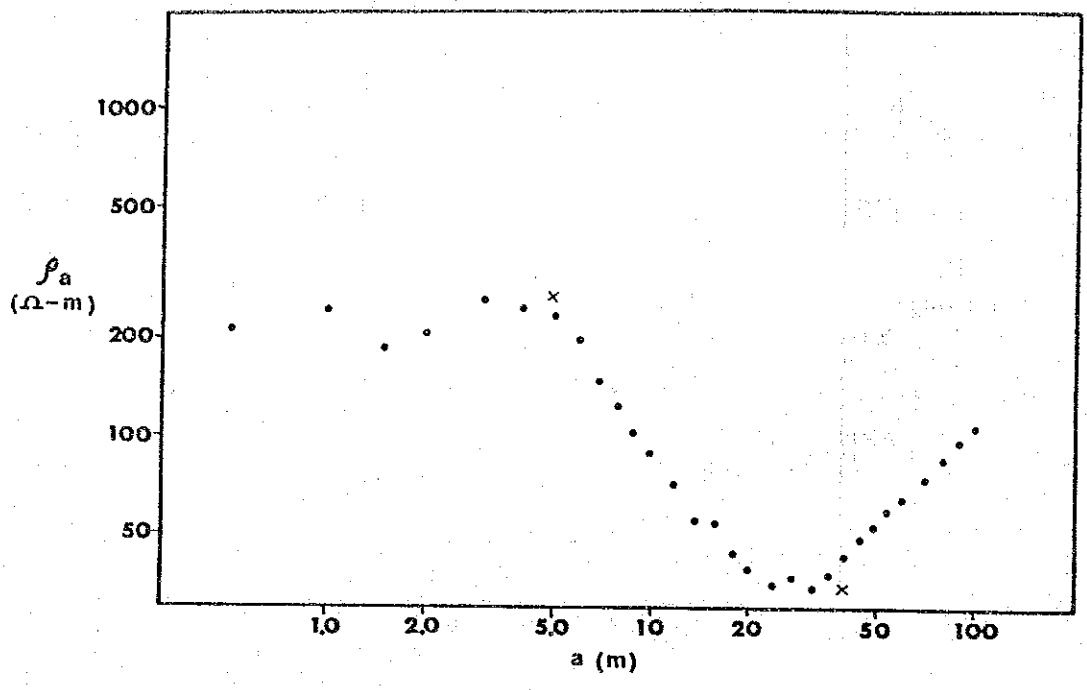
No. 2



540	54	120	1640

A-8 (6)　ρ - a Curve (Electric Prospecting)

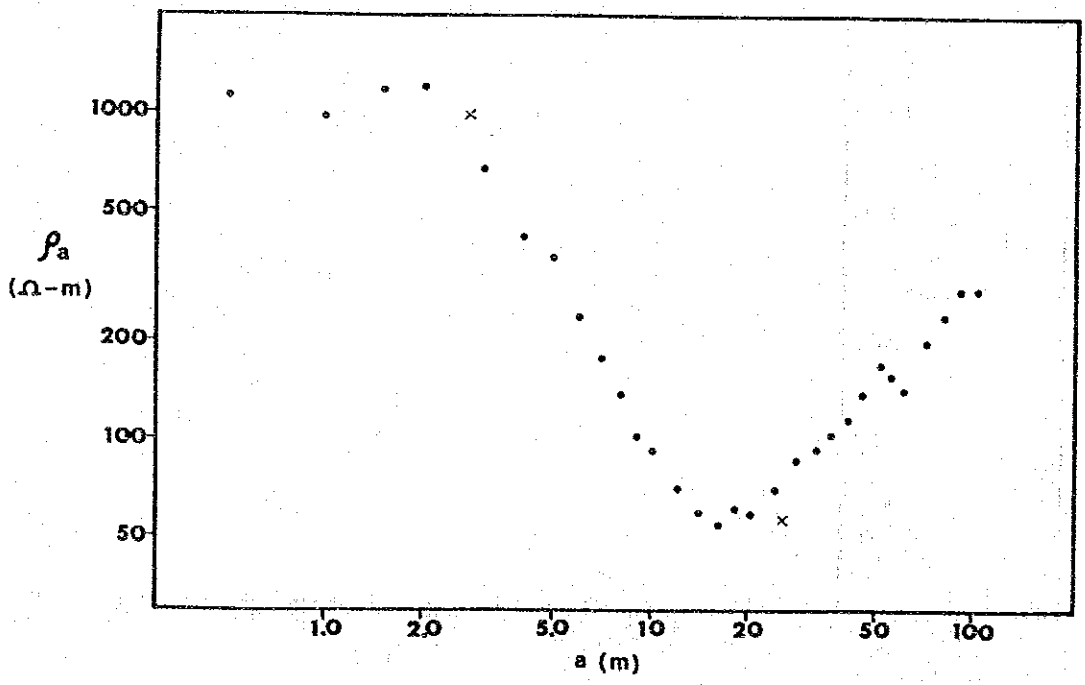
No. 3



260	29	1020

NKHOKWE

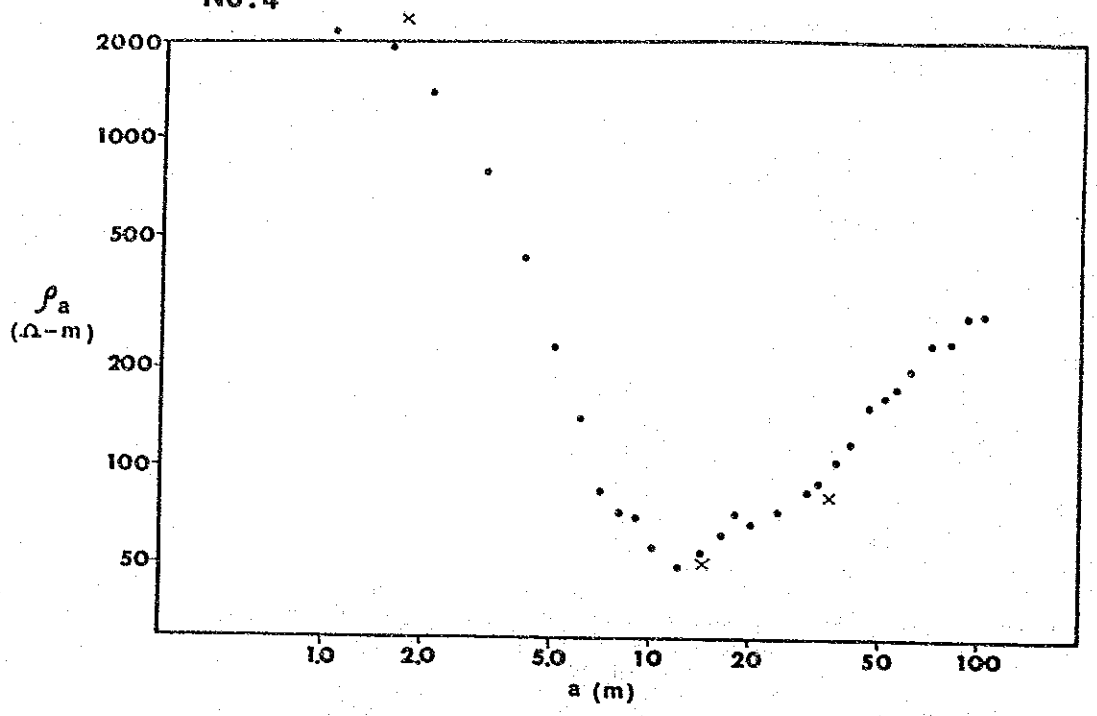
No. 1



1000	50	3000

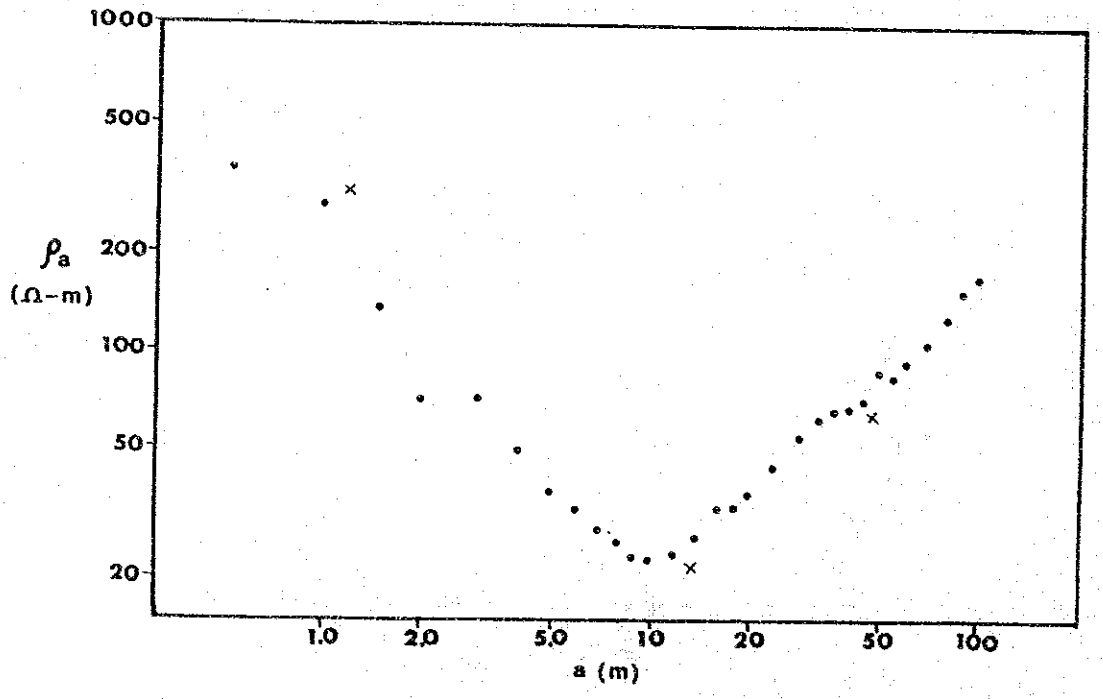
A-8 (8)　ρ - a Curve (Electric Prospecting)

No.4



2400	48	150	2400

No.5

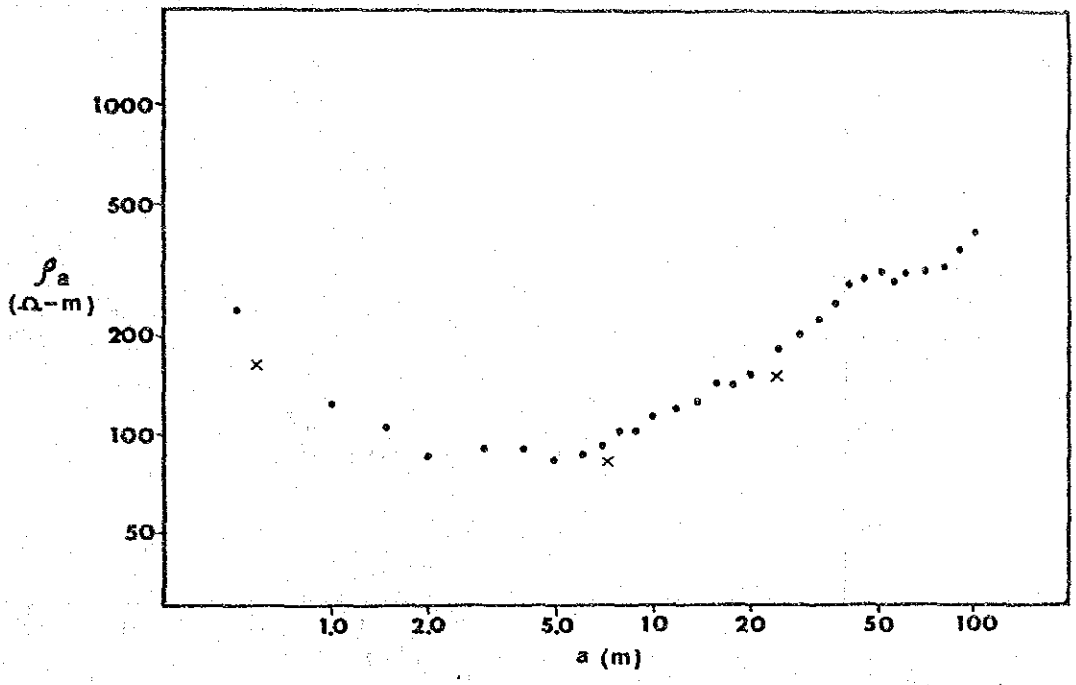


310	21	360	1950

CHIKWEO

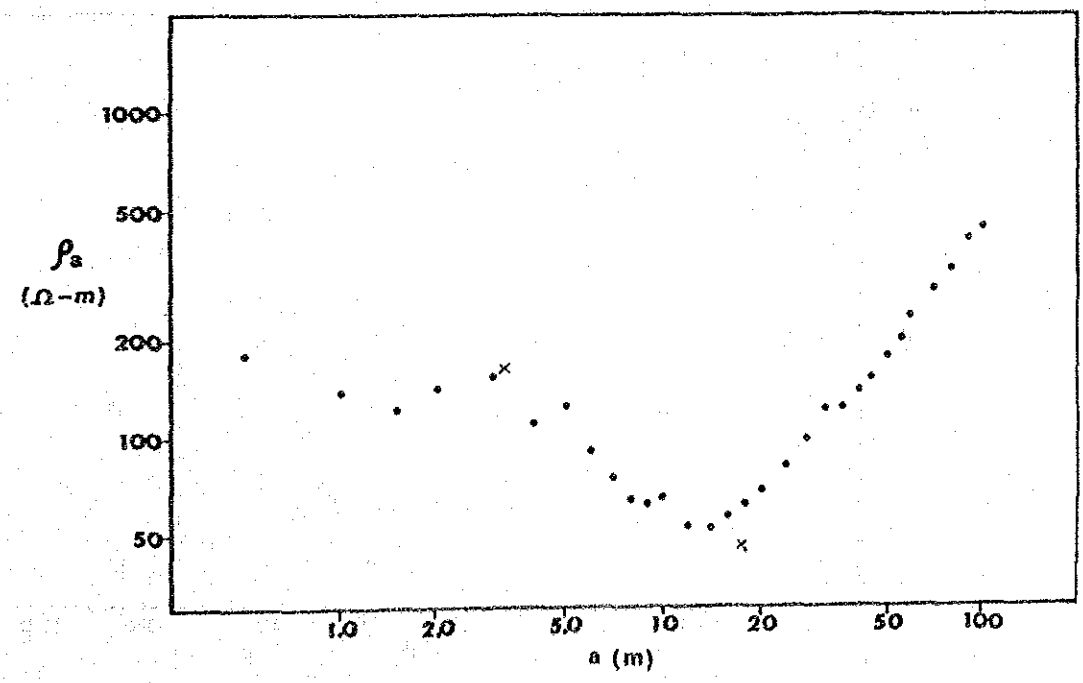
A-8 (9) ρ - a Curve (Electric Prospecting)

No. 1



160	80	250	600

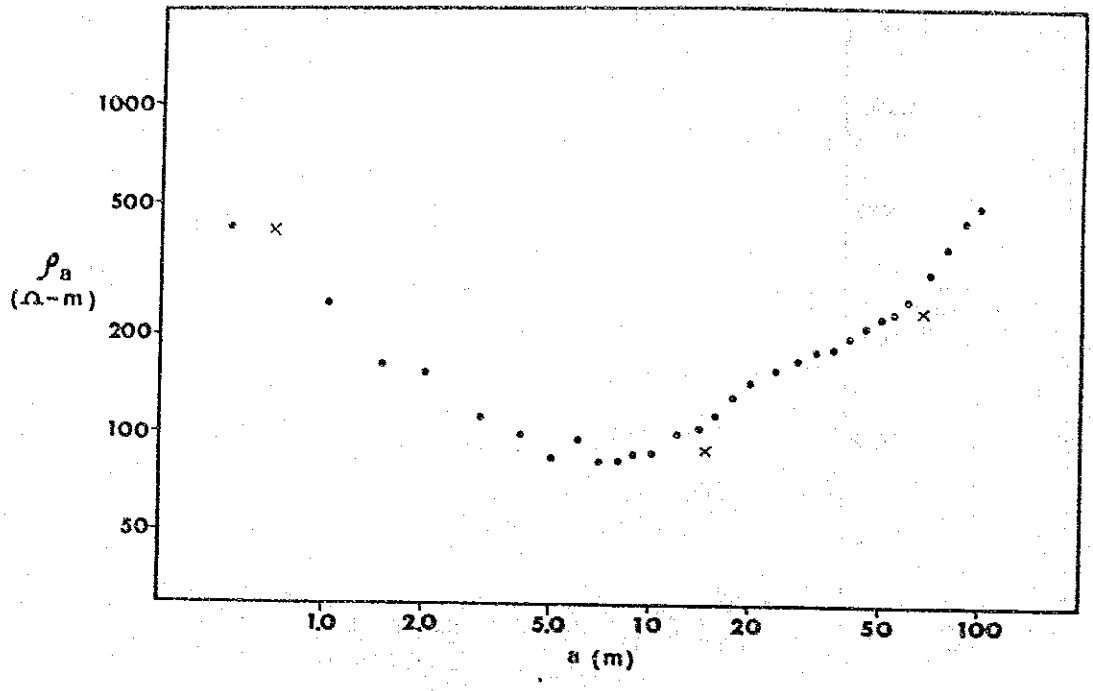
No. 2



160	40	2300<

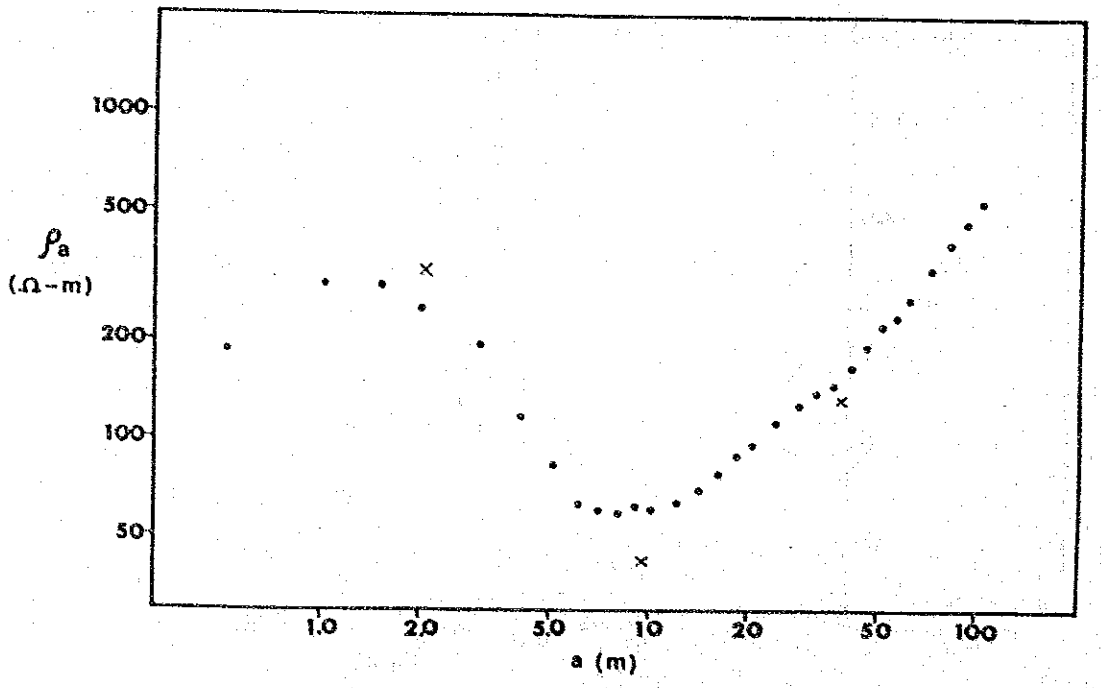
A-8 (10)　ρ - a Curve (Electric Prospecting)

No. 3



400	80	440	5000 <

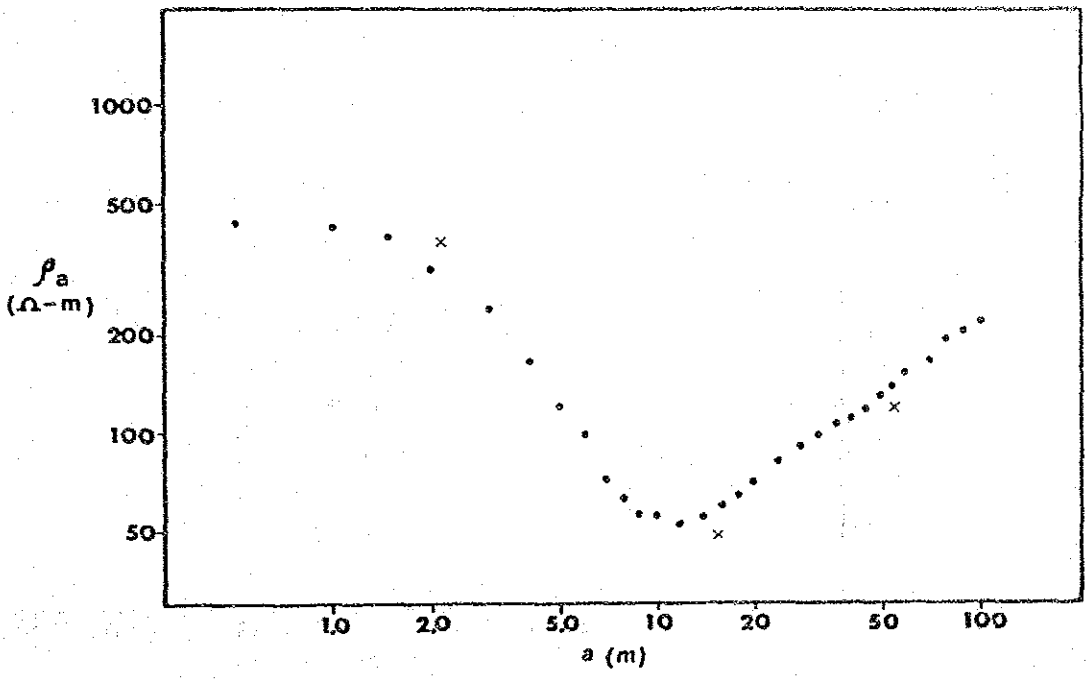
No. 4



330	33	420	5000 <

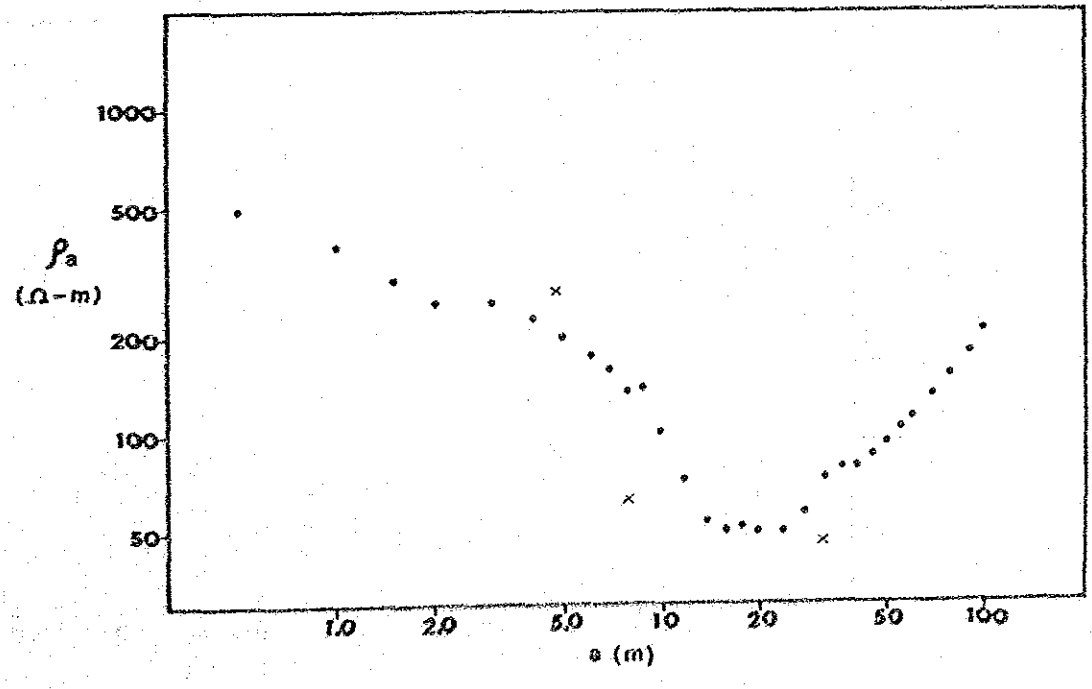
A-8 (11)　ρ - a Curve (Electric Prospecting)

No. 5



790	88	600	1440

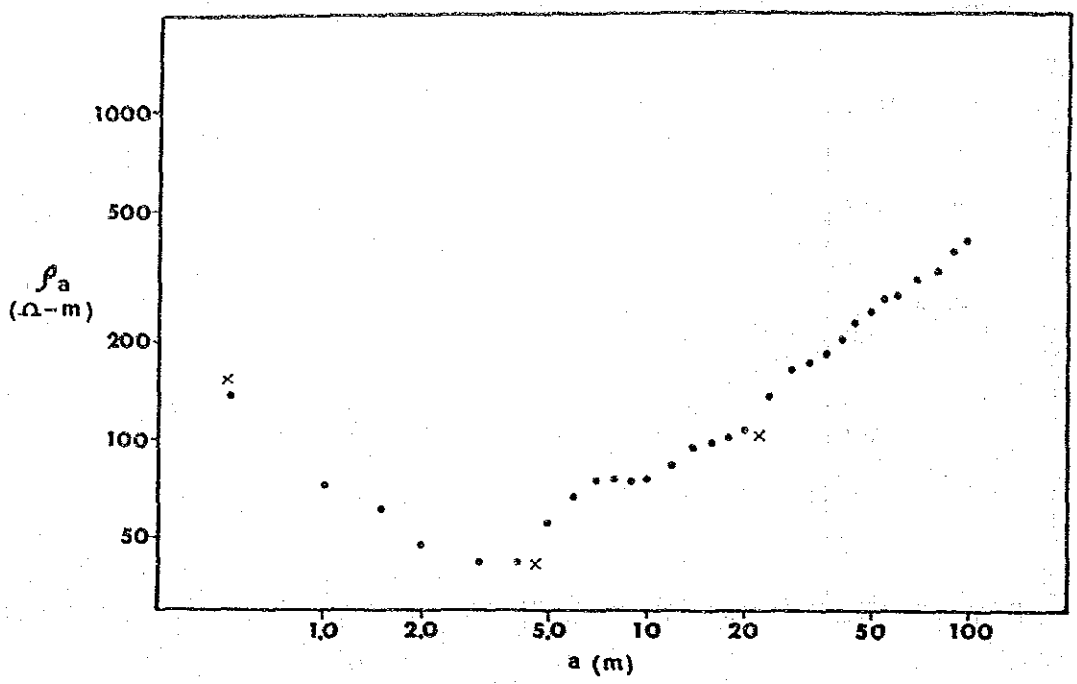
No. 6



560	56	83	4500

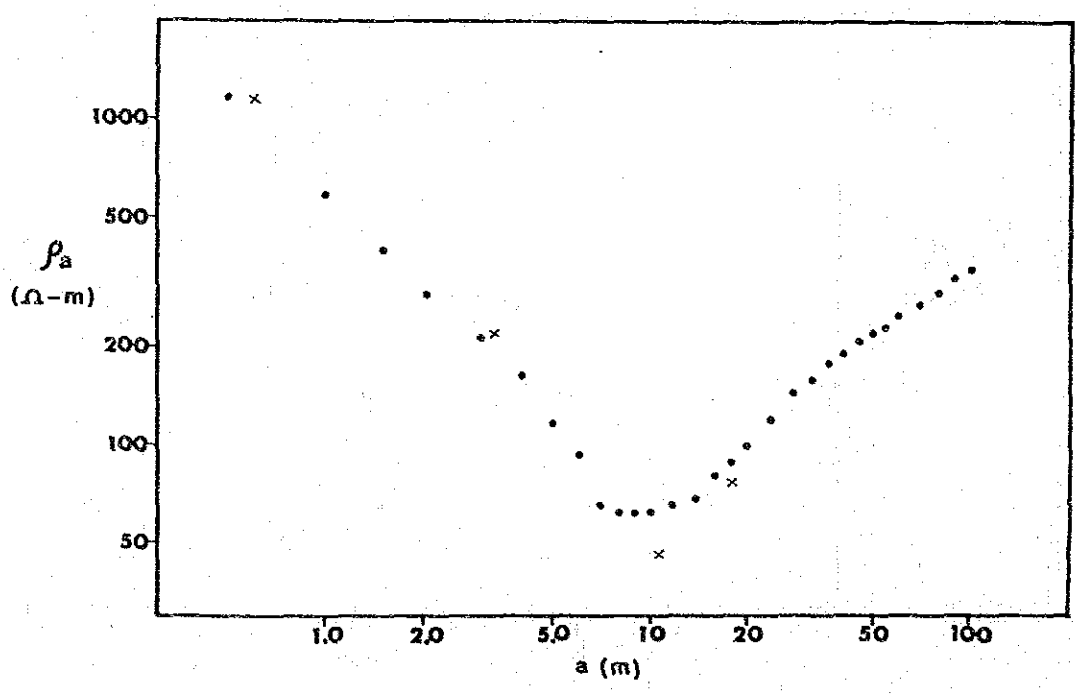
A-8 (12) ρ - a Curve (Electric Prospecting)

No. 1



150	38	168	1000

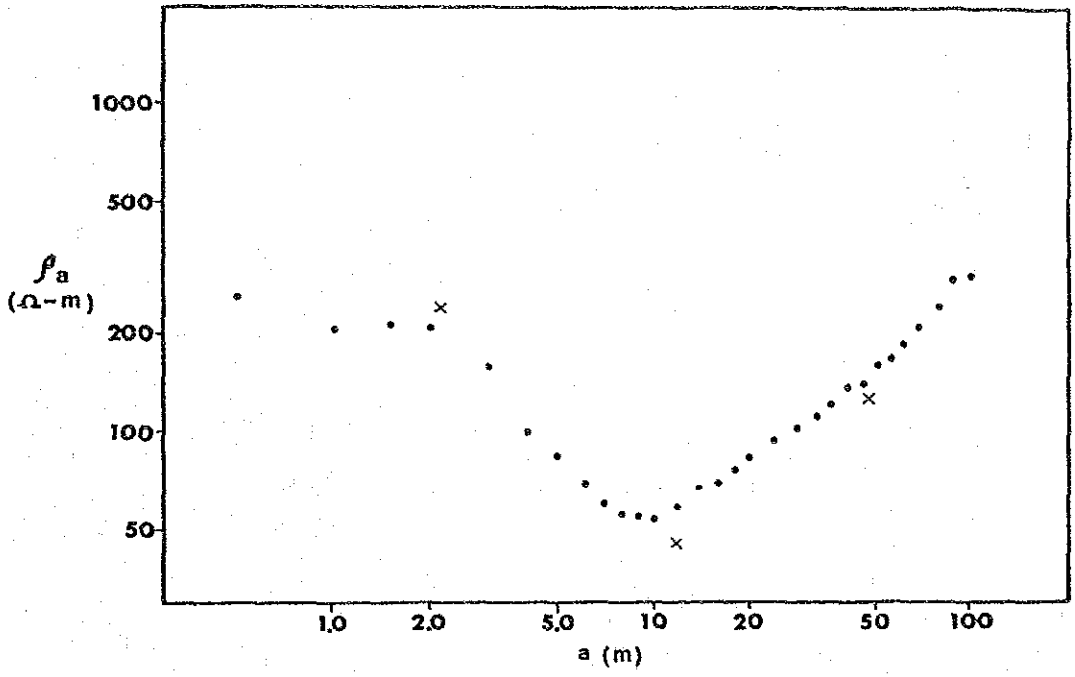
No. 2



1150	192	37	360	1125

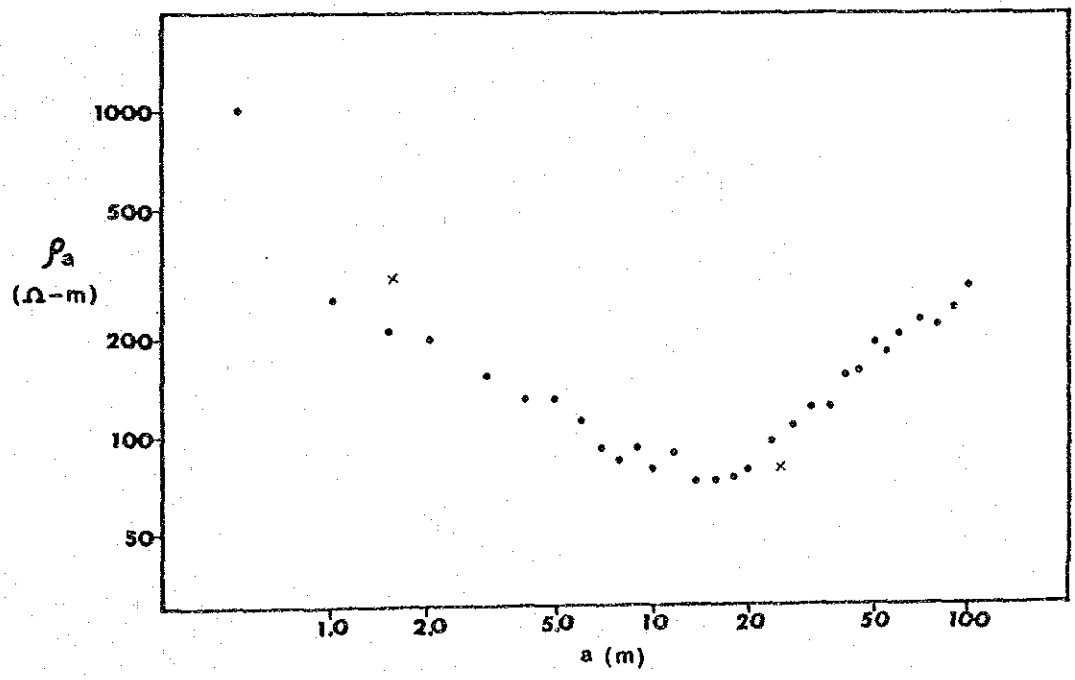
A-8 (13)　ρ ~ a Curve (Electric Prospecting)

No. 3



240	40	315	3000

No. 4



310	78	1275

APPENDIX IV LIST OF INTERVIEWEES

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1) Embassy of Japan in Kenya

Mr. Y. Nishitani	First Secretary

2) JICA in Kenya

Mr. A. Takahashi	Resident Representative
Mr. S. Kaiho	Assistant Resident Representative
Mr. K. Miyauchi	Expert
Mr. T. Toyoda	Expert

3) JICA in Malawi

Mr. M. Narawa	Resident Representative
Mr. S. Ono	Coordinator
Mr. M. D. Manger	Officer

4) Office of President and Cabinet

Mr. T. A. Kalebe	Senior Economist

5) Ministry of Works and Supplies

Mr. Clark	Principal Secretary
Mr. A. E. Mkandawire	Acting Secretary for Works and Supplies
Mr. B. H. Mwakikunga	Acting Engineer in Chief
Mr. John Brickle	Quantity Surveyor
Mr. C. de Souza	Acting Water Engineer-in-Chief Water Department
Mr. S. M. N. Mainala	Principal Hydrogeologist, Water Dept.
Mr. F. Msonthi	Hydrogeologist, Water Dept.

6) Ministry of Finance

Mr. T. A. V. Chande	Under Secretary, Development Section
Mr. H. S. Mononga	Acting Senior Assistant Secretary External Aid Section

7) Ministry of Agriculture

Mr. F. M. Kangaudi	*Controller of Agriculture Services (NRDP)*
Mr. E. Malindi	Acting Chief Agricultural Officer

Mr. D. J. Bisika	Deputy Chief Agricultural Officer (Planning & Monitoring)
Mr. A. D. Lidamlendo	Programme Manager, Liwonde A.D.D.
Mr. J. Malongo	Manager, Liwonde R.D.P.

8) Ministry of Forestry and Natural Resources

Mr. J. C. Chatupa	Chief Geologist, Geological Survey Dept.
Mr. A. T. Mndala	Assistant Chief Geologist Geological Survey Department

9) Ministry of Health

Mr. P. A. Chindamba	Chief Public Health Officer

10) National Statistical Office

Mr. H. E. Namarika	Commissioner for Census and Statistics

11) Department of Surveys

Mr. A. F. Tambala	Commissioner for Survey

12) Meteorological Department

Mr. G. Munthali	Chief Meteorological Officer
Mr. D. R. Kamadonya	Assistant Chief Meteorological Officer

13) Machinga District

Mr. M. S. M. Mlonga	Assistant District Commissioner
Mr. L. M. Nikisi	District Community Development Officer

14) UNDP

Mr. K. Liyanage	Design and Production Engineer

15) UNDP/World Bank in Kenya

Mr. J. Keen	Design and Production Engineer

APPENDIX V LIST OF COLLECTED DATA

APPENDIX V LIST OF COLLECTED DATA

1. Statement of Development Policies (1971-1980)
   - Office of the President and Cabinet (OPC) -
2. National Rural Development Programme, 1978
   - Ministry of Agriculture -
3. The International Drinking Water Supply and Sanitation Decade Directory (2nd Edition), 1984
   - UNDP -
4. National Water Resources Master Plan, 1986
   - Department of Water/UNDP -
5. Report on Machinga District Development Plan, 1986 (Draft)
   - OPC/UNDP/UNCHS -
6. National Physical Development Plan, 1986 (Draft)
   - UNDP/UNCHS -
7. Malawi Statistical Year Book, 1985
   - National Statistical Office -
8. Malawi Population Census, 1977 (Machinga District)
   - National Statistical Office -
9. Statistical Reference Tables, 1984
   - Ministry of Health -
10. Economic Report, 1985
    - OPC -
11. The Geology of the Lake Chiuta Area, 1970
    - Geological Survey Department -
12. Meteorological Data
    - Meteorological Department -
13. Manual for Integrated Project for Rural Groundwater Supplies, 1982
    - UNDP -
14. Development Operation and Maintenance of Low-Cost Rural Water Supplies in Malawi, 1986
    - Department of Water -

16. Annual Report on Handpump Testing in Upper Livulezi Project in Malawi

    - UNDP -

17. The National Atlas of Malawi

    - Department of Surveys -

18. Map of Natural Region and Areas - Southern Malawi (Scale 1:500,000)

    - Department of Surveys -

19. Map of North Kawinga Area (Sheet 1435C2, C4, D1 - D4) (Scale 1:50,000)

    - Department of Surveys -

20. Hydrogeological Reconnaissance Map (Sheet 6 Machinga, Sheet 8 Blantyre) (Scale 1:250,000)

    - Department of Surveys -

21. Map of Mangochi (Sheet 8) (Scale 1:250,000)

    - Department of Surveys -

22. Airborne Geological Survey Magnetic Contour Map (Sheet 1435D1 - D4) (Scale 1:50,000)

    - Geological Survey Department -

23. Distribution Map of Houses in Machinga District (DWG No. 122 - 129, 130 - 131) (Scale 1:25,000/1:50,000)

    - National Statistical Office -

24. Infrastructure Map of North Kawinga (Machinga 9, 10, 11) (Scale 1:50,000)

    - Liwonde ADD, Ministry of Agriculture -

25. Road Map of North Kawinga (Machinga 9, 10, 11) (Scale 1:50,000)

    - Liwonde ADD, Ministry of Agriculture -