4-3-2 Design Period

In this Project the design period is determined as ten years up to the year 2000 in accordance with the target year of the DWR and UNDP Rural Water Supply Project.

4-3-3 Project Distribution Area

The distribution area is projected in accordance with the administrative areas which are defined under the name of project sites.

4-3-4 Design Served Population

The design served population is determined by estimating the population at the end of the design period (10 years later) from the current population and the estimated growth rate. The population census was carried out in 1983 in the Gambia. The current population is estimated based on the calculated population by the RWSD and UNDP Rural Water Supply Project and this field survey. The estimated growth rate ranges 2.8% ～3.4% depending on the estimated year and the surveying agencies. In this project, the average growth rate during 10 years is decided as 3.0% per annum by following the guideline of the RWSD・UNDP Rural Water Supply Project (Table 4-2). The estimated current total population is 52,050 in 1990 and the design served population (in 2000) is estimated to be 75,210 for the 30 project sites.

4-3-5 Unit Consumption

The unit consumption, a basis for designing facilities, is recommended as 30～40 ℓ / capita / day for domestic water by the WHO and the UNDP Rural Water Project in the Gambia. The field survey revealed that the current water consumption is about 7 ～10 ℓ / capita / day. The unit consumption is, thus, decided as 35 ℓ / capita / day.

Also there are numbers of cattle, horses, donkeys, sheep, goats, and poultry in the sites along with village inhabitants. Their average daily consumption is deemed to be 35 ℓ / head of equivalent cattle / day in this project.

4-3-6 Water Demand

There is no standard for the capacity calculation for water tanks in the DWR. The following specifications are, therefore, set here in connection with the UNDP Rural Water Supply Project.

1) Daily Demand:

(Daily Demand) = (Design Population Served) × (Unit Consumption)
+ (Design Number of Cattle)× (Unit Consumption)

2) Maximum Hourly Water Consumption:

(Maximum Hourly Water Consumption) = (Hourly Demand)× (150%)

3) Emergency Demand:

The emergency demand is specified as follows in taking consideration of the shut-down period for repairing.

(Emergency Demand) = (3 ℓ / capita / day) × (Design Population Served
× (5 day)× (70%)

Where The Minimum Water Demand = 3ℓ / day

Emergency Period = 5 day

(duration between the report of emergency and the completion of repair)

Age Factor = 70%

(the factor which is assumed by the mixture of children)

4) Pumping Hours:

The water can be delivered 24 hours but the pumping hour is assumed to be 8 hours by equalizing the water demand through water tank capacity.

5) Design Water Tank Capacity:

(Design Water Tank Capacity) = (Maximum Hourly Water Consumption)
× 2 hours + (Emergency Demand)

4-3-7 Water Supply System

The flow diagram of the water supply facilities is shown in Fig. 4-2.

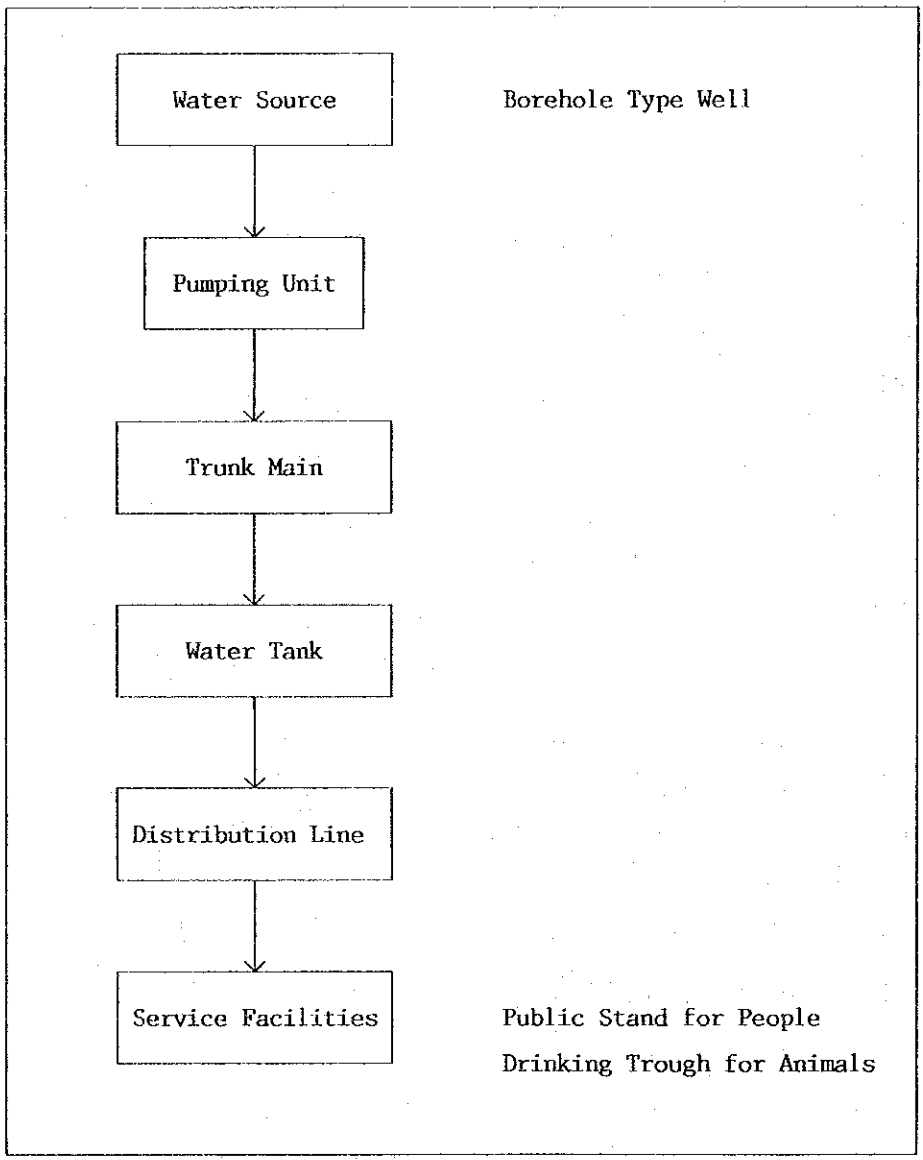


Fig. 4-2 Basic Concept of Water Supply System

1) Water Source

The water source is decided as a ϕ6 ″ (150㎜) borehole type well which is considered sanitary and pollution-free in conformity to the water source evaluation in section 4-3-1.

2) Pumping Unit

A powered pumping unit is needed for the requirements from the served

population, distribution of the settlements and water supply areas for this project, and a submersible motor pump system is most recommended which is being popularly used in the water supply projects in the Gambia.

An independent power plant is required at each site for the pumping unit due to the current situation of rural power supply. The power source can be either the conventional type (diesel engine) or the non-conventional type (solar photovoltaic power).

The solar pump is positively recommended by the Government of the Gambia from its energy strategy and both the rural inhabitants and the DWR desire the introduction of the solar system from the performance of the two test plants at Jambanjali and Kaiaf in the Gambia.

The utilization of solar system is progressing in the world very rapidly, and its application to the pumping system has extended to the rating power of about 5 kw. Sub-sahelian African countries have high interests in solar systems and many international cooperations have been granted to these countries and numerous successful performance reports have been issued. Thus, both systems are compared at each site from technical and economical considerations for various characteristic conditions of each site and operational considerations such as the rating power and selection of pumping sub-systems are examined.

3) Trunk Mains

The pumped water will be directly led to a water tank through a trunk main.

4) Water Tanks

An elevated water tank (H = 5m) is designed in order to distribute water by natural gravity force.

5) Distribution Lines

Water will be sent to water service facilities through a distribution line.

6) Service Facilities

A public stand for people and a drinking trough for animals are designed to be installed as water service facilities. In planning the facility layout, a public stand is placed within 15 minutes walking distance and 1 set is allocated to every 350 inhabitants. Also one drinking trough is placed for every 1,000 equivalent cattle.

4-3-8 Local Management of Water Supply System

After the completion of the water supply system, the local "Cooperative" will be assigned to manage the system. The "Cooperative" will operate and maintain the facilities under the technical instruction of the DWR by establishing an autonomous managing and operational organization within a site.

4-3-9 Selection of Equipment and Materials

The borehole type well shall have specifications as listed below for a water source of the Project:

diameter : 6″ (150 mm)
average depth : 90 ～100 m (maximum 150 m)

A drilling rig, tools, accessories, materials and various equipment shall be planned for use:

1) Equipment and Materials for Drilling Rig

The hydrogeological conditions of the project sites must be studied prior to the choice of the drilling method and equipment and machineries. The objective sites lies over the sediments of Quaternary and Tertiary Series and have prominent and wide-spread aquifers in sands of Tertiaries. For these formations, either percussion or rotary drilling method is suited. Although the DWR used to have both types of rigs, the Department is now undertaking groundwater development with only the rotary rig because of the higher drilling efficiency and effective usage of auxiliary machines under the instruction of the UNDP. The selection to limit use to the rotary rig in use can be well understood through the field study of the technical and methodological skills of personnels of the RWSD and records of foreign assistances. The DWR has a used rotary rig and has been drilling with this. Therefore, the specifications of the auxiliary equipment and materials to be supplied shall be decided by considering their drilling experience. It is necessary to supply a drilling rig,

standard accessories, auxiliary machines such as compressors, mud pump, enough quantity of drilling tools and spare parts for not only the new drilling rig but also for the above mentioned existing rotary rig of the DWR. This supply of equipment and materials shall be provided to reinforce their scheme for groundwater development.

2) Vehicles and Equipment for Surveying and maintenance

The following equipment and vehicles are concluded to be supplied for carrying out the drilling works and the preceding groundwater surveys for this project. The Project contains on-the-job training with technical transfer during the drilling and construction period by using the provided equipment and materials. After the completion of works, these equipment and materials shall be handed to the RWSD, who has been performing borehole type well drillings. In addition to the above, a supply of equipment and materials for operation and maintenance as also described below is necessary.

- Cargo Truck with Crane

  A cargo truck with a 3t crane for heavy weight items is necessary for the transport of equipment and materials for the drilling team. A four wheel drive type is strongly recommended because of the road conditions in the project area (hereafter, all of the vehicles to be supplied shall be four wheel drive type due to the same reason).

- Water Tank Truck

  A water tank truck shall be assigned to transport water for drilling and other various works. This can function as an emergency water supplier.

- Pump Hoist Truck

  A pump hoist mounted on truck is necessary for rehabilitation of wells, installation and removal of pumps. This shall be used for operation and maintenance of borehole type wells in the country.

- Pickup trucks and Station Wagon

  Two pickup trucks and a station wagon shall be used to carry personnel and light cargo for drilling, construction, operation and maintenance.

• Geoelectric Prospecting and Geoelectric Logging Instruments

A resistivity meter and a well logger are needed for the groundwater survey and for the analysis of the aquifer after drilling.

• Water Quality Analysis Kit and Pumping Test Apparatus

A set of pumping tester is required for the quantitative well test for a completed well. Also water quality analyzers are necessary for water quality testing, and shall include a pH meter, a conductivity meter, a set of chemical reagents, water samplers and a water level monitoring system.

• Tools and Equipment for Maintenance

The function of the workshop at the main depot will be reinforced by the supplied tools and equipment. Vehicles and equipment at the main depot and pumps and generators brought from the sites to the main depot will be repaired. Each water supply facility site will have a set of maintenance tools and routine maintenance and light repairs will be possible with these tools.

• Camping Facilities

Equipment and materials for camping at the drilling sites.

• Wireless Telephone

Telecommunication conditions are not dependable in the Gambia, and therefore, 3 sets of wireless telephone shall be provided as a safe and sure means of communication. These will contribute to the smooth management of their activities such as instructions to local fields, requests for materials and emergency dispatch in the event of unexpected accidents. A set of stationary type is for the depot and two sets of mobile type are for the vehicles.

• Standby units of Pump Assembly and Accessories

Standby units Pump of submersible motor pump and generators and components of electrical equipment should be prepared for good and smooth operation for both conventional and solar systems. Changeability should be considered to minimize number of items and quantity.

• Spare Parts

Spare parts shall be added for the maintenance of the completed water supply facilities. The items and quantities shall be decided independently to meet its requirements from the characteristics of equipment for each phase.

3) Materials for Wells

Such materials shall be needed as casing pipes, well screens, well caps, centralizers, mud materials and bentonites for drilling wells. The diameter of casing pipes and well screens shall as taken of ϕ 6" (150 mm) in accordance with the pumping rate, and their materials shall be PVC/FRP because of the low pH of the groundwater. Hand pumps can be temporally used until the commencement of piped water supply system after the completion of borehole wells for their early use. These hand pumps should be selected from the standard models of RWSD based on the UNDP selection.

4-3-10 Depots

Two depots shall be constructed as work bases for the Project where equipment and materials will be stored. A main depot shall be located near Banjul and a sub-depot shall be sited near Soma for the effective operation of the Project.

CHAPTER V BASIC DESIGN

CHAPTER V
BASIC DESIGN

5-1 Basic Concepts

The basic concepts are to specify and design the water supply facilities for the project to coordinate the local conditions on the basis of the background of the request of the Gambia and its policy for preparation of rural water, in consideration with the natural and social environments of project areas and water use situations, paying attention to the easiness of management of completed facilities for inhabitants. And in scheduling, the project is advisable to be phased in order to complete the project within the time limit, which is inavoidable to the grant aid system, being self-contained with sufficient effects for each phase.

The project covers not only the construction of facilities but also technical transfer during the project period so that thereafter the Gambian side will continue to implement the works for the rural water supply projects and groundwater development on their own, using the equipment and materials supplied in the project.

5-2 Design Conditions

Historically the rural water supply projects in the Gambia has been promoted and prepared under the positive technical assistance by the UNDP, employing the WHO standards for the facilities. Therefore, the design conditions are determined as follows, based on the WHO standards, considering the results of field survey in this project.

Item	Design Conditions
Design Period	Up to the year of A.D.2000
Design Served Population	Population at the design target year estimated on the basis of annual growth rate at 3.0% over the current population
Unit Consumption	Inhabitant: 35ℓ / capita / d Animal : 35ℓ / cattle / d (equivalent cattle)
Daily Demand	(Design Population Served)× (Unit Consumption) + (Number of equivalent Cattle)× (Unit Consumption)
Maximum Hourly Water Consumption	(Hourly Demand) × 1.5
Emergency Water Consumption	(Design Population Served)×(3ℓ / capita / d)× 5d × 70%
Design Water Tank Capacity	(Maximum Hourly Water Consumption × 2hrs) + (Emergency Water Consumption)
Design Unit of Public Stand	350 persons / 1 unit of public stand for people
Design Unit of Drinking Trough	1,000 equivalent cattle / 1 unit of drinking trough for animals

5-3 Facility Plan

5-3-1 Water Source Facilities

1) Water Source Analysis

The quality and quantity of water sources for each site are analysed and evaluated from the field surveys, groundwater surveys and data of existing wells. The structure of the existing wells are shown in Fig. 5-1 and their hydrogeological information is presented in Fig. 5-2. At the following 5 project sites, existing borehole type wells are concluded to be utilized as the water sources for the project through the hydrogeological investigation.

Fig. 5－1　Well Design at Project Sites

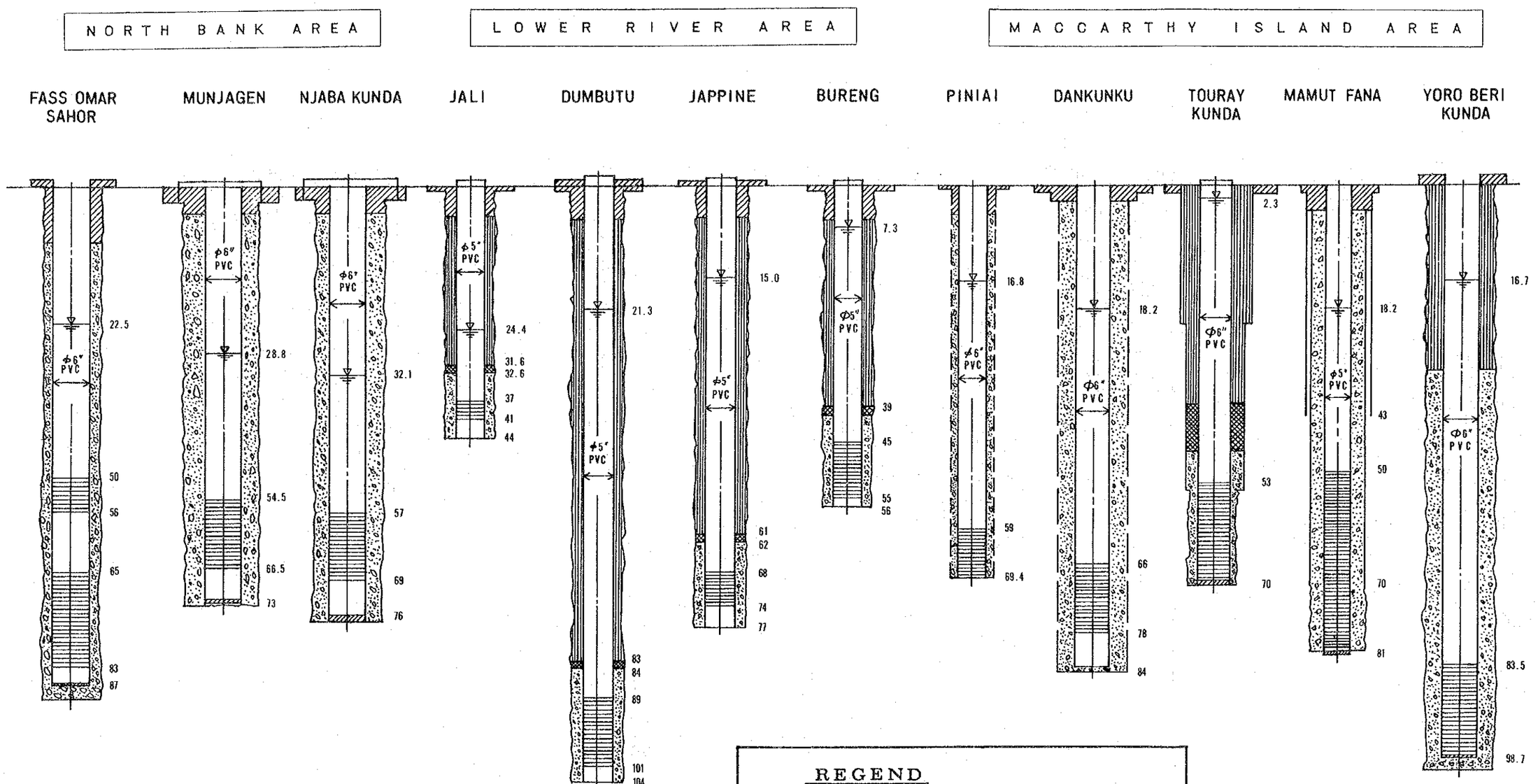
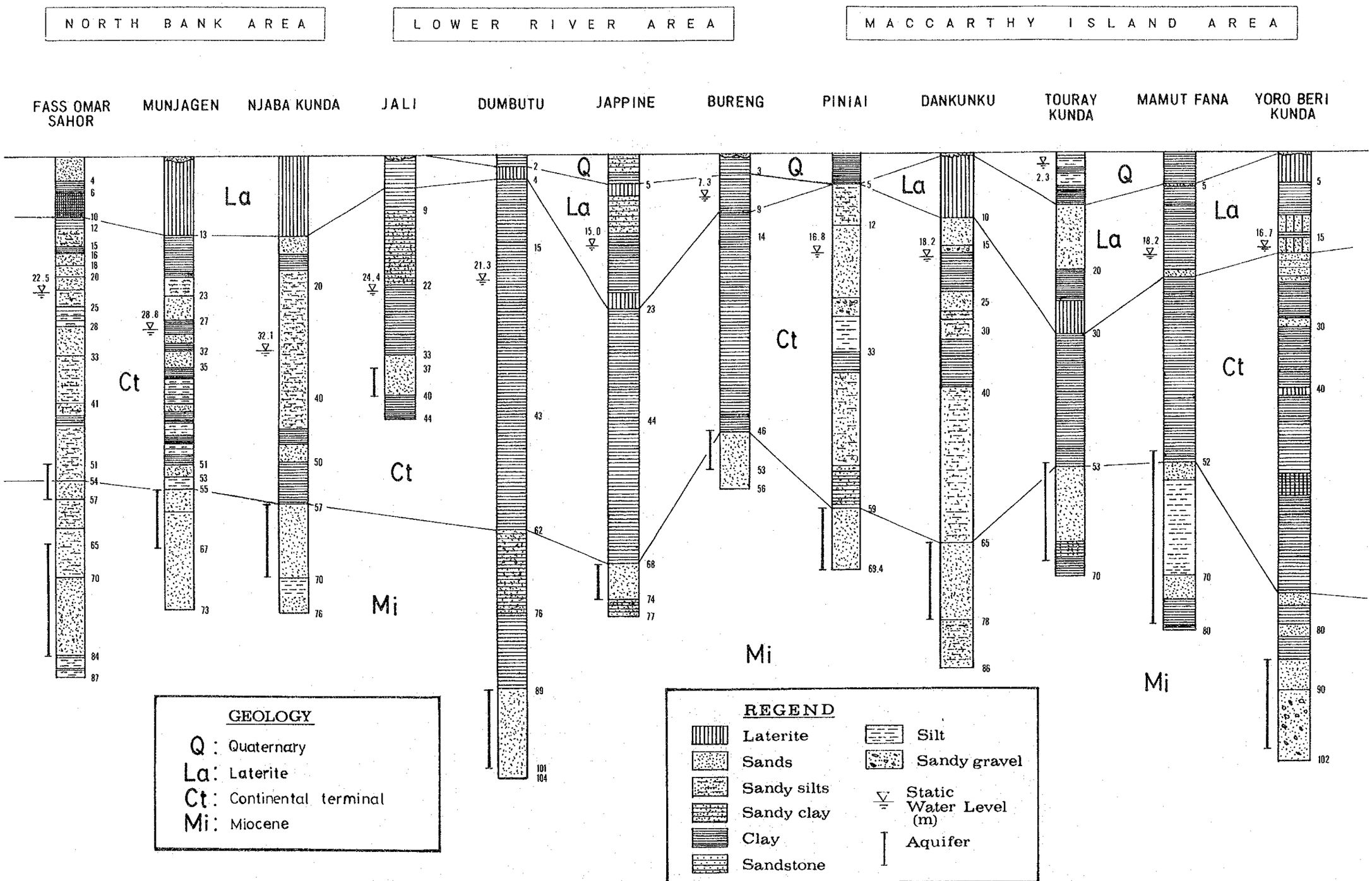


Fig. 5—2 Geological Well Logs at Project Sites



Sites to use existing wells	Sites to drill new wells	
N- 2 Fass Omar Sahor	N- 1 Njaba Kunda	N- 7 Illiassa
	N- 3 Katchang	N- 8 Munjagen
	N- 4 Ndungu Kebbeh	N- 8 Tuba Kolong
	N- 5 Saba	N-10 Madina Sering Mass
	N- 6 Fass Njaga Choi	
L- 2 Jappine Marko	L- 1 Nema	L- 6 Toniataba
L- 7 Bureng	L- 3 Dumbutu	L- 9 Pakali Ba
L- 8 Jali	L- 4 Pakalinding	L-10 Massembe
	L- 5 Baro Kunda	
M- 2 Piniai	M- 1 Mamut Fana	M- 7 Touray Kunda
	M- 3 Brikama Ba	M- 8 Sami Pachonki
	M- 4 Madina Umfally	M- 9 Sukuta
	M- 5 Saruja	M-10 Galleh Manda
	M- 6 Dankunku	
Total 5 sites	Total 25 sites	

2) Pumping Rate

The design daily pumping rates of sites range between 37.5 and 224.0m³ / d (see Table 4-2). The hourly rate for either diesel or solar pumps is consequently 5.4 ～32.0m³ / hr assuming seven hour operation which is determined by the solar system in the Gambia. The groundwater potential is estimated to be 180.0～677.5 m³ / d for the wells with diameter 4″ ～ 6″ (110 ～150 ㎜) in the project area from the well test results of the existing wells, and the potential of the project target aquifer is considered sufficient for groundwater development. The pumping rate of existing wells of sites and nearby wells is summarized in Table 5-1.

Table 5 — 1 Hydrogeological Evaluation of Existing Borehole Wells

DIVISION	No.	Site Name	Project Name	Drilling Year	Well Dia. (mm)	Well Depth (m)	S.W.L (m)	P.W.L (m)	Draw Down (m)	D.R. m^3/hr	Specific Capacity m^3/h/m	D.R. m^3/day	Specific Capacity m^3/d/m	Screen Depth (m)
NORTH BANK	N-1	Njaba Kunda	UNSO-26	1979	150	76.0	32.1	37.0	4.9	7.0	1.4	168	34.3	57.0～69.0
	2	Fass Omar Sahor	RWS/R/15	1989	150	87.0	22.5	25.5	3.0	10.0	3.3	240	80.0	55.0～56.0 65.0～83.0
	8	Munjagen	UNSO-28	1979	150	73.0	28.8	34.7	5.9	4.0	0.7	96	16.3	54.5～66.5
LOWER RIVER	L-2	Jappine Marko	SSP-44	1987	110	77.0	15.0	16.9	1.9	10.0	5.3	240	126.3	67.5～73.5
	3	Dumbutu	SSP-67	1987	110	104.0	21.3	21.7	0.4	5.6	14.0	134	1,085.0	89.0～101.0
	7	Bureng	SSP-65	1987	110	56.0	7.3	8.4	1.1	6.2	5.6	149	135.5	45.0～55.0
	8	Jali	SSP-31	1987	110	43.3	24.38	26.44	2.06	5.4	2.6	130	63.1	37.6～41.1
MACCARTHY ISLAND	M-1	Mamut Fana	RWS	1986	150	81.1	18.2	22.0	3.8	12.9	3.4	310	81.6	50.0～81.0
	2	Piniai	RWS	1988	150	69.4	16.8	17.3	0.5	18.0	36.0	864	36.0	59.0～69.4
	6	Dankunku	CILSS-204	1979	150	86.0	18.2	19.2	1.0	8.2	8.2	197	196.8	66.0～78.0
	7	Touray Kunda	RWS	1986	150	70.0	2.3	2.39	0.09	13.1	145.6	314	3,488.9	53.0～70.0

* P.W.L • • • • Pumping Water Level
S.W.L • • • • Static Water Level
D.R. • • • • • Discharge Rate

3) Structure of Wells

The locations of the new wells are decided for the new water sources through geoelectric prospecting carried out in the representative sites during the field survey and hydrogeological interpretation including existing data. The structure of a typical well is designed to be of ϕ6 " (150 mm) to meet the possible pumping rate of the existing borehole type wells and the outer diameter of submersible motor pumps. The depth of a well is targeted to the sandstone layer of the Miocene of Tertiary series with a good quality of confined aquifer, and the average depth and average screen length are decided as follows through the electrical survey and analysis of existing data.

Division	Diameter	Average Depth (m)	Average Screen Length (m)
North Bank	ϕ6" (150 mm)	100	15
Lower River	ϕ6" (150 mm)	100	15
MacCarthy Island	ϕ6" (150 mm)	100	15

The well structure is shown in Fig. 5-3. PVC/FRP is selected for the casings and screens to meet the particular characteristics in water quality of the project area with low pH of 4.7~ 6.5.

5-3-2 Pumping Units

The submersible motor pump system is considered most appropriate which is often used for powered pumping in rural as well as urban water supply projects in the Gambia. Such factors as the pumping rate, total head and power rating were examined to meet the requirements for the well structures and technical data of pumps to be set for use in both existing and new deep borehole type wells.

An independent electric power plant is generally required as the power source for pumping systems to overcome the rural electricity difficulties. The diesel engine powered and photovoltaic solar generators are technical candidates for this purpose.

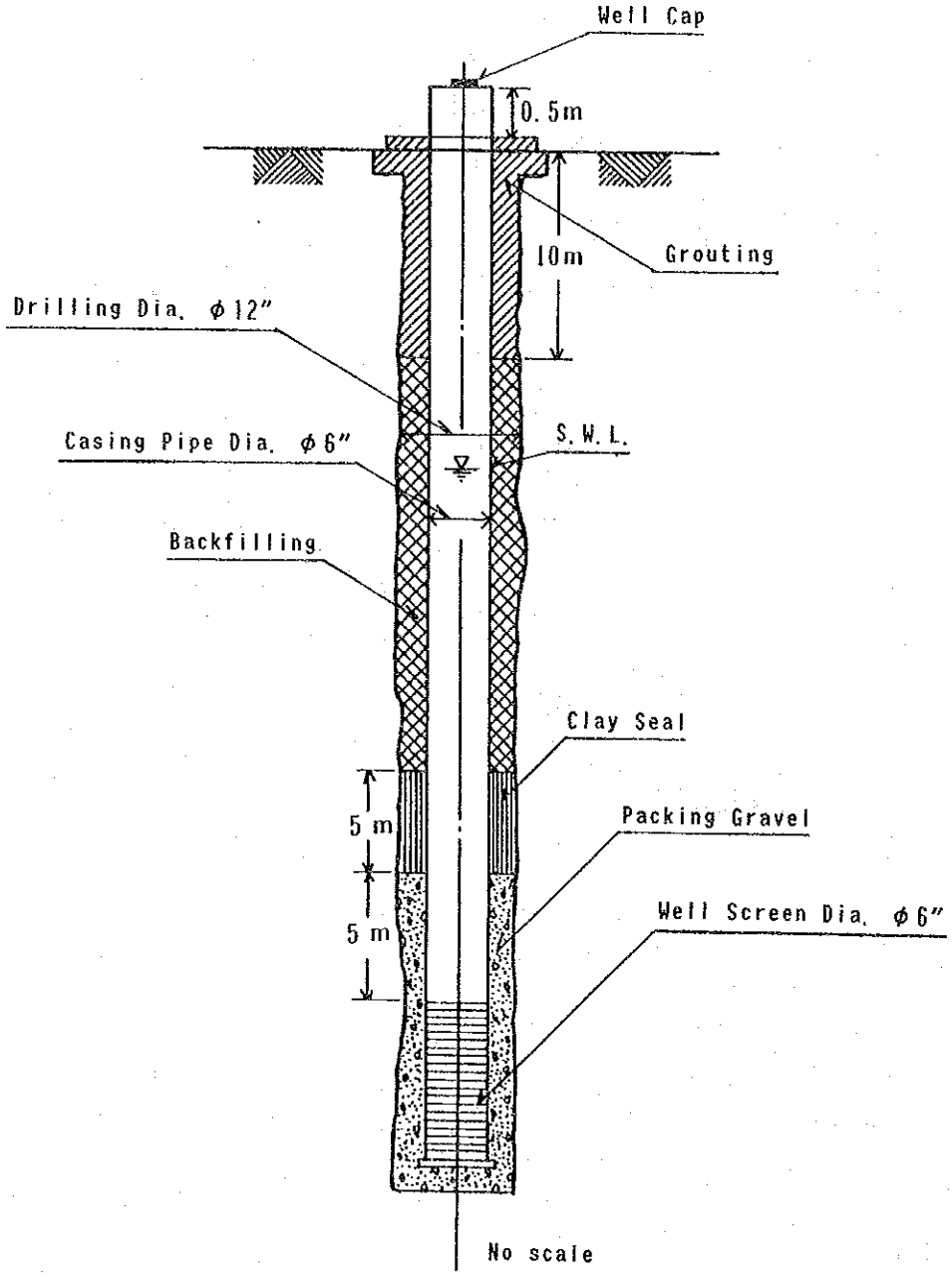


Fig. 5 — 3 Proposed Design of Borehole Type Well

Both methods were compared for each site for their feasibility from both technical and economical considerations of peculiar characteristics of each site such as:

- Structure and characteristics of the water source wells
- Dimensions and specifications of submersible motor pump
- Rating output of both methods
- Operating hours for both methods
- Fuel consumption rate for the conventional method
- Irradiation and solar panel output
- Conditions of maintenance and its related costs
- Life of component units of both methods
- Initial investment
- Operation cost

The results of comparison study for each site revealed that the break-even-point for both systems lies around the output rating of 5.5 kw. In other words, the smaller the capacity size of the solar system is, the more economical in the current conditions. Therefore, it can be concluded from the study that 3.7~5.5 kw is the applicable range if the output rating of the system is interpreted for a marketable system. Therefore, it was decided to select either solar or conventional method for each site in accordance with its peculiar conditions.

5-3-3 Pipe Lines

The pipe lines consist of 2 types: trunk mains and distribution lines in the facility plan for this project. The distribution lines distribute water to water supply facilities (public stands for people and drinking troughs for animals) by natural gravity force from the elevated water tanks. Due to the sandy soils of the project sites, pipe lines are planned to be buried and be of PVC material. The diameter of pipes shall be calculated in order to secure the flow rate of 15 ℓ / min / faucet at the public stand, taking consideration of economic velocity in the line for each distribution line for its maximum hourly demand. Thus, the diameter is chosen from ϕ 50 A, ϕ 65 A, ϕ 75 A, ϕ 125 A, ϕ 150 A using the Hazen-Williams formula.

The extension length of pipe lines for each site is in the range of 500 ~ 6,300 m (see Table 4-2). Various valves are to be located in appropriate

places along the lines depending upon the geographical features, pipe line layout and line pressure.

5-3-4 Water Tanks

A 5 m high typically designed cylindrical reinforced concrete structure is planned as the water tank in this project. This type of elevated water tank can distribute water to settlements by natural gravity force. The capacity is decided by the following design criteria.

(Maximum Hourly Water Consumption) × (2 hours)
+ (Emergency Water Consumption)

The capacity of water tanks is standardized and selected from 30m³, 50m³, 65m³, 80m³ and 100m³. The selected capacity is shown in Table 4-2 for each site.

5-3-5 Public Stands

A public water stand for people is to be installed as a water supply facility. A Stand shall be located within 500 m (15 min by foot) round trip between house and stand or installed in the center of a village to serve 350 persons per unit of public stand. Each water stand provides 2 to 4 faucets. The number of public stand to be installed is shown in table 4-2.

5-3-6 Drinking Troughs

Drinking troughs for animals are also installed for livestock. Cattle, horses, donkeys, sheep and goats are the major livestock, and these are converted to equivalent cattle by the hearing survey and the statistics of the government. A drinking trough for animals is installed at the ratio of one for every 1,000 heads of equivalent cattle. (see Table 4-2)

5-4 Equipment and Materials Plan

The equipment and materials which are necessary to drill and complete wells as water sources, and also to extend operation and maintenance after the completion of water supply facilities, are as follows:

1) Equipment and Materials for Drilling Rig

(1) Drilling Rig	1 Unit Rotary Type, mounted on 6×6 Truck, Capacity: ϕ150 mm × 150 m
(2) Tools	1 Set
(3) Compressor	1 Unit Diesel Engine Driven, Portable, Screw Type Rated Operating Pressure: Not less than 10 kg/ cm^2 Rated Air Delivery: Not less than 15 m^3/min.
(4) Auxiliary Tools and Accessories	1 Set

2) Vehicles

(1) Cargo Truck With Crane 4WD	1 Unit Load Capacity: Not less than 6,000 kg Engine: Water-Cooled Diesel Not less than 190 ps Crane Capacity: Not less than 3,000 kg/ 2.5 m
(2) Water Tank Truck	1 Unit Tank Capacity: Not less than 6,000 ℓ Engine: Water-Cooled Diesel Not less than 190 ps
(3) Pump Hoist Truck 4WD	1 Unit Hoist Capacity: Not less than 5,000 kg Sandreels: Not less than 100 m Engine: Water-Cooled Diesel Not less than 165 ps
(4) Pick Up Truck, 4WD	2 Units Engine: Water-cooled, Not less than 80ps

(5) Station Wagon, 4WD	1 Unit Engine: Water-cooled, Not less than 80ps Load Capacity: Not less than 9 persons

3) Equipment for Surveying

(1) Geoelectric Prospecting Instrument	1 Set Digital Type Measuring Depth: Not less than 300 m
(2) Geoelectric Logging Instrument	1 Set Digital Type Measuring Depth: Not less than 300 m Measuring Parameters: Normal Resistivity
(3) Data Processing Unit	1 Set Appropriate for Data Analysis of the Survey by the above (1) and (2)
(4) Water Quality Analysis Kit	1 Set Portable Type
(5) Pumping test Apparatus	1 Set Submersible motor pump, Head: 50 m Capacity: 600 ℓ / min with diesel engine generator

4) Equipment for Maintenance, Others

(1) Welding Equipment (Gas)	1 Set Acetylene/Oxygen Welding
(2) Welding Equipment (Electric)	1 Set Diesel Engine Powered Welding Current Range: 50~270 A
(3) Machines and Tools	1 Set

for workshop	General Tools and Tools for Vehicles
(4) Tools for Water Supply Facilities	30 Sets General Tools
(5) Camping Facilities	1 Set
(6) Wireless Telephone (Stationary Type)	1 Set Output: 50W Type: MHF/HF, SSB
(7) Wireless Telephone (Mobile Type)	2 Sets Output: 50W Type: MHF/HF, SSB
(8) Standby units of Pump Assembly and Accessories	1 Set
(9) Spare Parts	1 Set Equivalent to 15% of the Amount of Equipment and Tools

5) Materials for Wells

(1) Casing Pipes (ϕ150 mm)	2,340 m
(2) Well Screens (ϕ150 mm)	375 m
(3) Well Bottoms (ϕ150 mm)	30 pc
(4) Well Caps (ϕ150 mm)	30 pc
(5) Centralizers (ϕ150 mm)	150 pc

(6) Drilling Mud and Additives 1 Set

(7) Packing Gravel 1 lot

(8) Hand Pump 10 sets
(10 ℓ/min. ×45m)

* 1), 2), 3), 4), 5) are to be phased.

5-5 Depots

Two Depots shall be constructed as work bases for the project where equipment and materials will be stored. A main depot shall be located near Banjul and a sub-depot shall be sited near Soma for the effective operation of the project.

5-6 Basic Design Drawings

The basic design drawings are presented in appendix for the 30 project sites which are drawn based on the forementioned basic concepts.

CHAPTER VI
PROJECT IMPLEMENTATION

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PROJECT IMPLEMENTATION

6-1 Organization for Project Implementation

The executing agency for implementation of this project is the DWR of the MWRFF. Sections of Drilling, Groundwater and Project of the RWSD will support the project.

After the Exchange of Notes, the executing agency will make a contract with a Japanese consultant for the detailed designing and construction supervision and the agency will perform a packaged tendering for construction of water supply facilities and supply of related equipment and materials with an assistance of the consultant. As a result of evaluation on tenders, the agency will be contracted with a contracting firm. As this is a Japanese grant aid project, the principal contractor shall be a Japanese firm.

Under supervision of the consultant, the contractor will construct the required facilities and supply of the related equipment and materials.

After the inspection by the DWR, the completed facilities shall be handed to villagers' organization called "Cooperative" for general operation and maintenance while the RWSD shall handle specialized works.

The supplied equipment and materials shall be handled by each section which receives technical transfer through the implementation of the project after the inspection by the DWR.

6-2 Implementation Responsibilities

The responsibilities of the Japanese and the Gambian sides are summarized for the project as follows:

6-2-1 Responsibilities of the Japanese Side

1) Construction of water supply facilities with water sources of groundwater for the 30 objective villages which are spread over in three Divisions.

2) Completion of borehole type wells for intaking groundwater as water sources:

- rehabilitation for 5 sites where the Gambian side has provided existing wells.
- drilling new wells for 25 sites where there is no appropriate wells.

3) Supply of equipment and materials necessary for the construction of water supply facilities and for the enforcement of activities for completing borehole type wells which have been performed by the DWR with its own organization and staff and for the promotion and continuation of groundwater development.

4) Provision of an on-the-job training programme for technical transfer necessary for construction of the facilities and maintenance during the implementation of the project.

5) Consulting services for the implementation of the project related to the items mentioned above.

6-2-2 Responsibilities of the Gambian side

1) Acquisition of land for sites and depots required for the water supply facilities and preparation of access roads to the land for the implementation of the project.

2) Smooth enforcement of administrative measures necessary for the implementation of the project such as arrangements on duty clearance and tax exemption, the furnishing of data and information and the delivery of the existing wells.

3) Bearing any charges including the bank commission charge other than those covered by the Japanese grant aid necessary for the execution of the project.

4) Preparation of an appropriate managing and maintenance organization with personnel and budget required for functioning properly the supplied equipment and materials for the project and the completed facilities.

6-3 Construction Supervision

As part of the Japanese grant aid programme, this project will be contracted with a Japanese firm on a packaged basis. Since this project requires a combined work for both groundwater development and surface water facilities, the contractor must have sufficient knowledge and experience of such specialized works in arid and semi-arid areas. In addition, the cooperation of local specialist firms and those of neighbour countries will be required for the construction works. Only by the joint achievement of consultation and construction management, the project can be implemented within a rational period and budget.

The consulting services shall be carried out by a Japanese consultant under the Japanese grant aid system. The consultant shall render such services as detailed designing, tendering, supervision of construction and operational guidance in the following procedures:

Pre-construction Stage
- (1) Detailed designing
- (2) Preparation of tender documents
- (3) Representation for tendering
- (4) Tendering result evaluation
- (5) Assistance in contracting

Construction Stage
- (6) Construction Supervision
- (7) Preparation of on-the-job training programme
- (8) Inspection and operational guidance
- (9) Reporting and others

After the Exchange of Notes between the governments of Japan and the Gambia for the project, the consultant shall commence the detailed design for each project site necessary for the implementation of the project including site survey as the first step of the pre-construction stage. Then the consultant shall determine the specifications of equipment to be supplied and the facilities to be constructed and complete tender documents. The consultant also shall establish the tendering schedule, carry out the tender, evaluate the tendering results and assist the Gambian government for contracting with the contractor.

During the construction stage, the consultant shall adjust all organizations

related to the project, be responsible for total quality control and for scheduling of the construction works. Also the consultant shall prepare an on-the-job training programme for technical transfer which is intended to be implemented during the construction period and promote technical training for the drilling and completion of wells and for the construction of water supply facilities.

When the drilling and construction works nears completion, the consultant shall inspect and test the facilities, equipment and machinery supplied and installed, and train and instruct operational and maintenance procedures for those. The consultant shall submit a completion report after the completion of the construction works.

6-4 Supply of Equipment and Materials

Basic materials required for construction works of the project such as water, sand and gravel can be procured locally. Other construction materials, however, are advisable to be secured from neighbour countries and Japan because of the shortage of supply and of the less competitive price in the Gambia.

6-5 Operation and Maintenance

6-5-1 Managerial Organization for Water Supply Facilities

The water supply facilities for the 30 project sites shall be handed to and managed by the local "Cooperative" from the DWR after the completion inspection. The facilities shall be generally operated by operators who are appointed by the "Cooperative" while the RWSD of the DWR shall carry out the training of local operators and deal with technical troubles which can not be solved by the "Cooperative".

6-5-2 Managerial Organization for Equipment and Materials used in Well Completion

The DWR has long been drilling borehole type wells under the technical assistance from the UNDP. Therefore, the Department shall receive the technical transfer program during the implementation of the project which shall include groundwater survey for groundwater development with the set of equipment to be supplied, and drilling and completing borehole type wells.

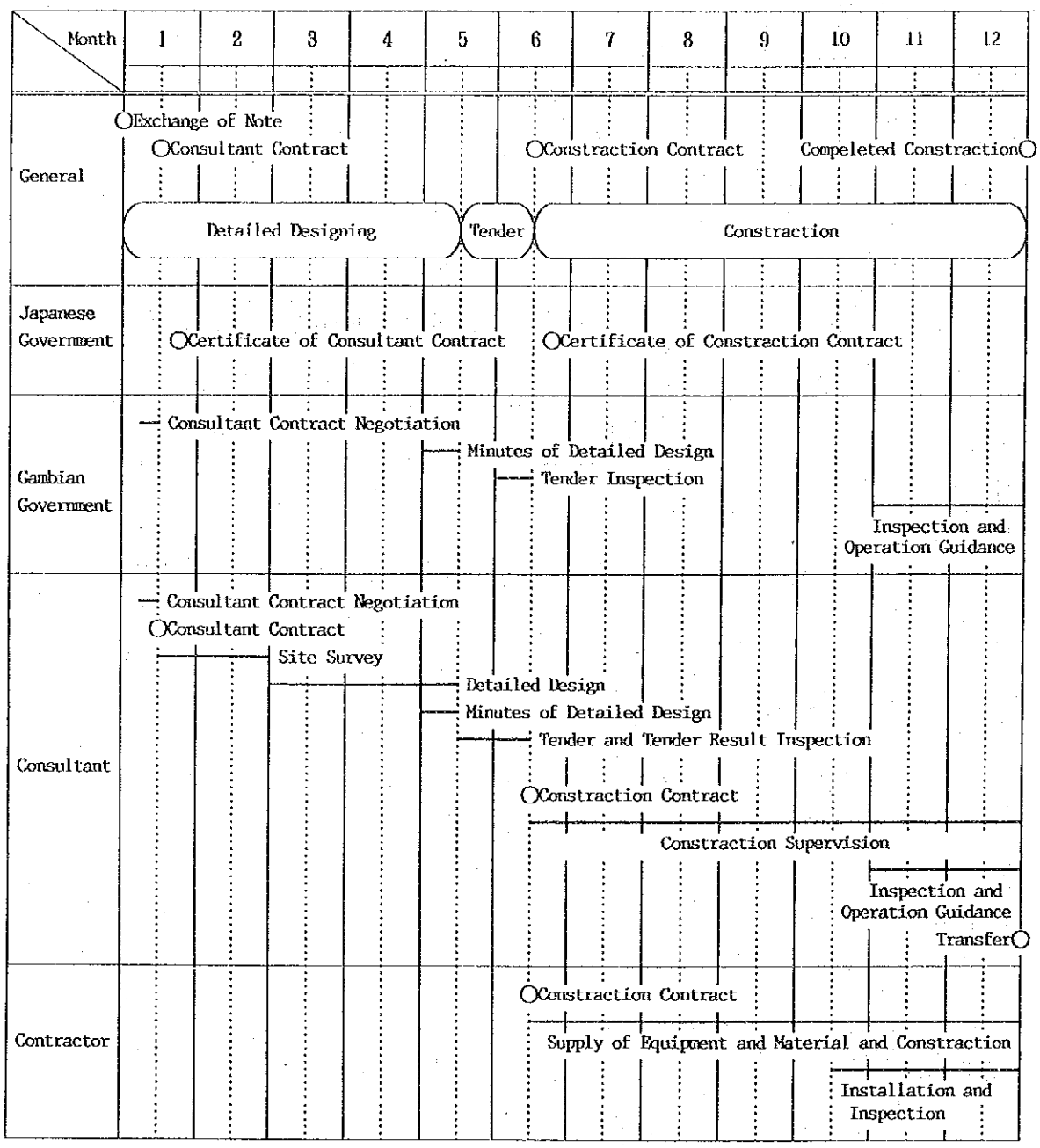
The Department shall also be deemed to continue the groundwater development and borehole type well completion using the supplied equipment and materials after the project. Therefore, the Department is strongly recommended to promote proper men in the organization to strengthen its technical capability.

6-6 Project Schedule

It is very advisable to phase this project into four phases for its implementation in consideration of the Japanese grant aid system and the Gambian factors such as its organizational structure, project efficiency, procurement time for equipment and materials, and local climate. The self-contained nature is a distinguishable characteristic of this project. Therefore, the phasing will not bring any inconvenience and unsatisfaction.

The recommended schedule is shown in Table 6-1. Each phase is to be completed in 12 months taking consideration of the rainy season.

Table 6 — 1 Project Schedule



CHAPTER Ⅶ
PROJECT EVALUATION

CHAPTER Ⅷ
PROJECT EVALUATION

The project is self-evidently important and urgent for the Government of the Gambia in view of its high priority among various economic development policies and the high positioning of the rural water supply project in the request to the Government of Japan. The project is also evaluated to be beneficial to the rural inhabitants who undertake the rural development strategy which is being promoted by the government. The same reason applies to the EC, W.Germany and Saudi Arabia as well as the UNDP why they have positively assisted and promoted the Rural Water Supply Projects in evaluating the significance. The beneficiaries of the project are estimated to be 75,000 who will account for more than 10% of the total rural population together with 37,000 heads of equivalent cattle.

The project will also contribute extensively to resolve the public health problems caused by poor water quality in the project area. The project will complement significantly the rural recovery plan which is being promoted in the area as part of the National Action Plan and will contribute to the improvements of regional socio-economy. Furthermore, the organization for groundwater development to be formed during the execution of the project will strengthen the hydrogeological capability through the technical transfer of the project and can expect an influential effect in solving the problems of water resources development and conservation.

The executing agency for this project, the DWR, has been accelerating many projects through bilateral and international cooperations. The activity and capability of the organization and its personnel is quite high.

Rural water supplies in the Gambia have been provided without charge to the villages. In this effect, the Gambian government is requesting that the rural inhabitants participate by forming an autonomous organization for operation and maintenance of water supply facilities on a self-help basis for covering the running costs, and is hoping that the inhabitants improve their consciousness on health, sanitation and environment.

Although the DWR, being at the center of water supply undertakings, requires

huge budgetary backups, the Department is not necessarily being financially supported and has not been able to implement many organized projects centered on groundwater development, particularly the introduction of the solar type non-conventional pumping system which has been proposed for years. Therefore, the implementation of this project will open a new stage of development in the Gambia.

In view of the above factors, this project is evaluated to have its high feasibility for implementation under the Japanese grant aid programme.

CHAPTER Ⅷ
CONCLUSION AND RECOMMENDATIONS

CHAPTER Ⅷ
CONCLUSION AND RECOMMENDATIONS

8-1 Conclusion

The Government of the Republic of the Gambia has been in immediate need of construction of numerous rural water supply facilities to provide a stable supply of safe and sanitary water to the rural inhabitants and has been endeavouring its acceleration under bilateral and international assistances.

The construction of water supply facilities using groundwater by borehole type wells will be carried out in this project in rural villages where inhabitants suffer from the security of drinking water. At the same time, equipment and materials for the drilling and completion of borehole type wells shall be supplied in order to help the DWR for the undertakings of well construction works on their own. Moreover, the introduction of a solar system desired by the Gambian government is planned to be realized through the technical and economical evaluation.

The project is evaluated to contribute in raising the level of living and rural economy of the project area. The project also complements the rural recovery and development projects which are being carried out in the same areas; thus this project can enable an Integrated Water Use through installation of drinking troughs for watering livestock as requested by the inhabitants. The executing agency of the project, the DWR, has been intensifying technically and organizationally since 1981 under the assistance from the UNDP; therefore, the Department is believed to pocess sufficient capability to execute the rural water supply projects.

Therefore, the project is concluded to be meaningful and feasible to be implemented under the Japanese grant aid.

8-2 Recommendations

The project is expected to contribute to the betterment of sanitary environment and life basis, and rural area promotion as mentioned above. However, the following points must be considered for further effective performance of the supplied equipment and the completed facilities, and for maintaining the stable

life basis in the future:

1) Increased efforts for maintenance will be required for the proper and smooth operation of the water facilities to both the Gambian government and the rural "Cooperatives".

2) The systematic approach in using a personal computer was already introduced to the Gambia for compilation, integration and storing of records and files of construction, observation and operation. Thus, a more effective system is recommended for managing the completed facilities and for future utilization of compiled data for the planning, construction, operation and maintenance of the new facilities.

3) The continuous endeavours of the Gambian government are encouraged for promoting education on the meaning of a stable supply of safe and sanitary water and improving the consciousness towards the importance in conserving the good and sanitary environment through appropriate and effective use of water.

4) The DWR is recommended to enforce technically the maintenance system and substantiate the periodical training system for the local operators in order to deploy the introduction of the non-conventional-energy-powered pumping system on a national scale.

5) The Gambia has a high potential for groundwater resources in comparison with neighboring countries. The DWR is, therefore, recommended to establish an areal monitoring system for the water balance and water quality and a master plan for the groundwater control in order to coexist the future effective groundwater development with its conservation.

6) It is very crucial for and desired by the Gambian government strongly to undertake the improvement and substantiation of rural infrastructure, particularly rural water supply projects. This can be accomplished through continuous assistances from powerful countries like Japan, without regard to the required amount of budget as is the tendency in recent bilateral and international assistances.

APPENDICES

APPENDIX 1 MINUTES OF MEETING

MINUTES OF DISCUSSIONS
ON
INTEGRATED WATER USE PROJECT
IN
THE REPUBLIC OF THE GAMBIA

In response to the request of the Government of the Gambia, the Government of Japan decided to conduct a basic design study on the Integrated Water Use Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Republic of the Gambia the study team headed by Mr. Nagatoshi Makita, Director, Konan Division, Waterworks Bureau, Yokohama Municipal Government.

The team had a series of discussions on the Project with the officials concerned of the Government of the Gambia and conducted a field survey.

As a result of the study, both parties 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.

Banjul, 8th of February, 1990

N. Makita

Nagatoshi Makita
Team Leader
JICA Study Team
Japan

A. K. Njie
Permanent Secretary
Ministry of Water Resources,
Forestry and Fisheries
The Republic of the Gambia

ATTACHMENT

1. The object of the Project is to construct water wells and water supply facilities and to provide the necessary equipment and materials for the construction of the wells and operation and maintenance of the water supply facilities for the people of the rural area in the North Bank, Maccarthy Island and Lower River Divisions where development of drinking water is urgently needed.

2. The scope of work of the Project is:

   (a) to construct water supply systems which include construction of water supply facilities such as water wells, pumping units, storage tanks, pipelines and supply equipment and materials such as well drilling machineries, vehicles, materials, and work shop systems required for proper operation and maintenance of the facilities and equipment.

   (b) to provide on-the-job training under the program of technology transfer utilizing equipment and materials donated by the government of Japan during the construction period.

3. The Department of Water Resources (DWR) of the Ministry of Water Resources, Forestry and Fisheries (MWRFF) is responsible for the land acquisition, implementation, operation and maintenance of the Project.

4. Before the Japanese Grant Aid is extended to the Government of the Gambia, the Government will take the measures listed out in the Appendix.

5. Both Parties confirmed that the study team explained the scheme of the Japanese grant aid program and the Gambia side has understood it.

A P P E N D I X

The necessary measures to be undertaken by the Government of the Gambia for the Project are as follows:

1. To provide data and information necessary for the Project works.

2. To provide, secure, clear and level land at each construction site prior to the commencement of construction of water supply facilities (water wells, water supply facilities, etc.).

3. To provide and secure land to serve as base for workshop as well as storage of materials, equipment and other construction items both in Banjul and at the project sites. This land should be cleared and levelled before the start of construction.

4. To prepare access roads to the site before the start of construction.

5. Clearance is necessary for the implementation of the Japanese water supply construction works on existing well structures, well before the commencement of this particular project.

6. To bear commissions to the Japanese foreign exchange bank for the banking arrangement and the "Authorization to pay".

7. To ensure prompt unloading, tax exemption, customs clearance of the products at the port of disembarkation in Banjul and prompt internal transportation therein of the products and related equipment under the grant.

8. To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in the Gambia with respect to the supply of the products and the services under the verified contracts.

9. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contracts, such formalities as may be necessary for their entry into the Gambia and stay therein for the performance of their work.

10. To bear all expenses, other than those to be borne by the grant aid, necessary for execution of the project.

11. To organize necessary counterpart staff in the Department of Water Resources of the Ministry of Water Resources, forestry and fisheries for the execution (siting, well drilling, installation of water supply systems etc.) and coordination prior to the commencement of the project.

12. To take necessary measures for acquisition of essential local items necessary for the execution of the project.

13. To maintain and use properly and effectively the facilities constructed as well as the equipment and machinery provided under the grant.

* * * * *

APPENDIX 2 ITINERARY OF FIELD SURVEY

No	Date	Day	Schedule	Survey Activity
1	Jan.29	Mon	Leave Tokyo	Leave Tokyo for Paris
2	30	Tue	Arrive Dakar	Leave Paris for Dakar
3	31	Wed	Dakar	Courtesy call to Embassy of Japan
4	Feb. 1	Thu	Arrive Banjul	Leave Dakar for Banjul
5	2	Fri	Banjul	Courtesy call to Gambian Government, Meeting with DWR
6	3	Sat	Banjul, W.D.	Meeting with DWR and Site survey for Existing Water Supply System
7	4	Sun	L.R.D.	Site survey
8	5	Mon	N.B.D.	Site survey
9	6	Tue	Banjul	Meeting with DWR and Data collection
10	7	Wed	Banjul	Meeting with DWR and Preparation of Minutes
11	8	Thu	Banjul	Signing of Minutes
12	9	Fri	Banjul	Preparation for site survey
13	10	Sat	Banjul	Site survey
14	11	Sun	Banjul	Site survey
15	12	Mon	L.R.D.	Site survey
16	13	Tue	M.I.D.	Site survey
17	14	Wed	M.I.D.	Site survey
18	15	Thu	U.R.D.	Site survey
19	16	Fri	M.I.D.	Site survey
20	17	Sat	M.I.D.	Construction Material Survey
21	18	Sun	L.R.D.	Data Analysis and Arrangement
22	19	Mon	Banjul	Construction Material Survey
23	20	Tue	M.I.D.	Site survey
24	21	Wed	L.R.D.	Site survey
25	22	Thu	N.B.D.	Site survey
26	23	Fri	N.B.D.	Site survey
27	24	Sat	L.R.D.	Site survey
28	25	Sun	L.R.D.	Site survey
29	26	Mon	Banjul	Data Analysis and Arrangement
30	27	Tue	Banjul	Meeting with DWR
31	28	Wed	Arrive Dakar	Leave Banjul for Dakar
32	May 1	Thu	Dakar	Meeting to Embassy of Japan
33	2	Fri	Paris	Leave Dakar for Paris
34	3	Sat	Leave Paris	Leave Paris for Tokyo
35	4	Sun	Arrive Tokyo	Arrive Tokyo

* W.D. —— Western Division
L.R.D.— Lower River Division
U.R.D.— Upper River Division
N.B.D.— North Bank Division
M.I.D.— Maccarthy Island Division

APPENDIX 3 STUDY TEAM MEMBER LIST

Function	Name	Affiliation
Leader	Nagatoshi Makita	Yokohama Waterworks Bureau
Project Coordinator	Minami Nagai	Japan International Coorperation Agency
Water Supply Engineer	Kanji Takamatsu	Japan Techno Co.,Ltd.
Facilities Design Engineer	Shigeyoshi Kagawa	〃
Equipment Planning Engineer	Yoshitaka Hamanaka	〃
Hydrogeologist	Akira Sato	〃

APPENDIX 4 LIST OF PERSONS VISITED

Ministry of Water Resources, Forestry and Fisheries	
Permanent Secretary	Mr. A.K.Njie
Department of Water Resources	
Director	Mr. Momadou M. Sahor
Asstant Director/Head of Rural Supply Division	Mr. Sigsmnd Johnson
Rural Water Supply Division	
Senior Programme Officer	Mr. Saihou Omar Ceesay
Principal Technical Officer	Mr. Momodou S. Ceesay
Rural Water Supply Project,Yondum	Mr. Badou Sey
Rural Water Supply Project,Basse	Mr. Robert Duff
Water Foreman	Mr. Yusupha Balagh
UNDP Rural Water Supply Project	
Project Manager	Mr. Joseph de Bats
Ministry of Economic Planning & Industrial Development	
Permanent Secretary	Mr. Alieu M. N'Gum
Principal Planner	Mr. Ousman Jammeh
Planner	Mr. Sanneh
GREC: Gambia Renewable Energy Center	
Co-ordinator)	Mr. Saihou Omar Sallah
Ministry of Foreign Affairs	
Assistant	Mr. N'jey
Ministry of Health,the Environment Labour and Secial Welfare	
Medical and Health Department	Dr. Cham, MK
Ministry of Water Resources, Forestry and Fisheries	
JICA Expart (Fisheries)	Mr. Shinshichi Arima

Japanese Embassy (Dakar)	
	Mr. Mitsuhei Murata
	Mr. Sadamu Fujihara
	Mr. Hiroyuki Minami
	Mr. Tetsuro Fujitsuka
JICA Office (Dakar)	Mr. Iwao Tatsumi
	Mr. Yoshifumi Tukii

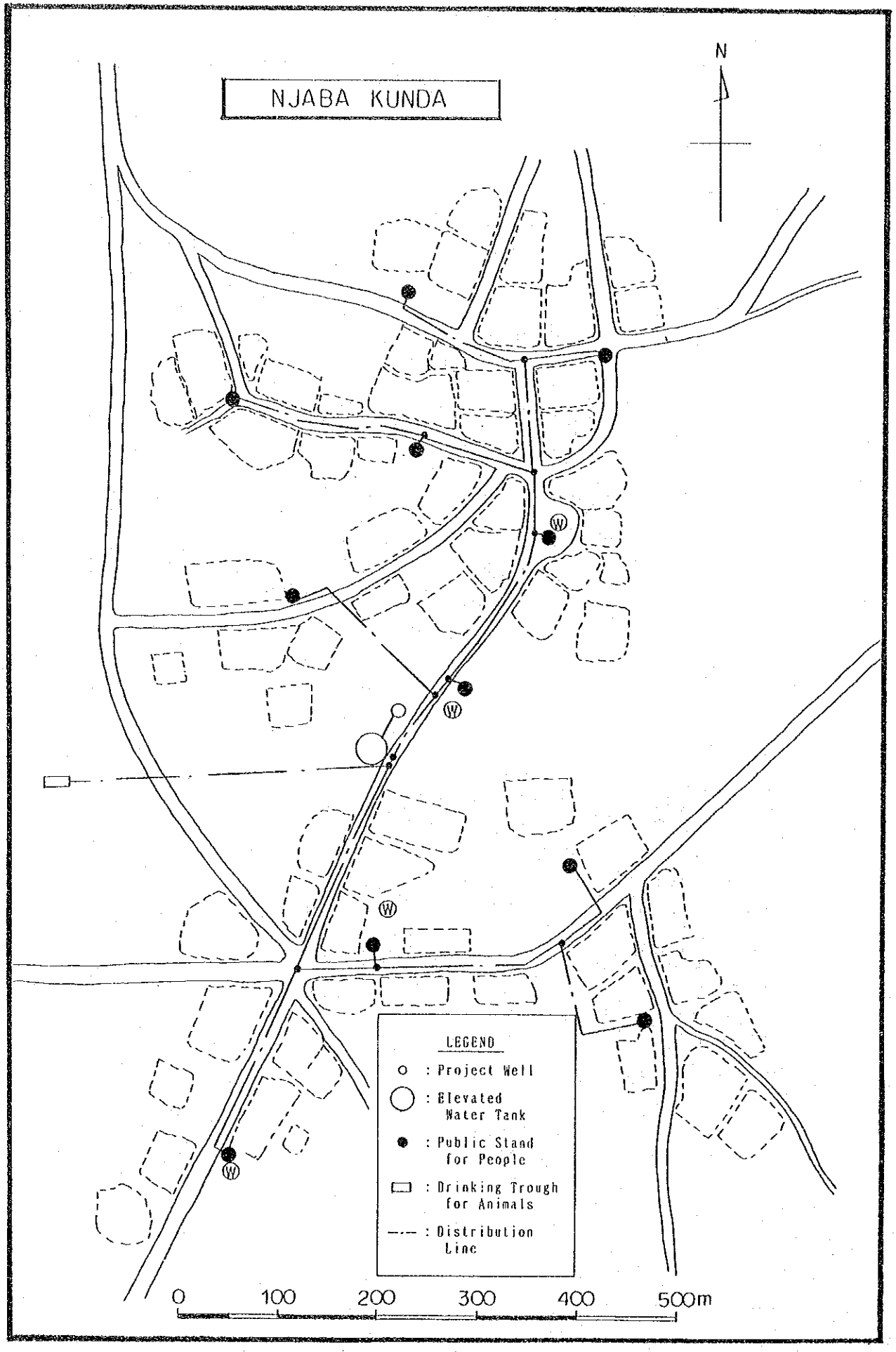
APPENDIX 5 BASIC DESIGN DRAWINGS

(1) Drawings for Project Site

(2) Drawings for Facilities

(1) Drawings for Project Site

NJABA KUNDA
FASS OMAR SAHOR
KATCHANG
NDUNGU KEBBEH
SABA
FASS NJAGA CHOI
ILLIASSA
MUNJAGEN
TUBA KOLONG
MADINA SERING MASS
NEMA
JAPPINE MARKO
DUMBUTU
PAKALINDING
BARO KUNDA
TONIATABA
BURENG
JALI
PAKALI BA
MASSEMBE
MAMUT FANA
PINIAI
BRIKAMA BA
MADINA UMFALLY
SARUJA
DANKUNKU
TOURAY KUNDA
SAMI PACHONKI
SUKUTA
GALLEH MANDA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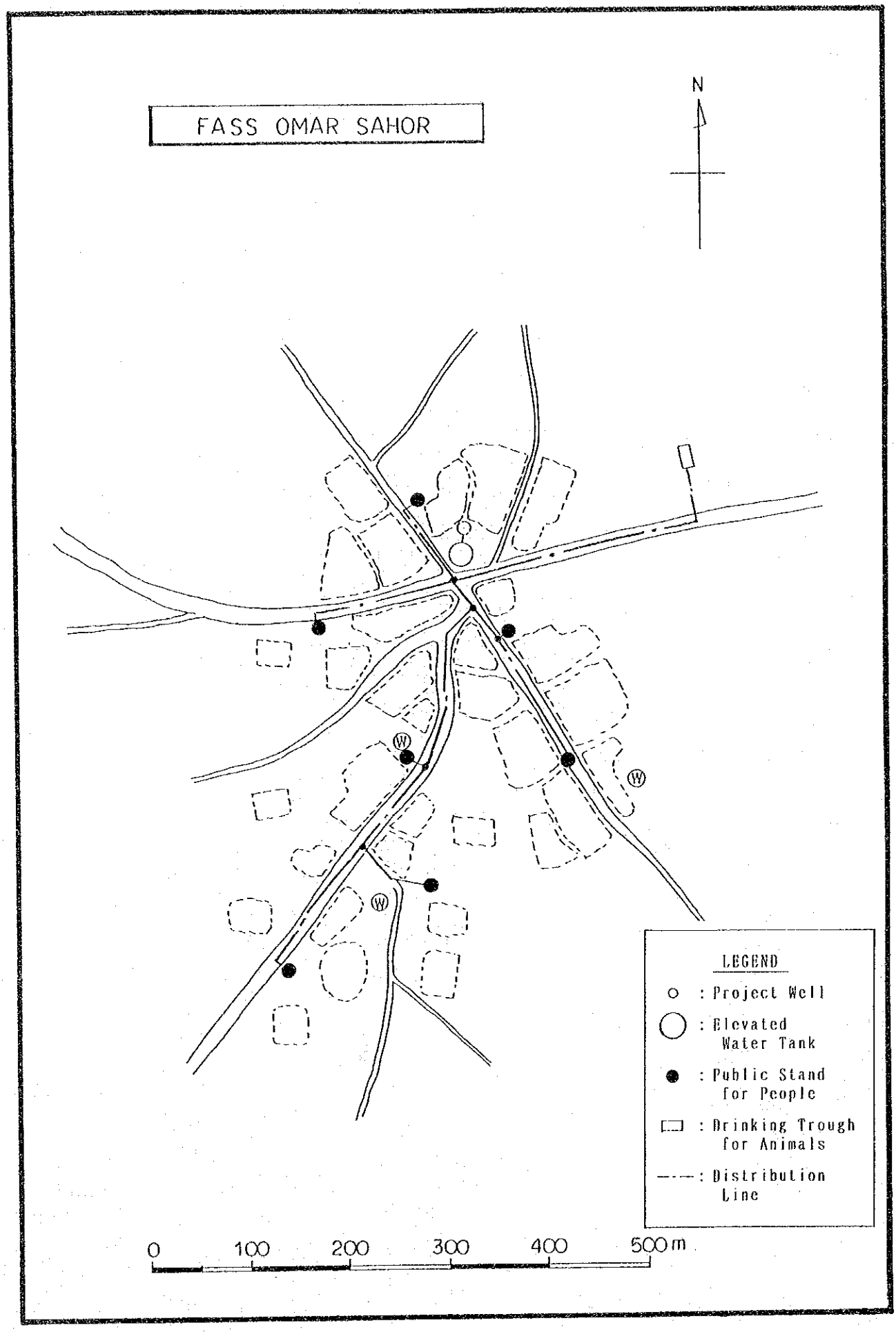
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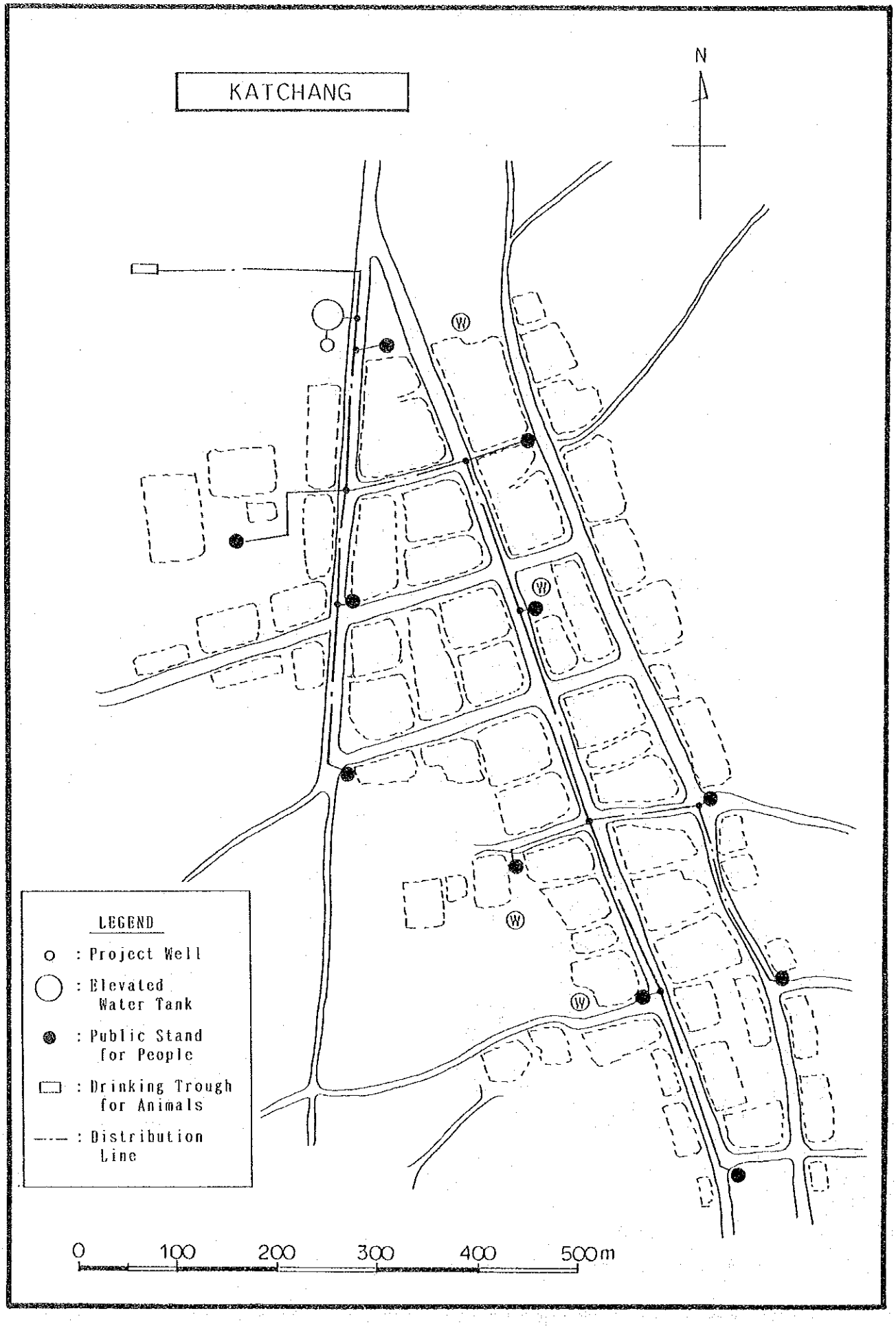
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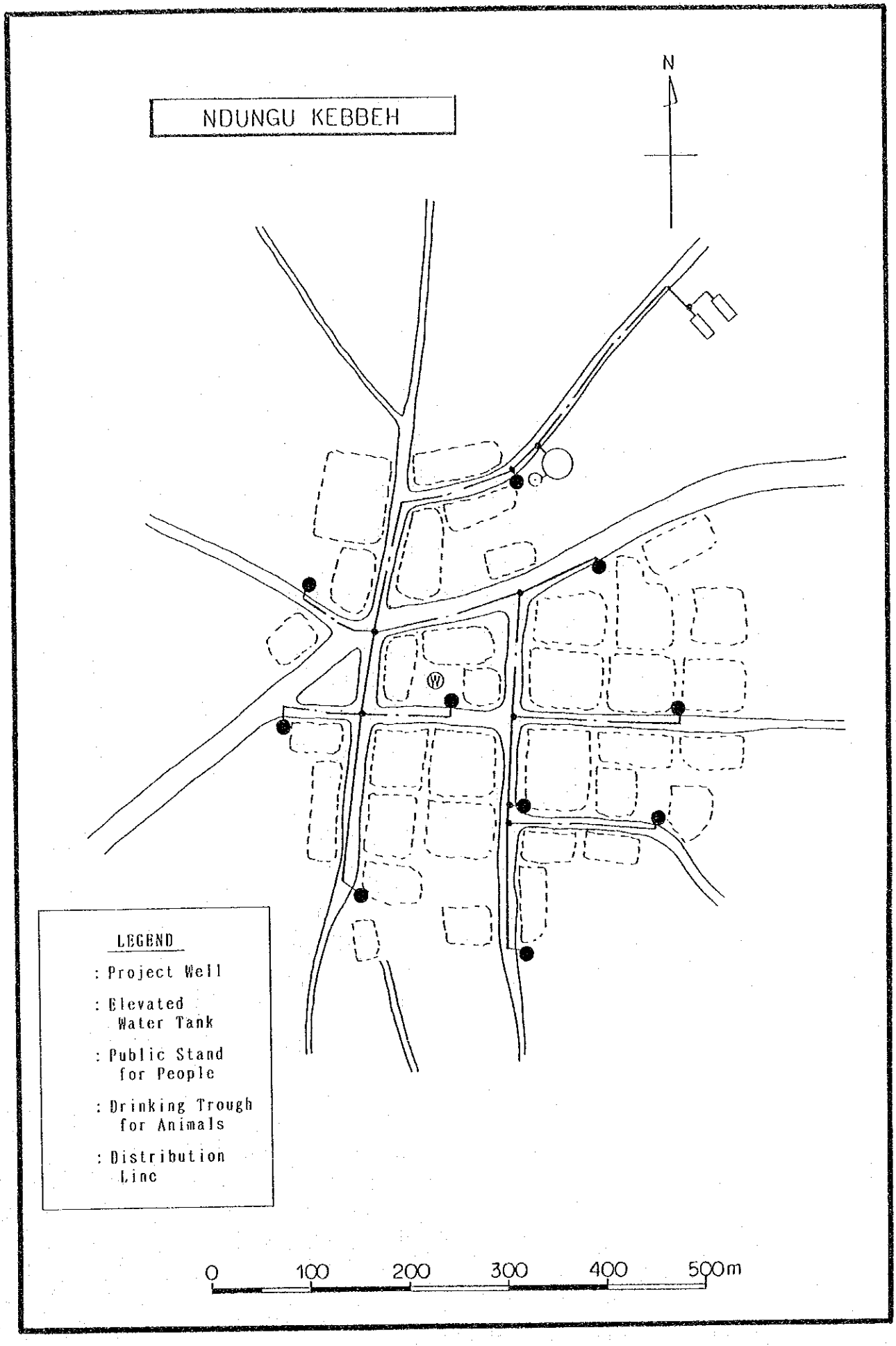
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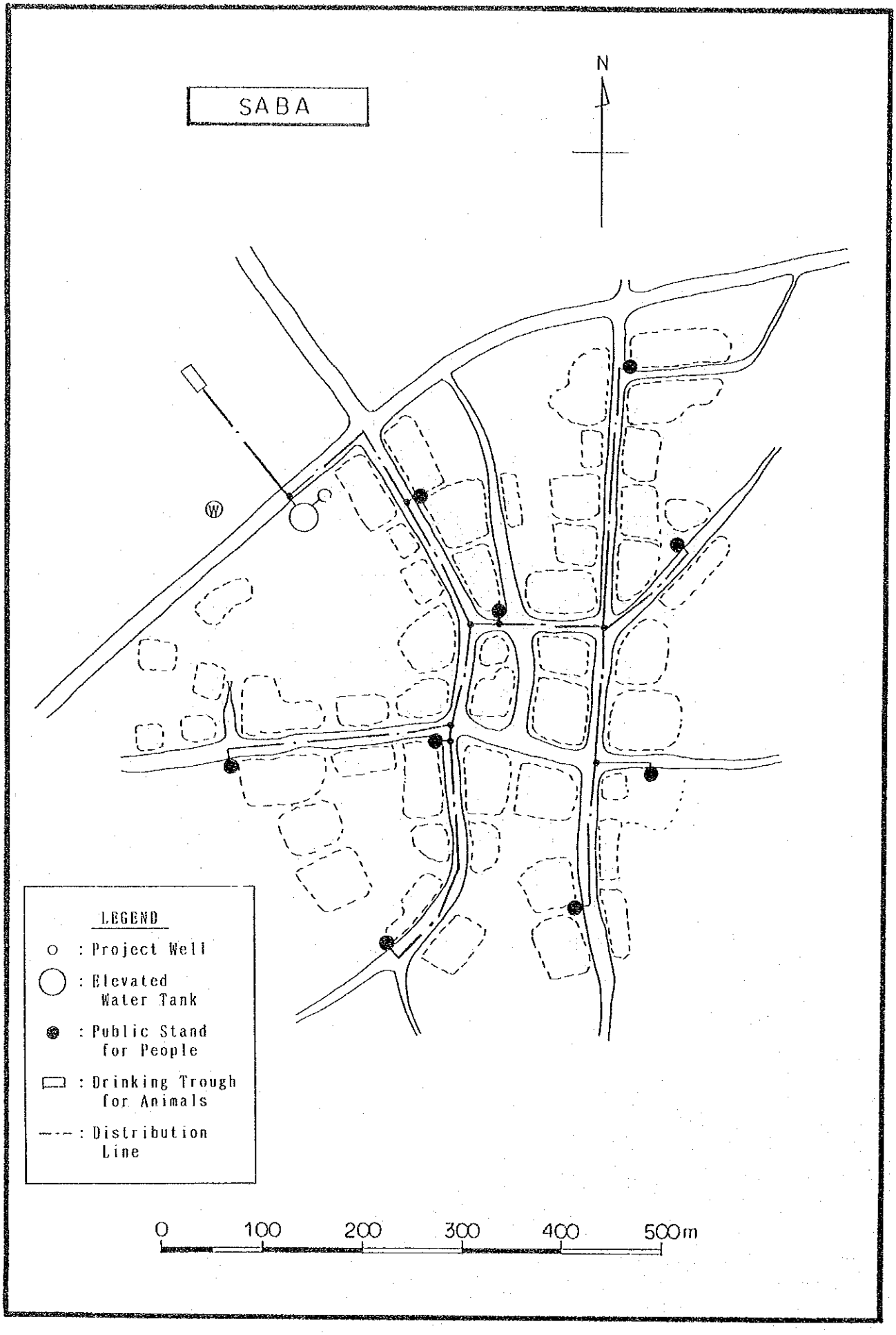
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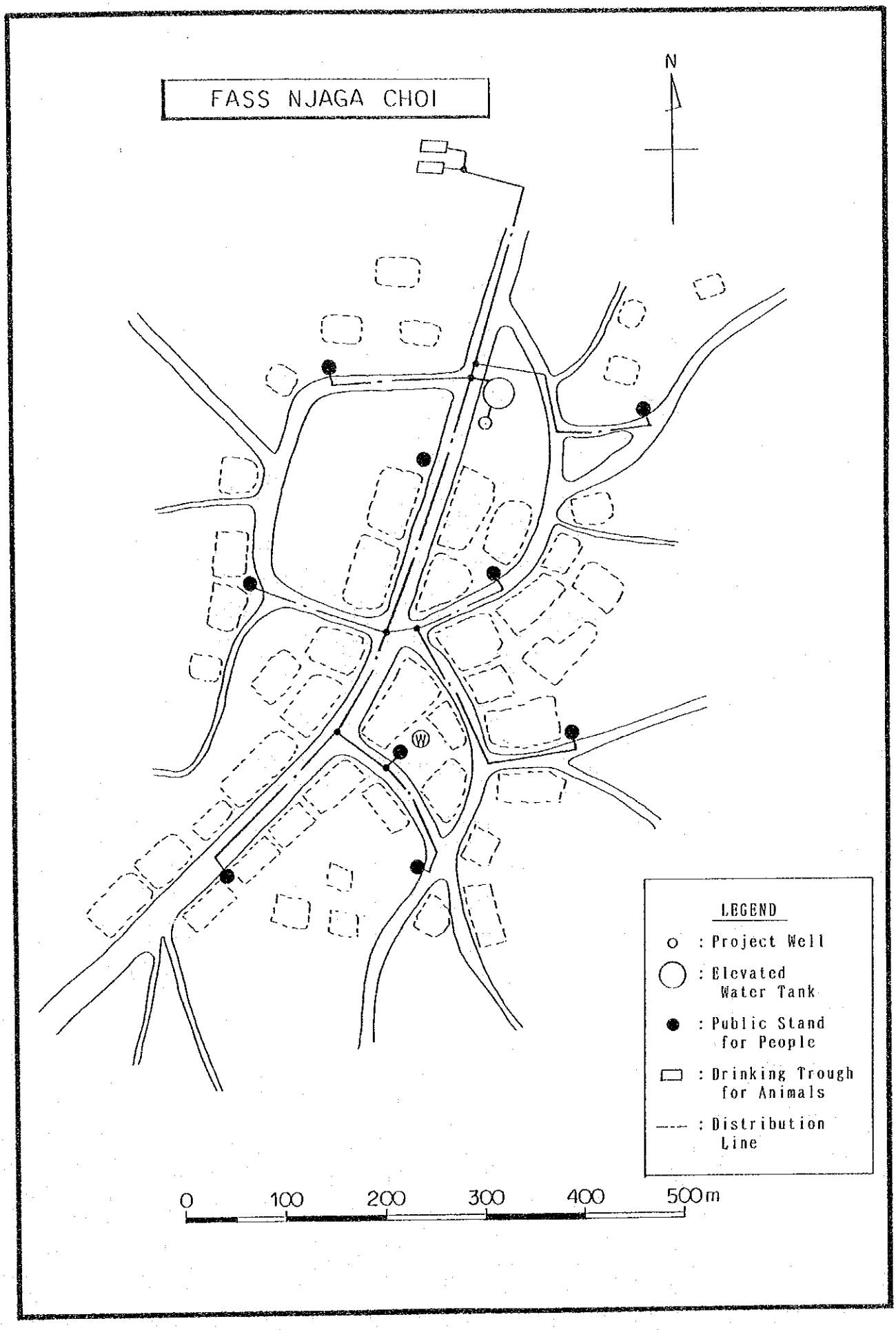
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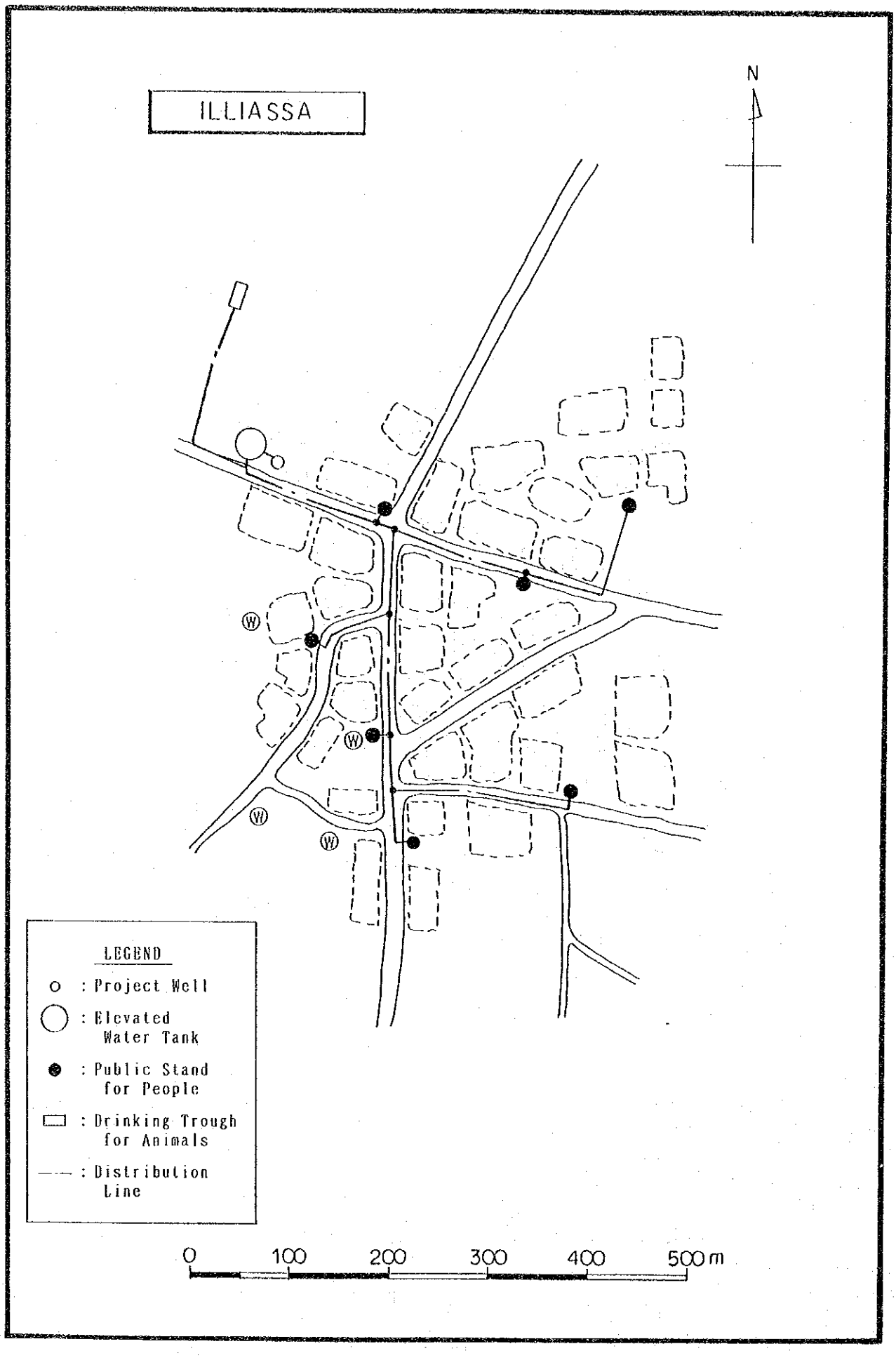
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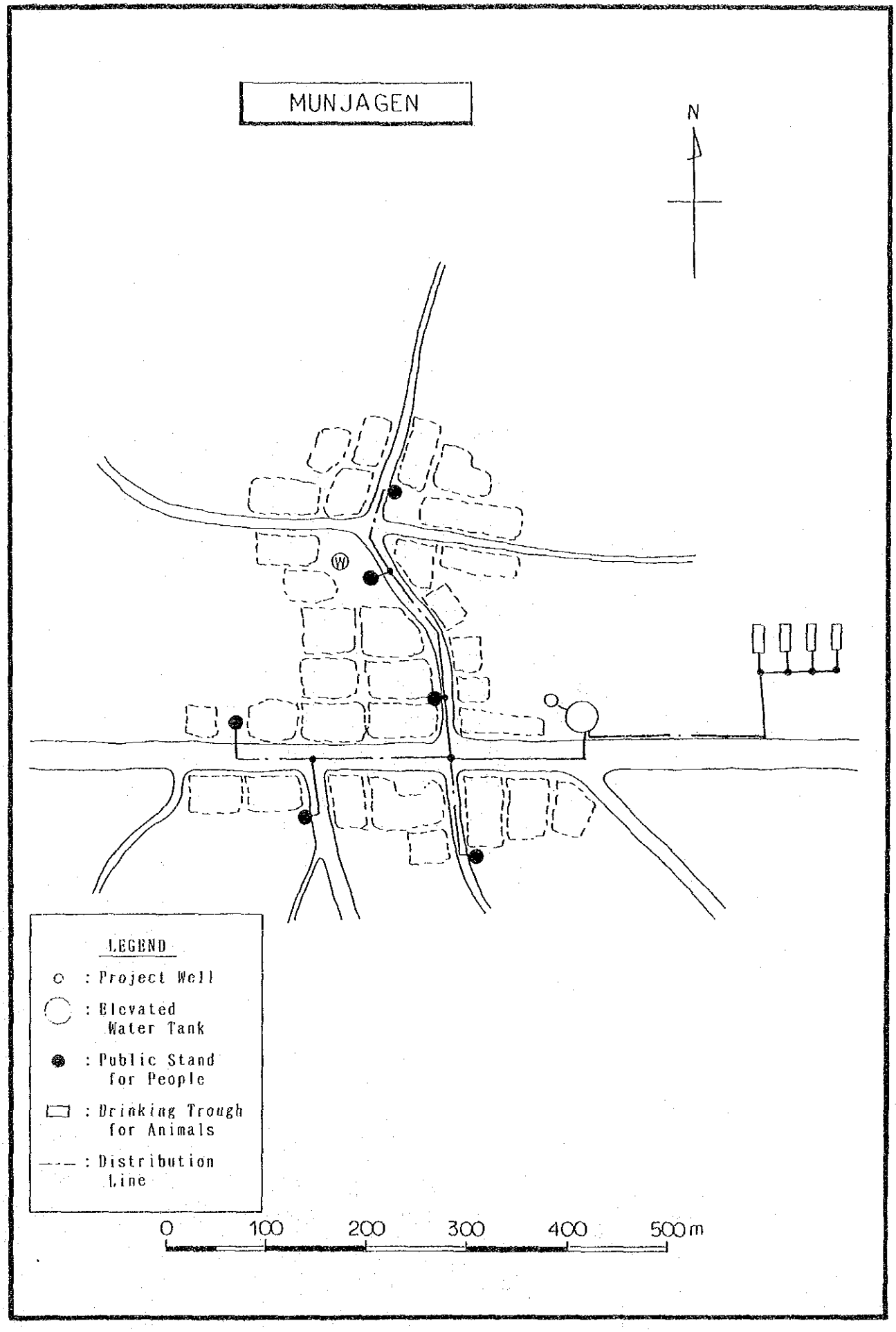
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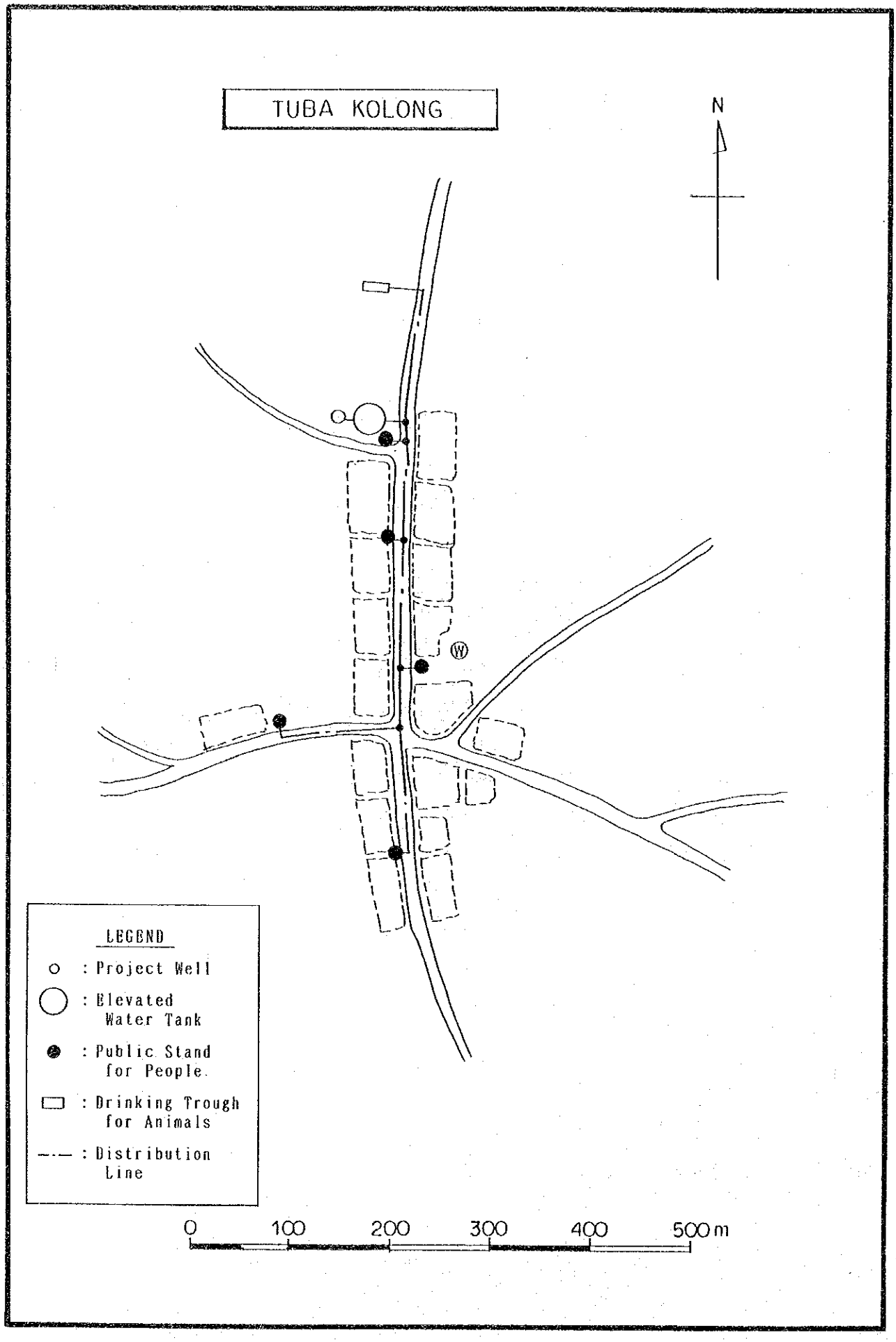
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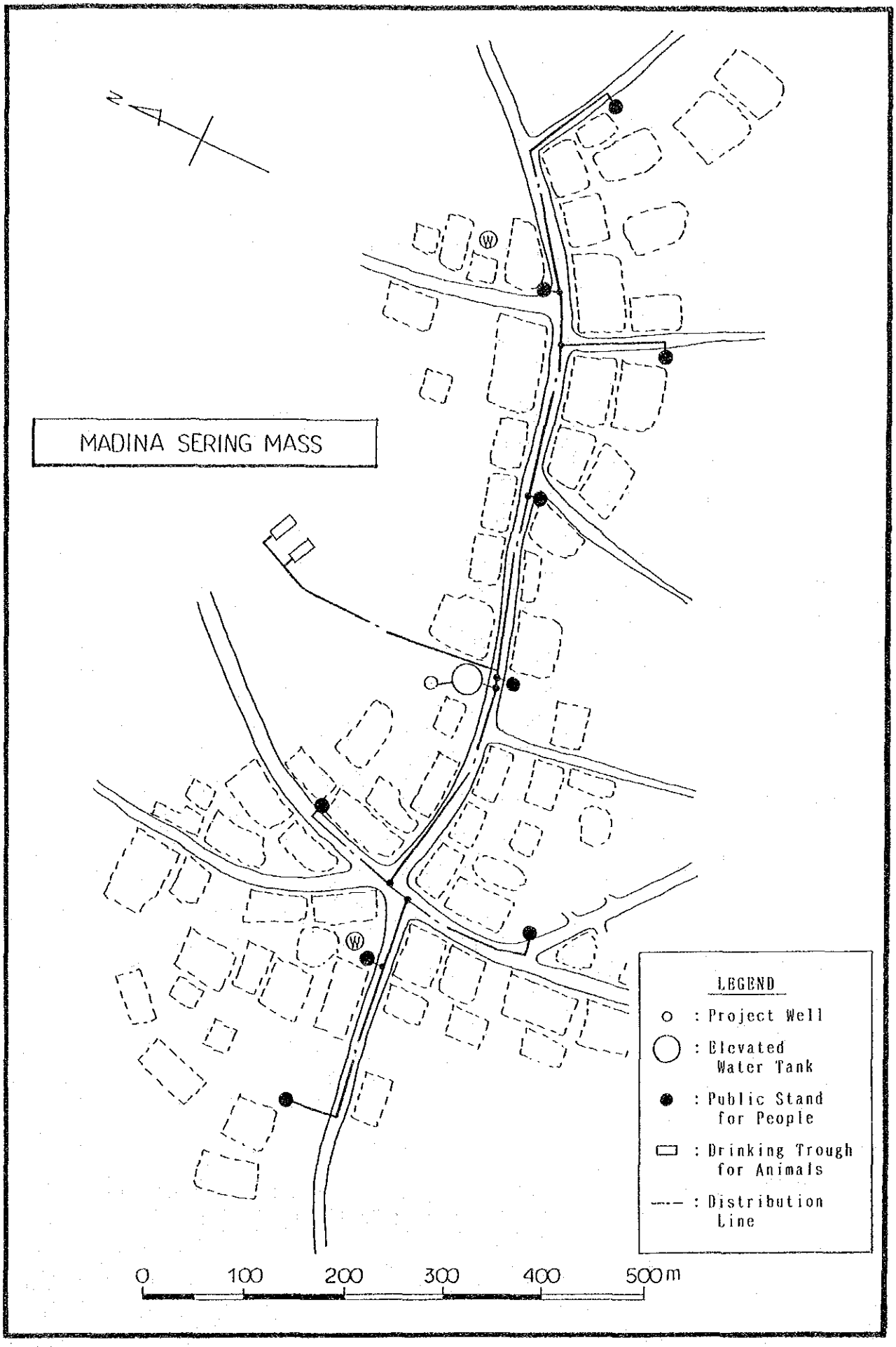
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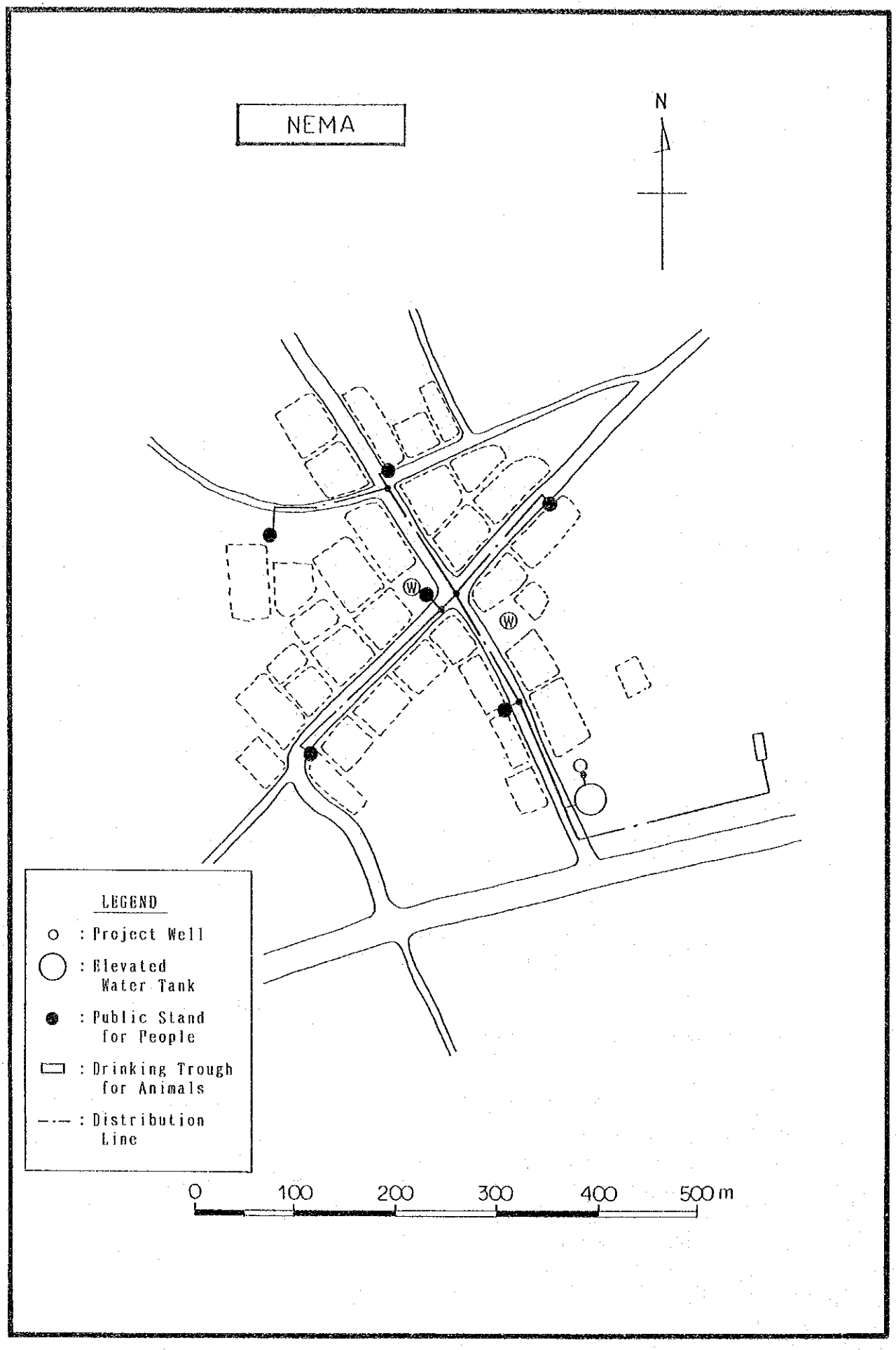
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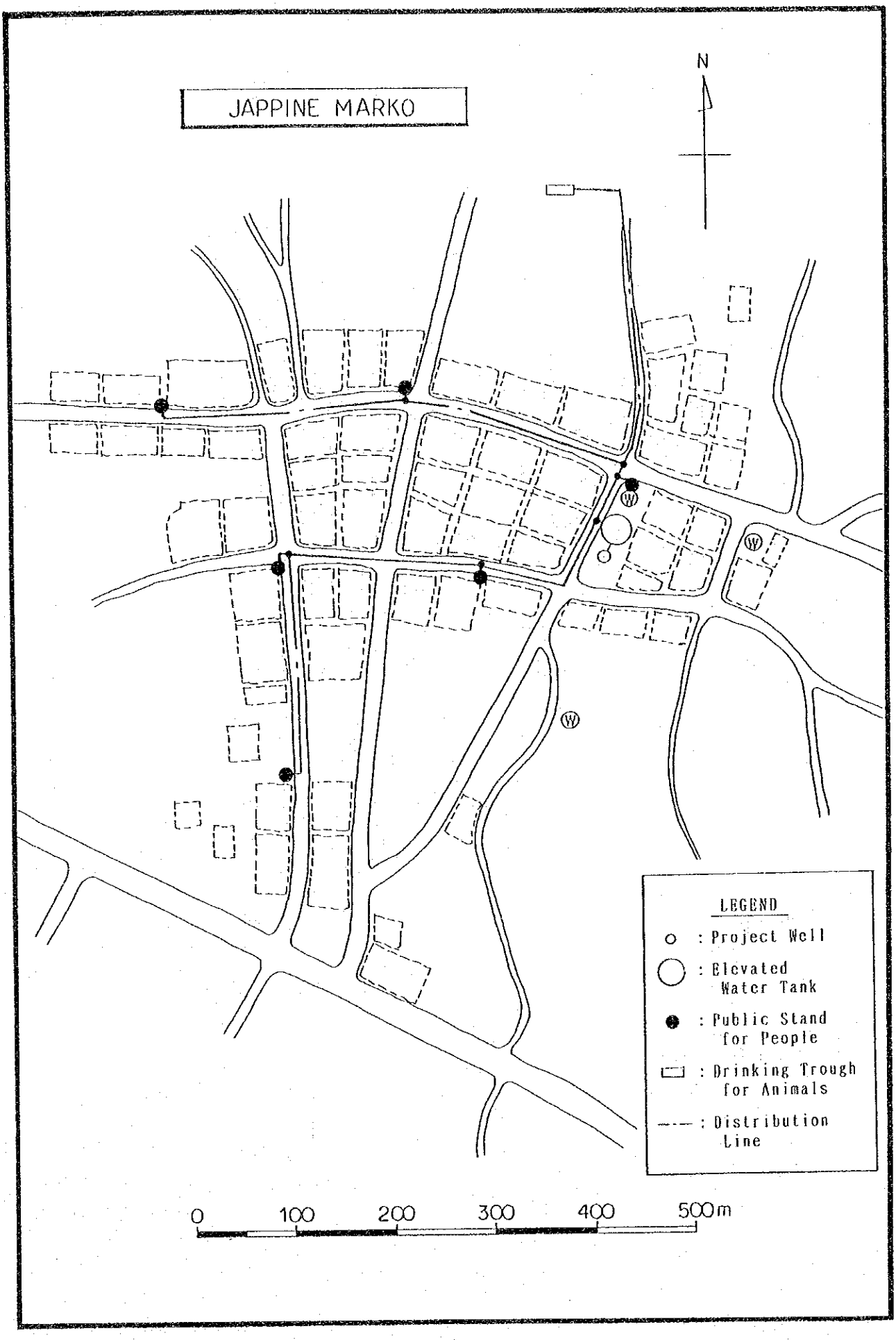
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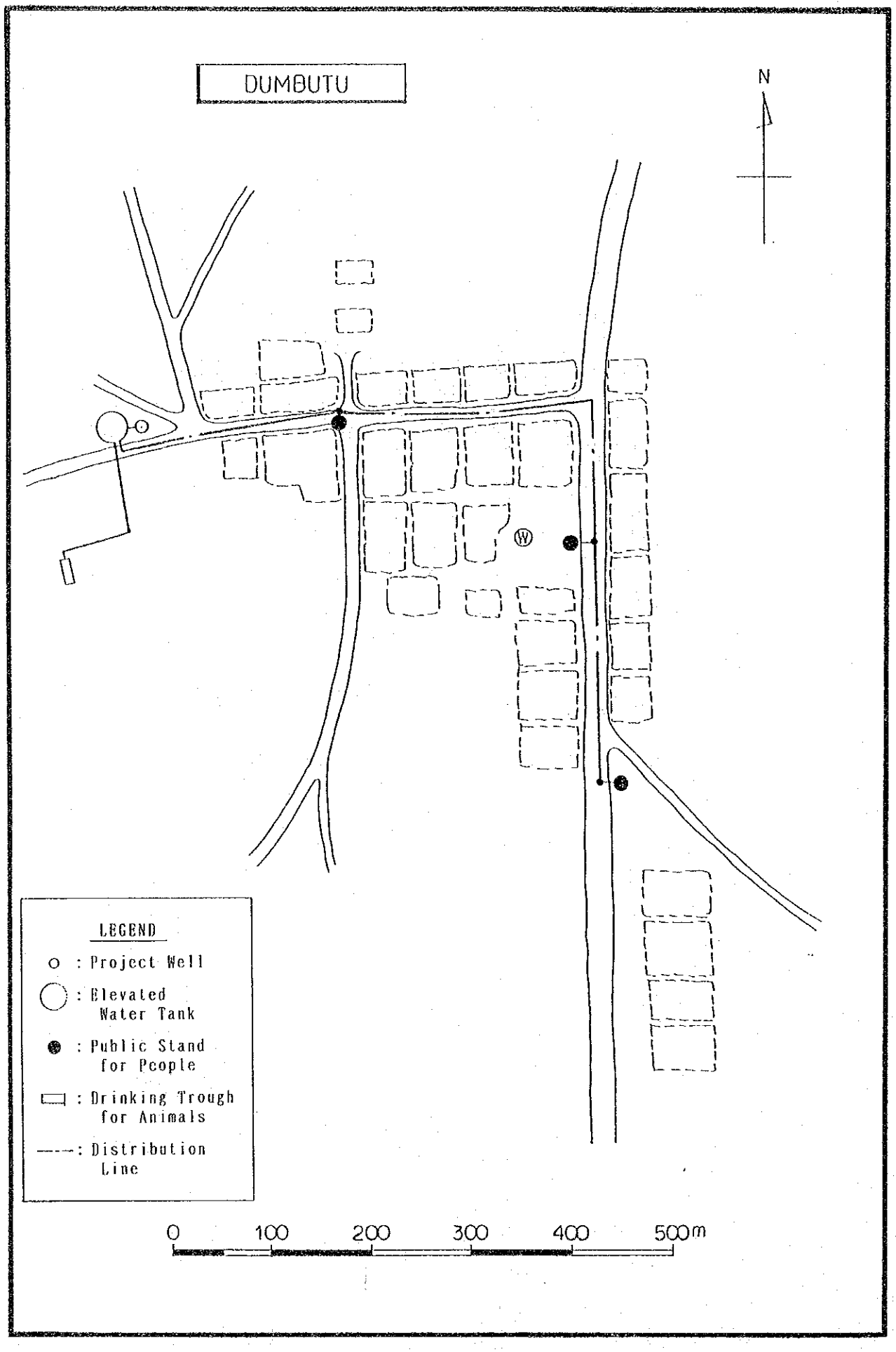
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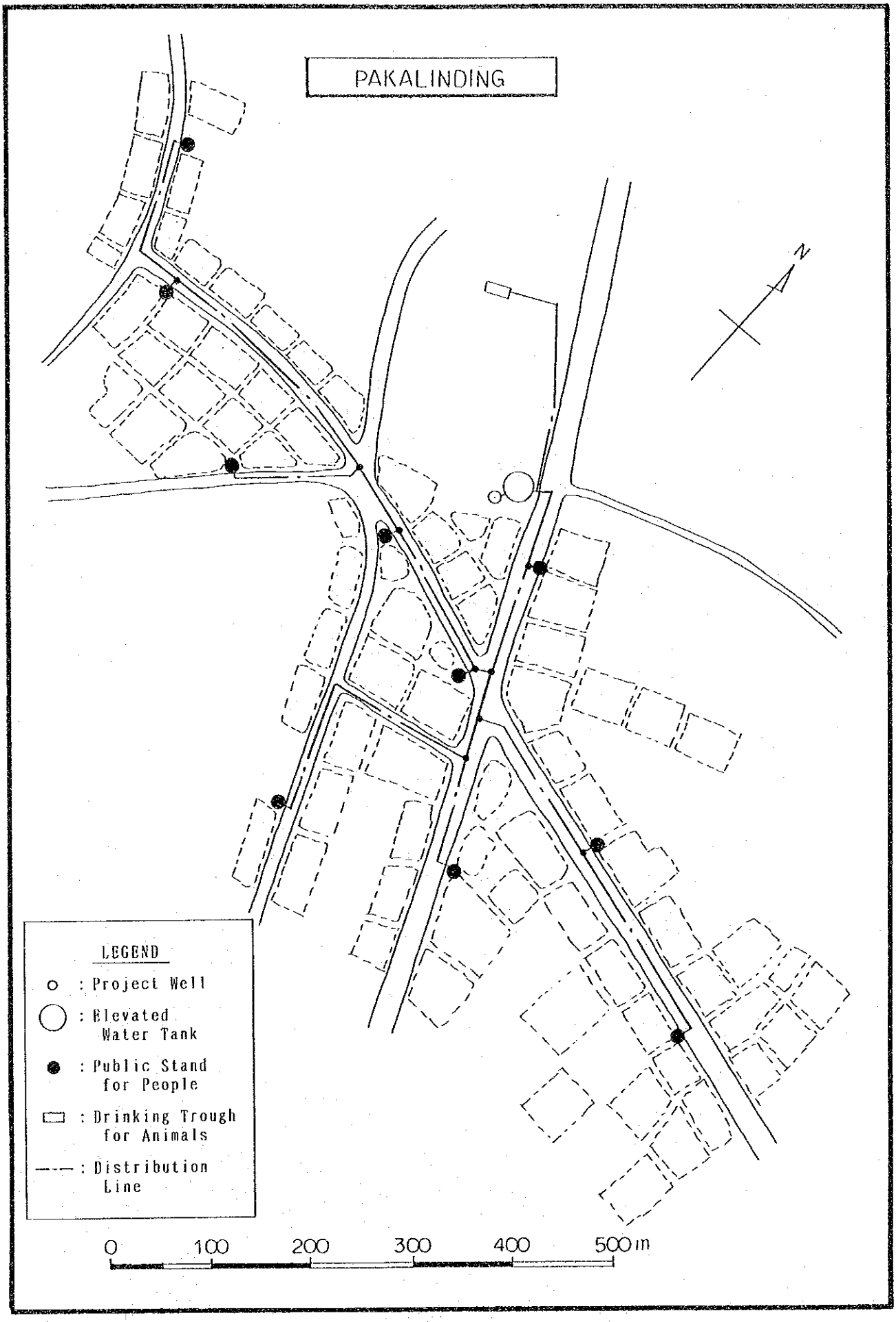
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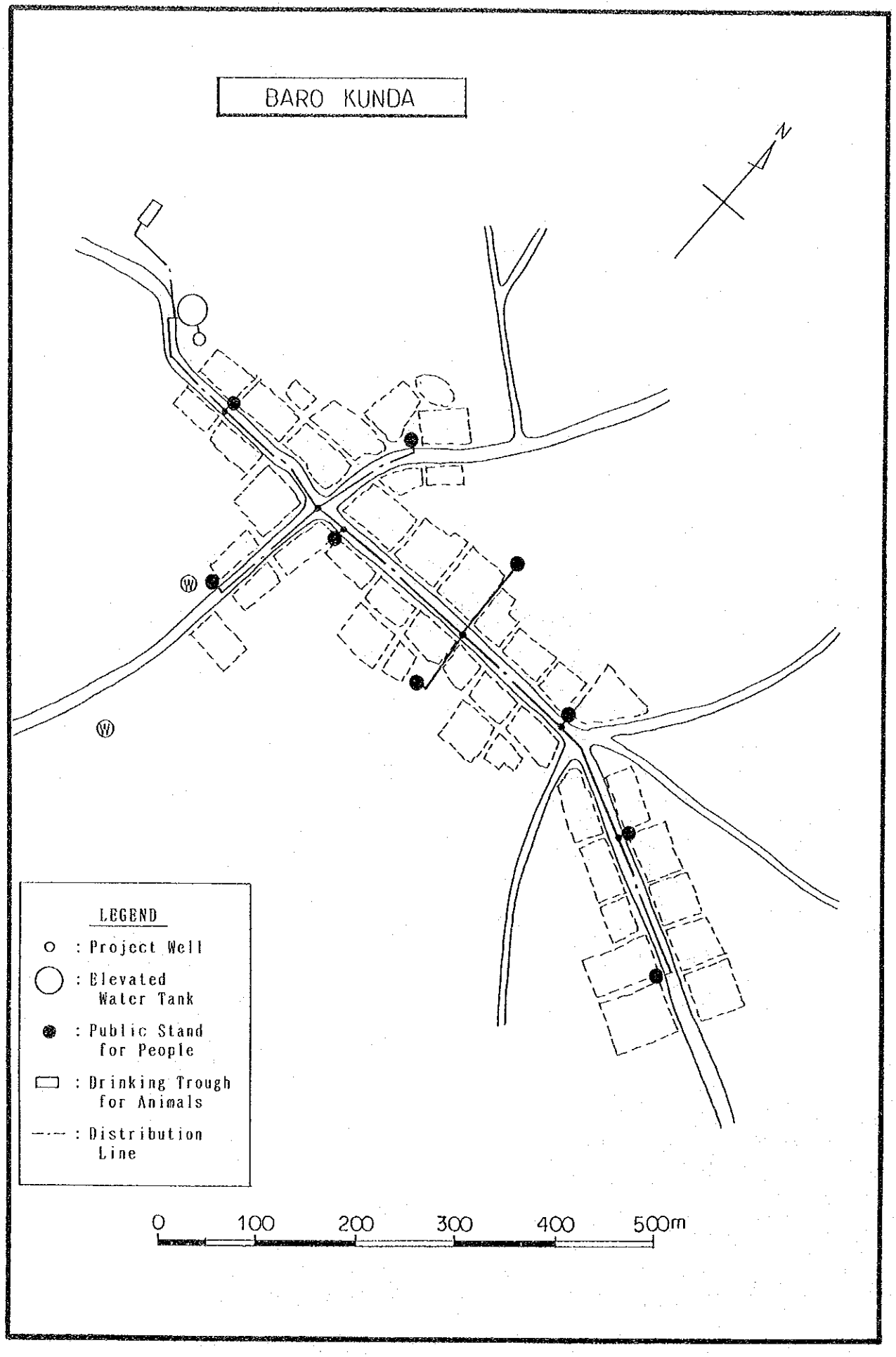
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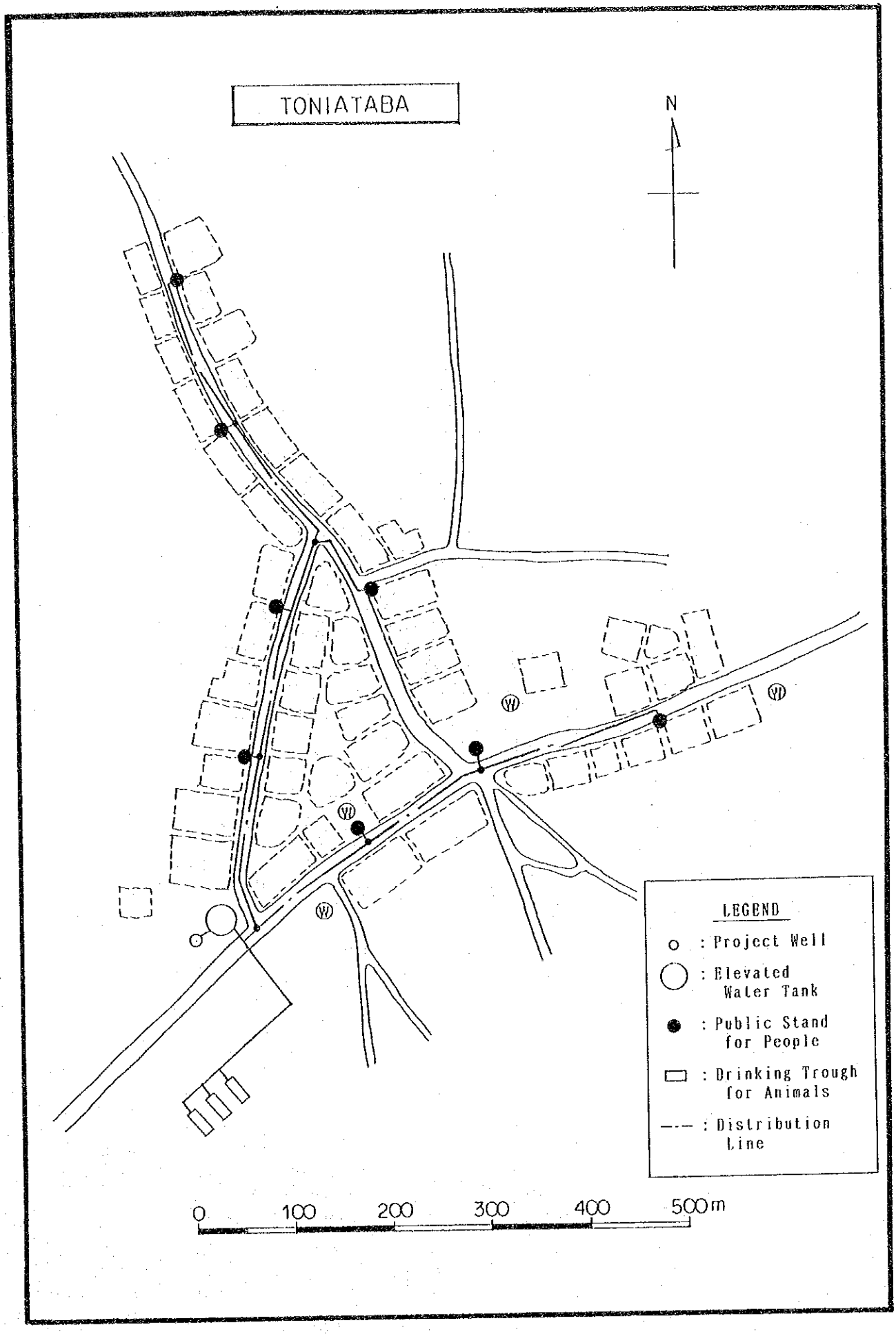
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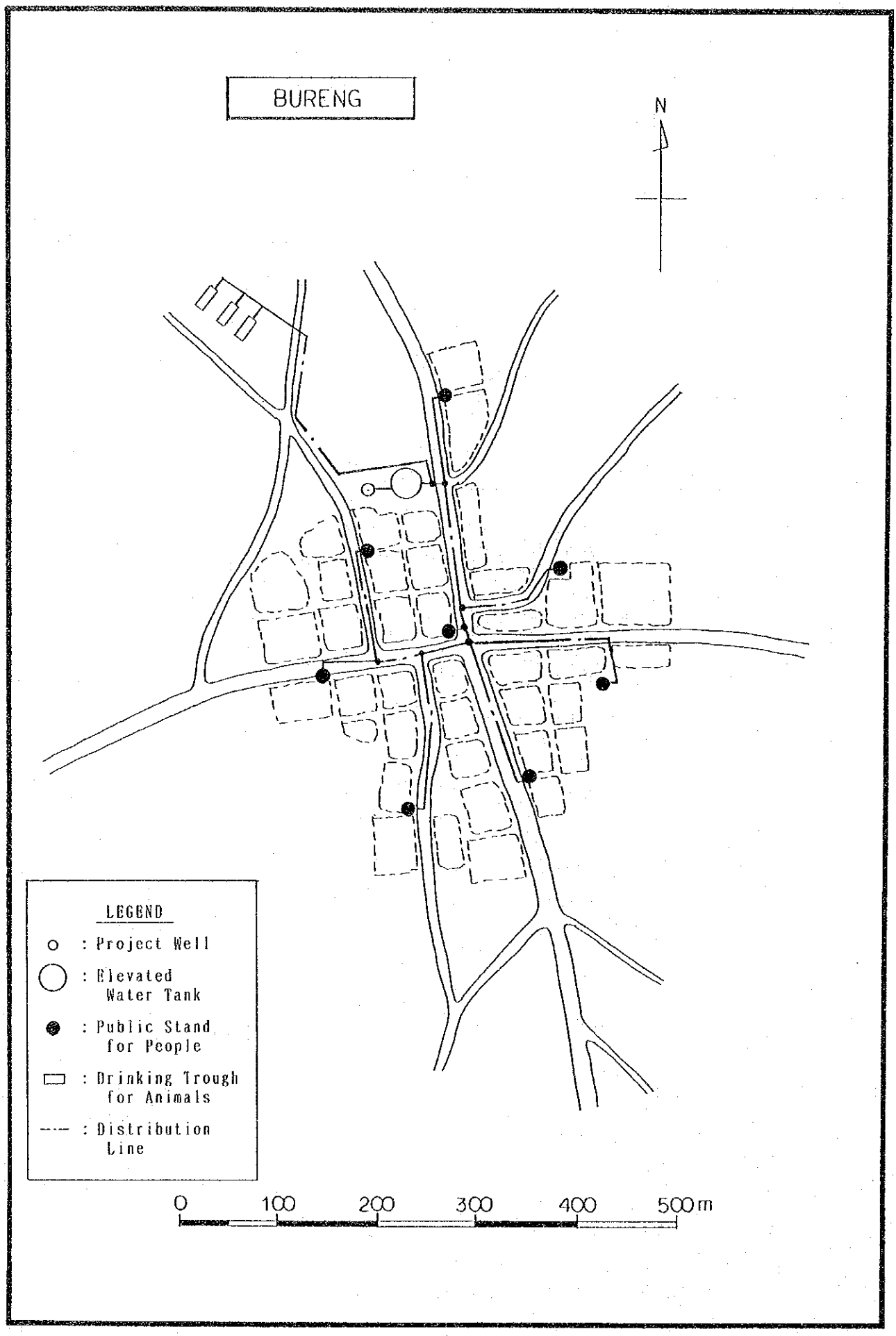
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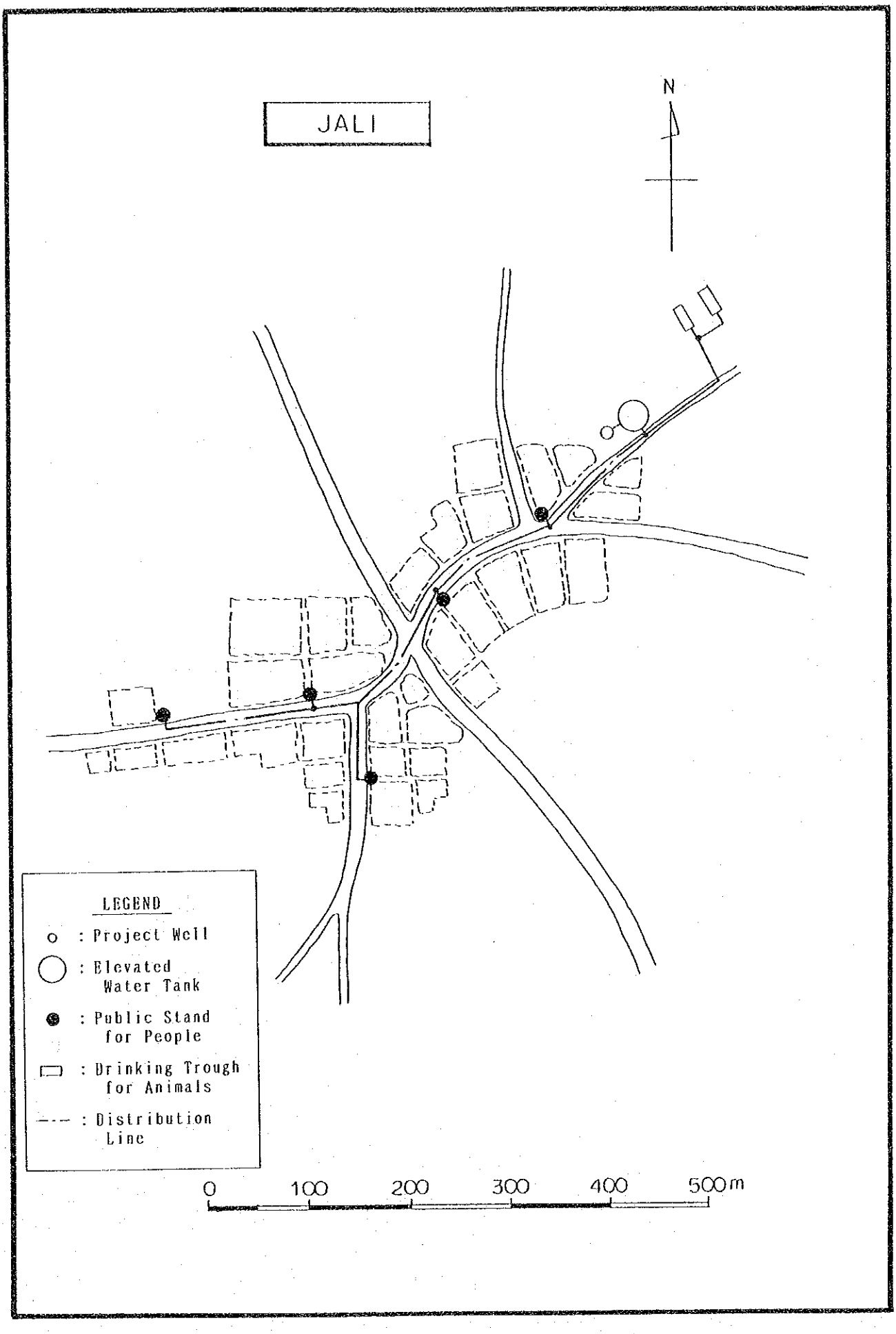
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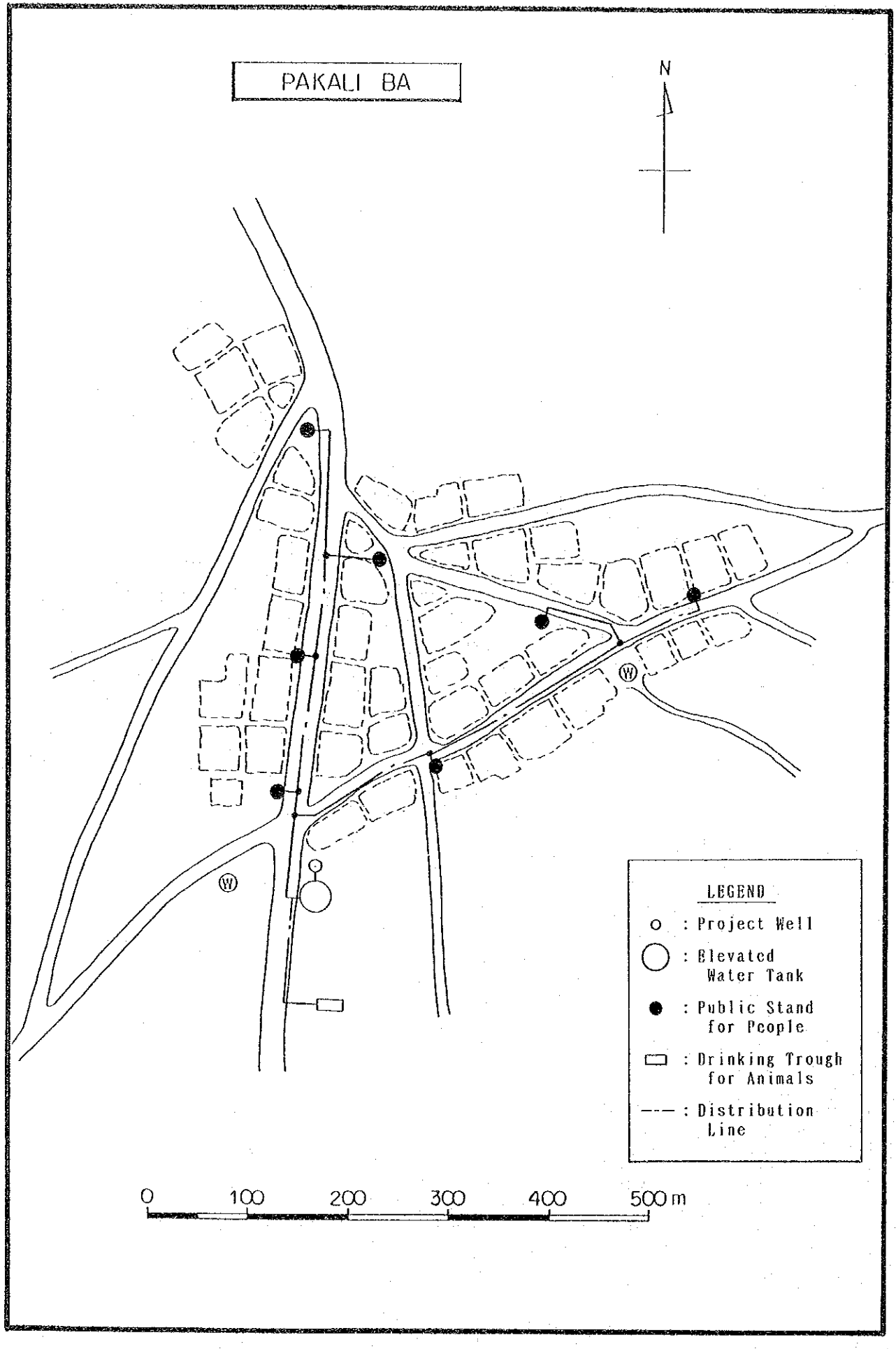
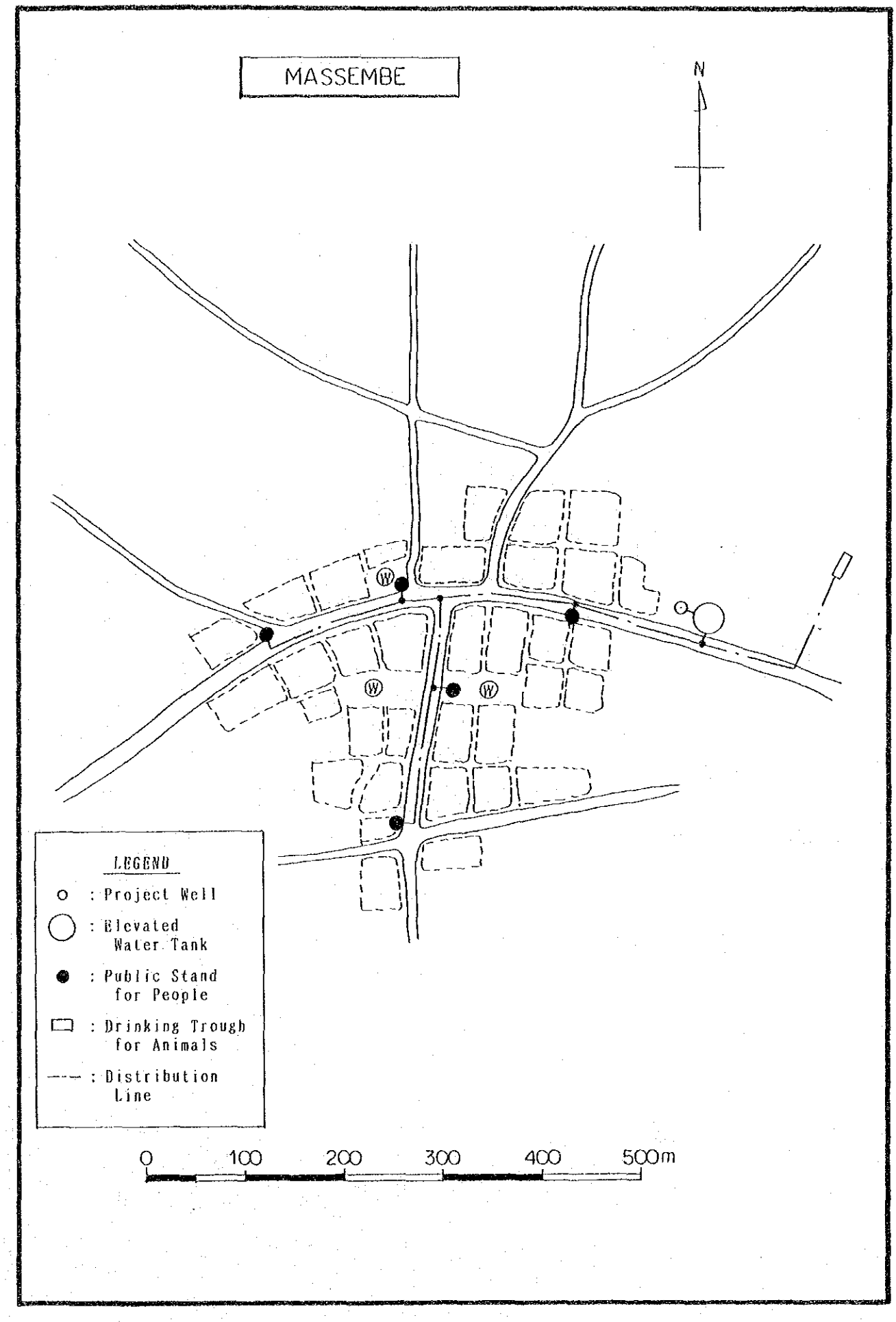
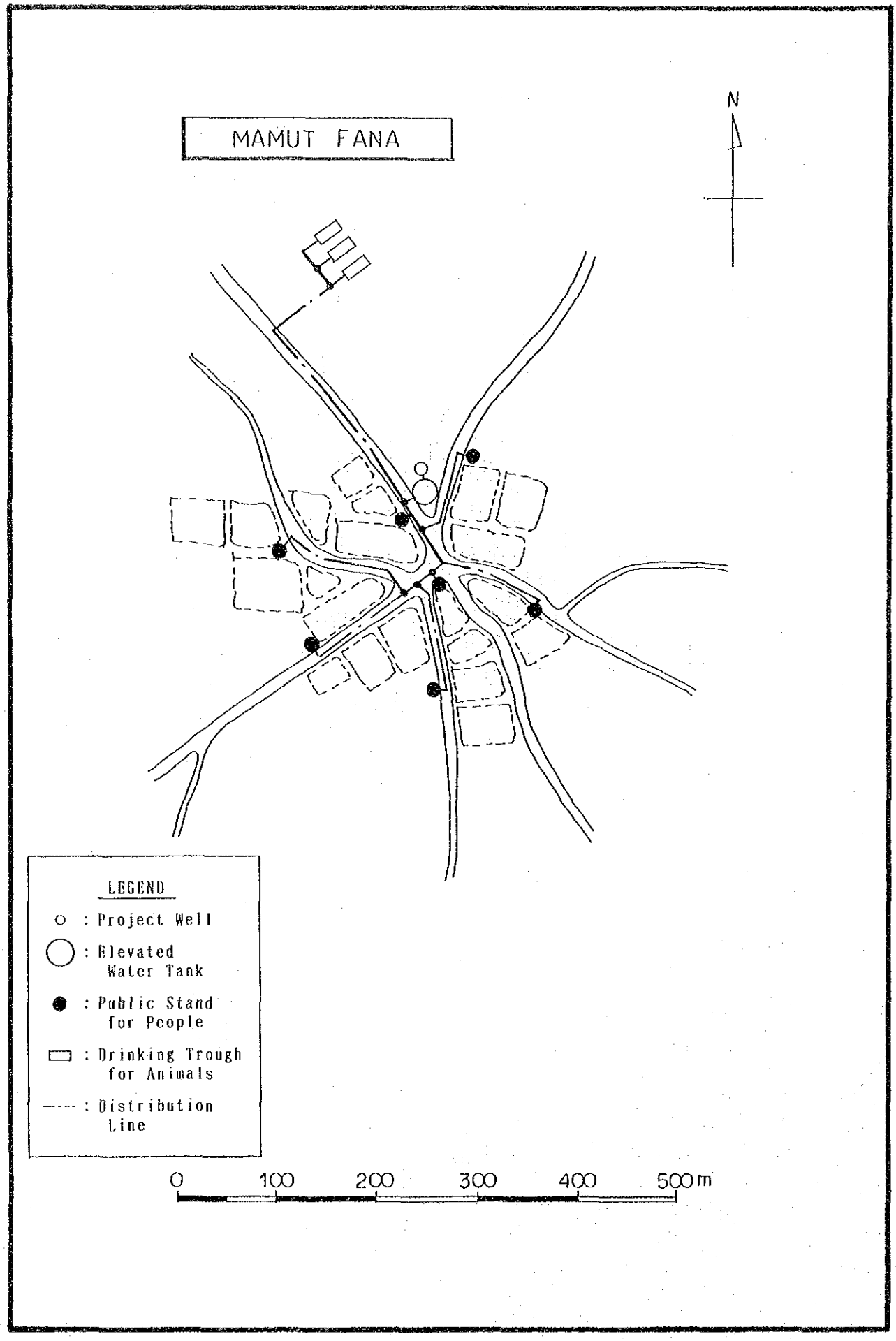
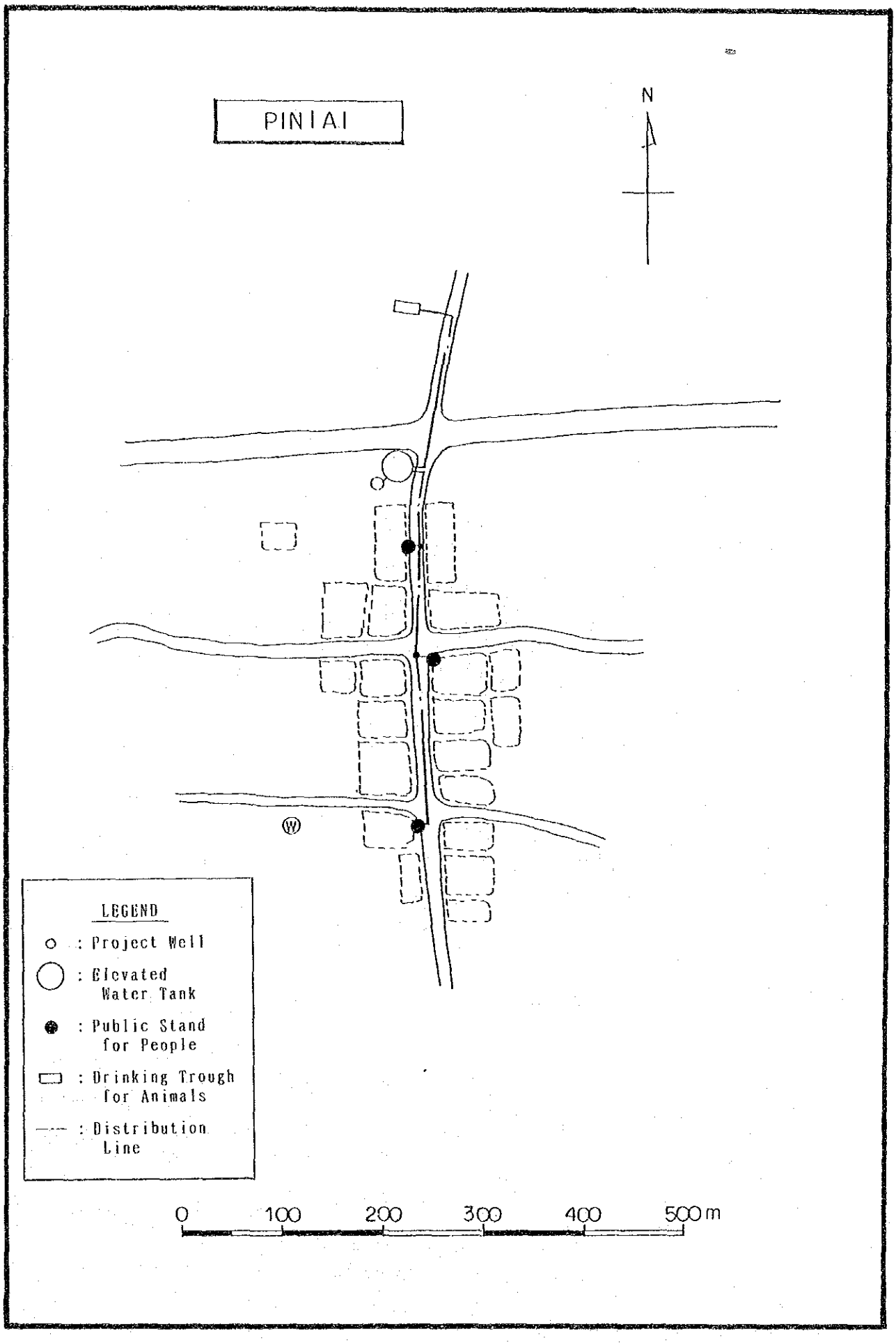
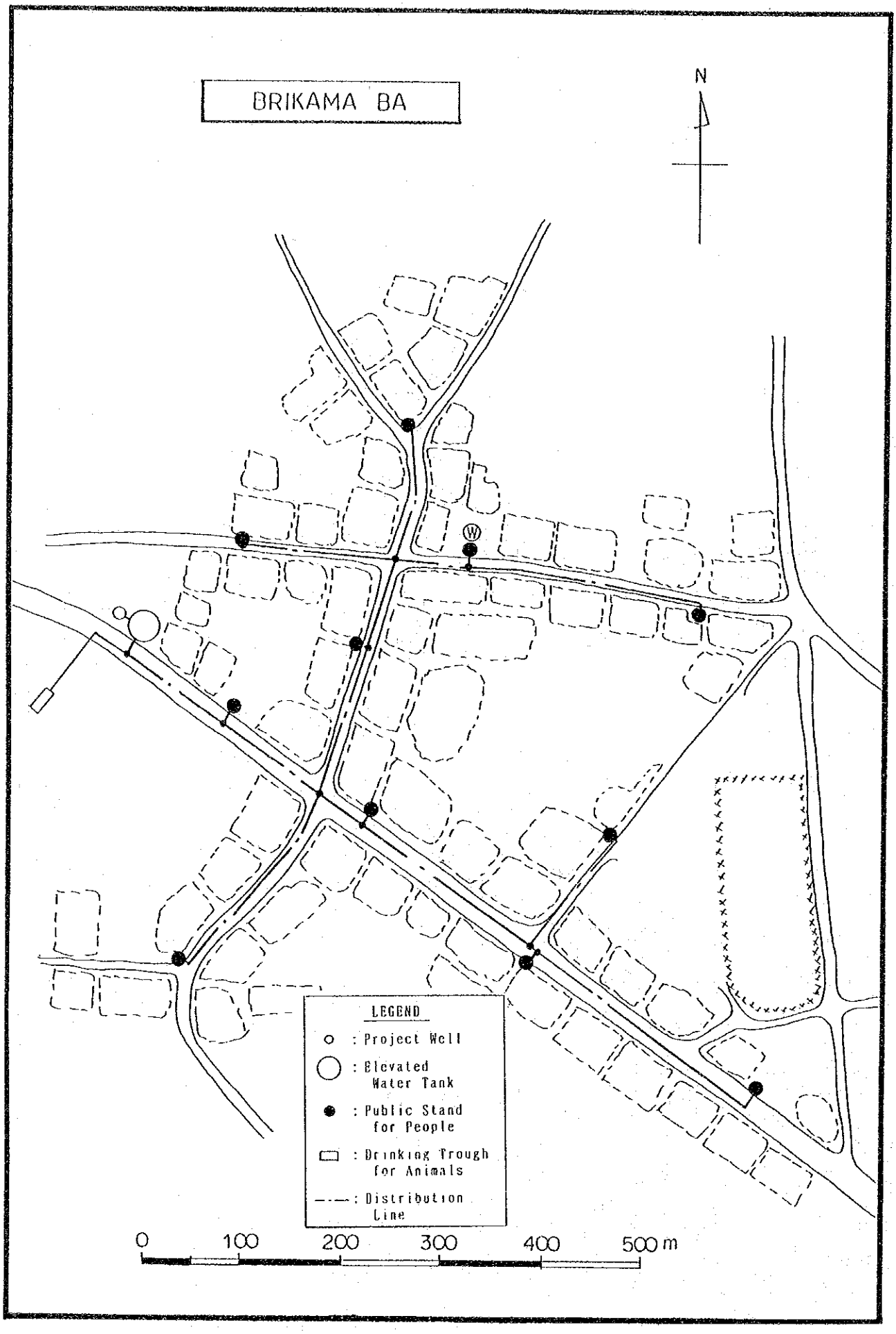
: Distribution Line
0
100
200
300
400
500m

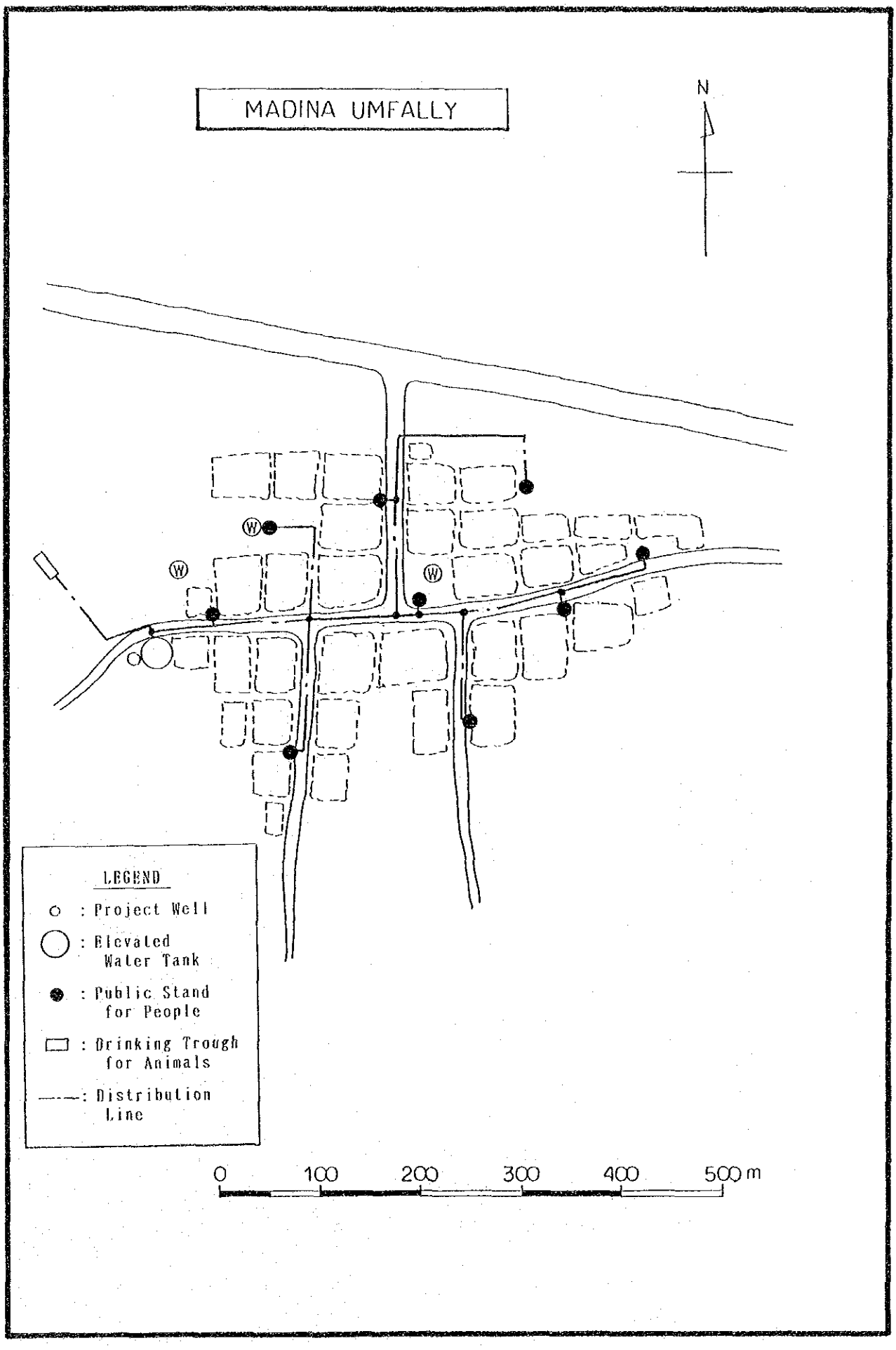

PAKALI BA
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m

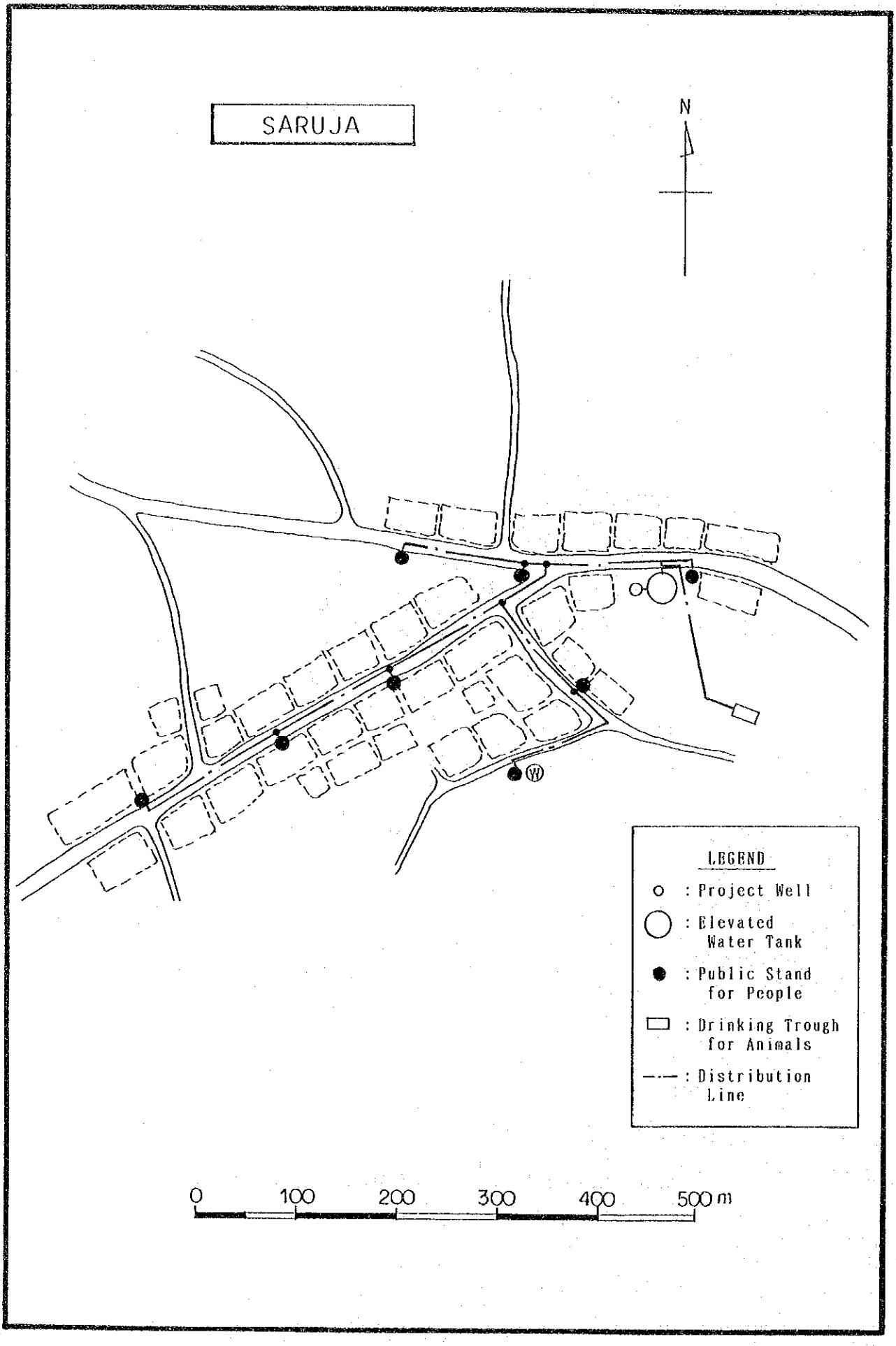

MASSEMBE
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500m

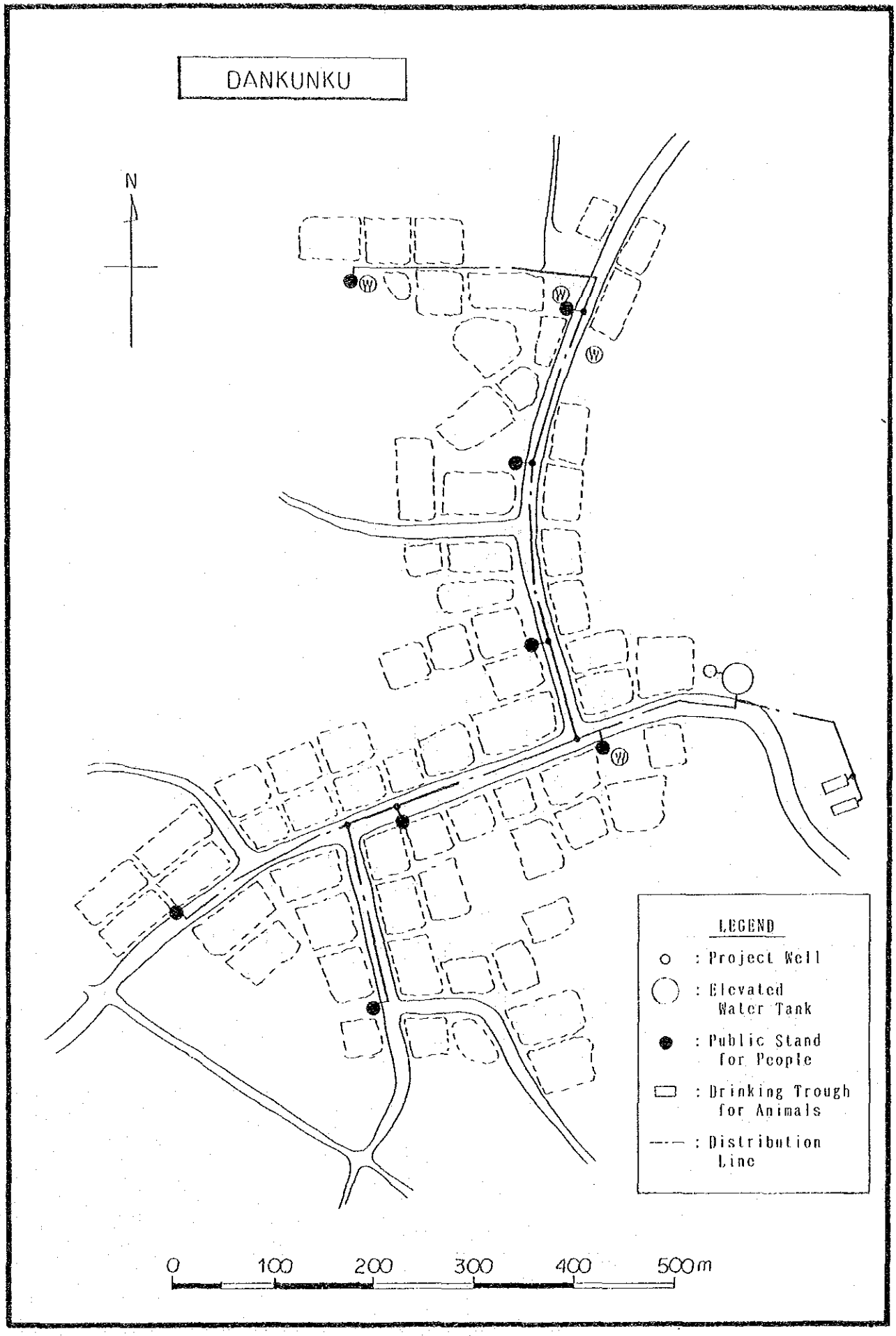

MAMUT FANA
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m

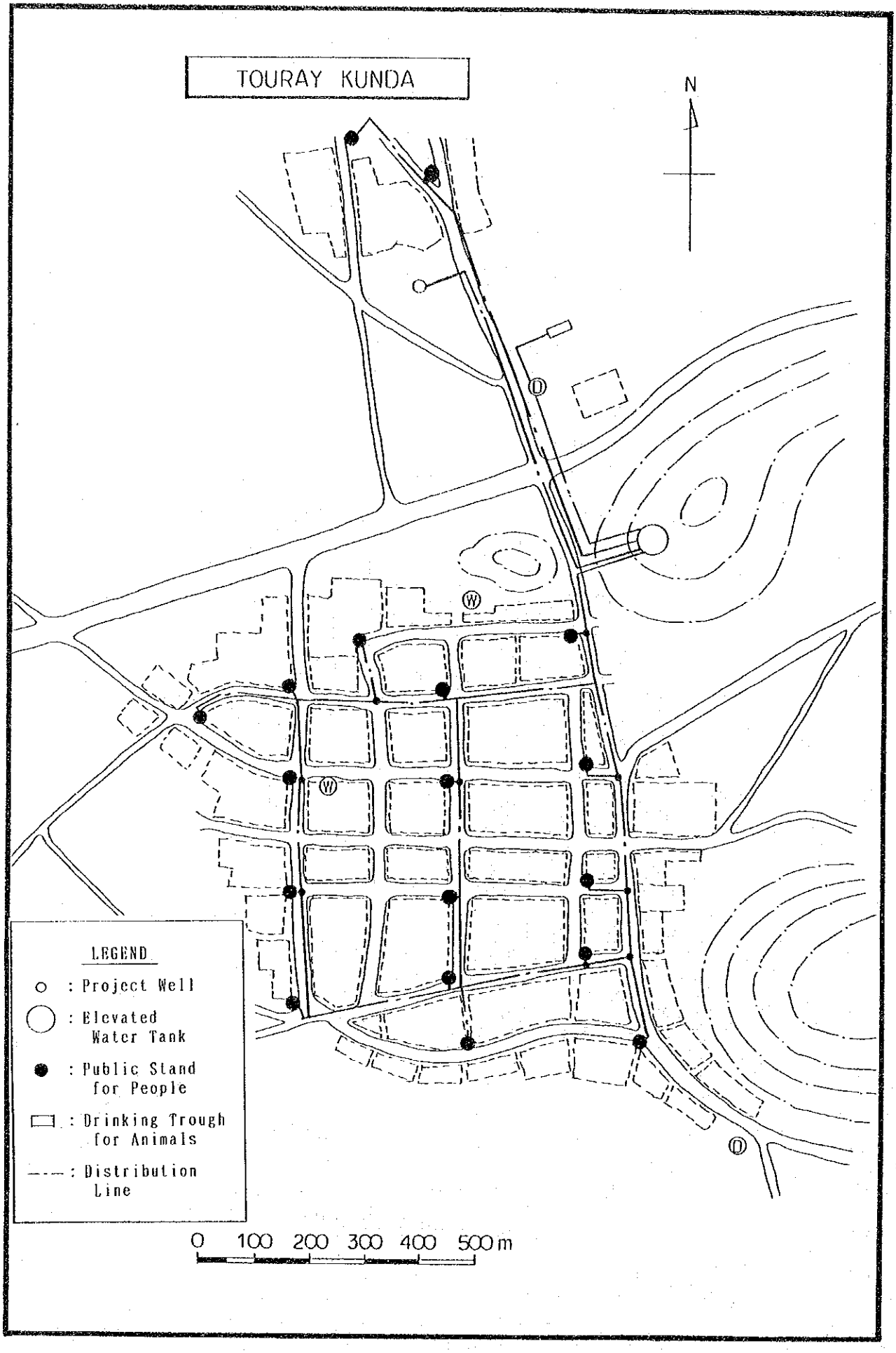

PINIAI
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m

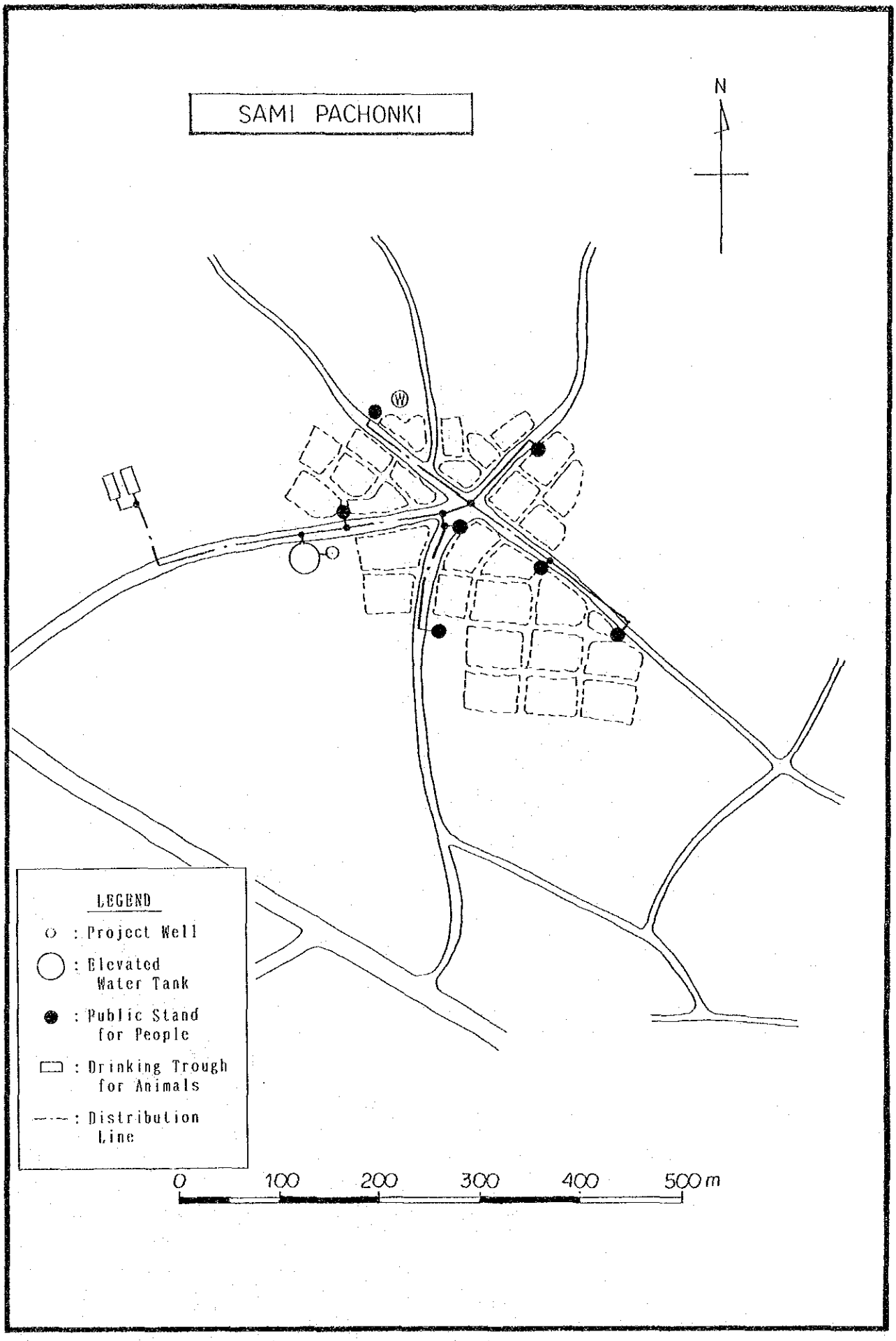

BRIKAMA BA
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m

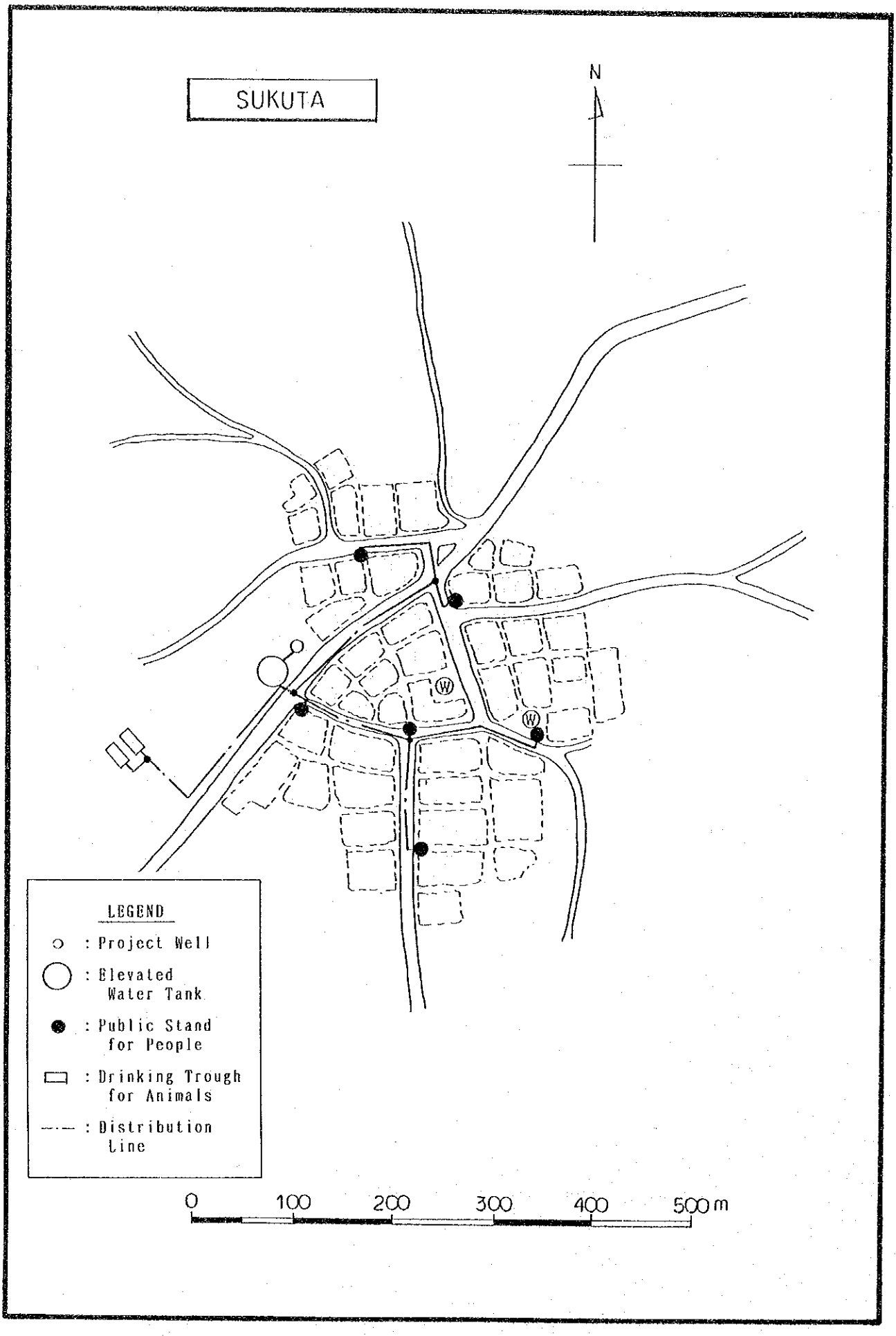

MADINA UMFALLY
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m

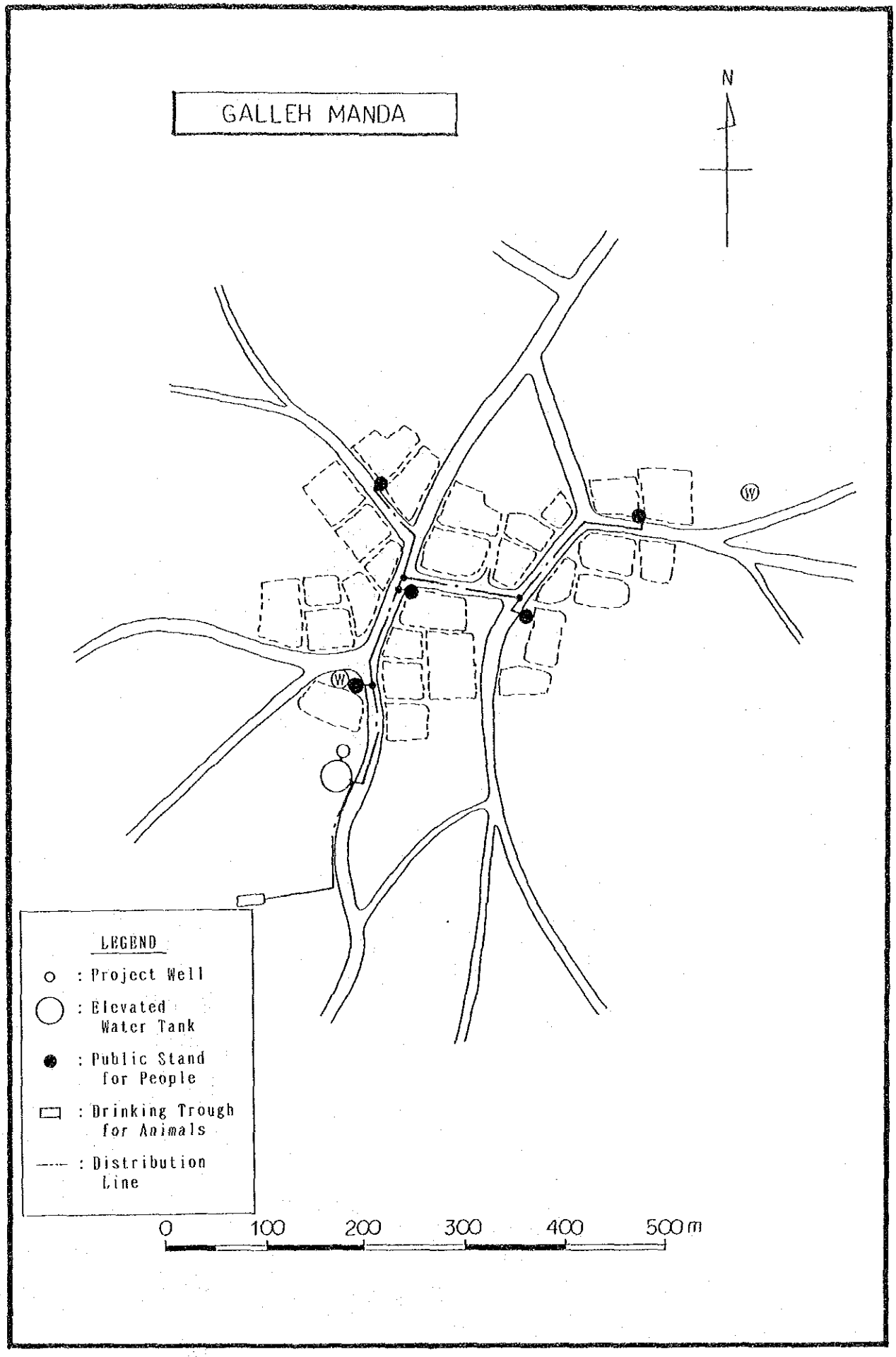

SARUJA
N
W
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m


DANKUNKU
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500m


TOURAY KUNDA
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0 100 200 300 400 500 m


SAMI PACHONKI
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m


SUKUTA
N
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m


GALLEH MANDA
N
W
W
LEGEND
: Project Well
: Elevated Water Tank
: Public Stand for People
: Drinking Trough for Animals
: Distribution Line
0
100
200
300
400
500 m

(2) Drawings for Facilities

Generator Room

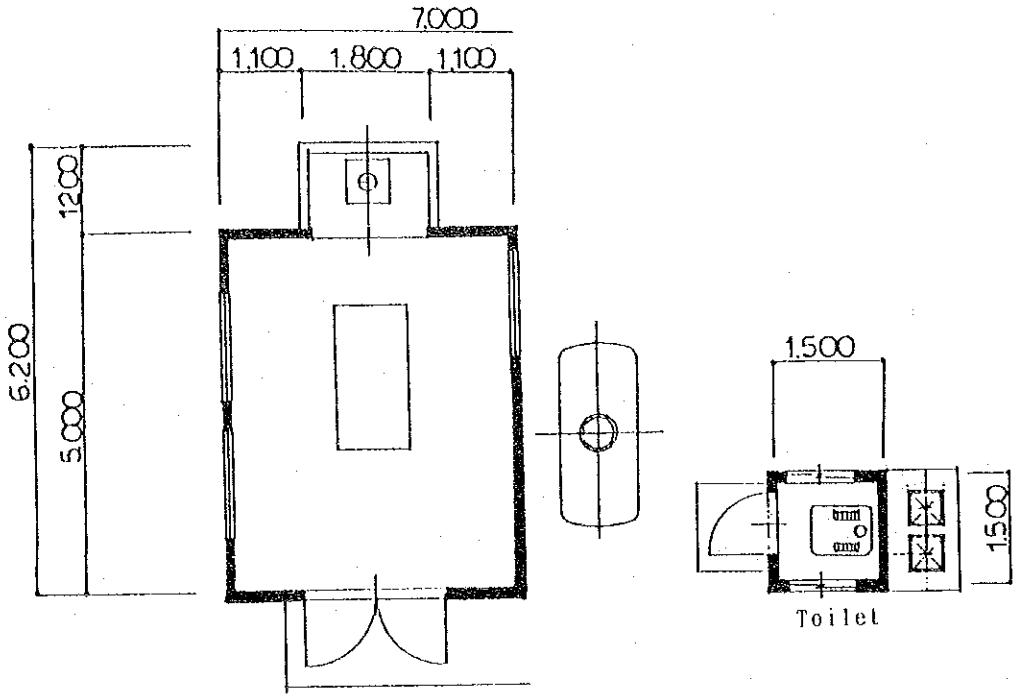
Elevated Water Tank

Public Stand for People • Drinking Trough for Animals

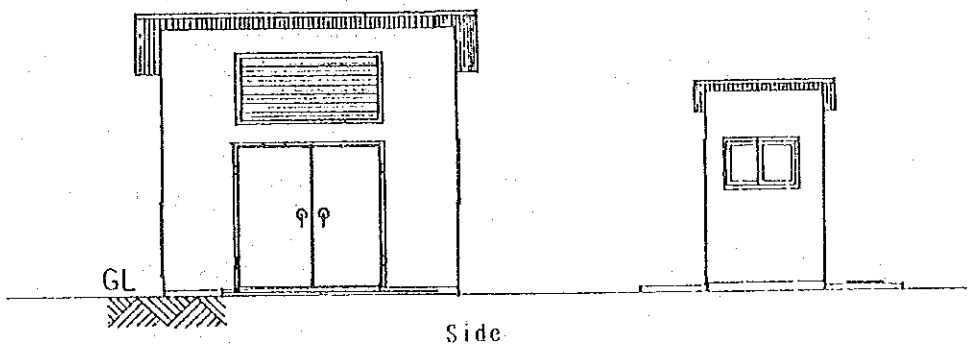
Valve Box

Drain Pit

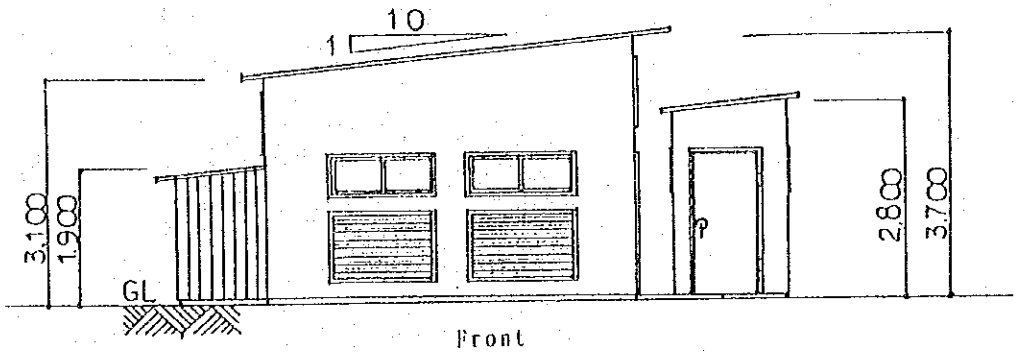
Well Structure



Plan

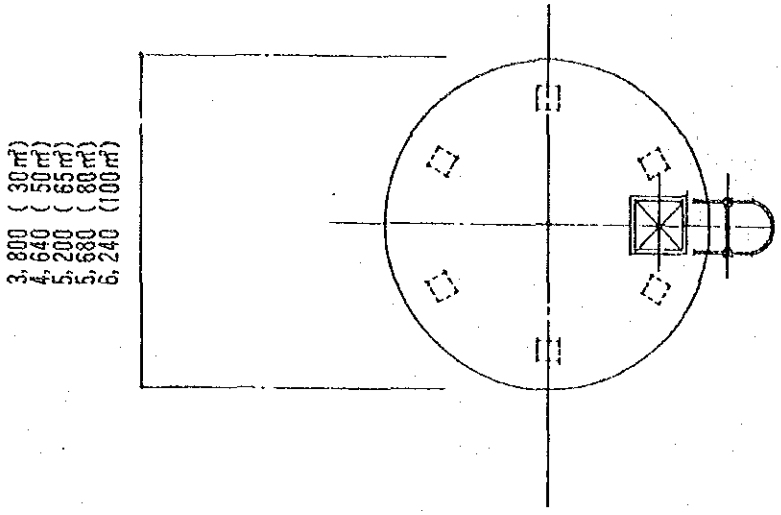


Side

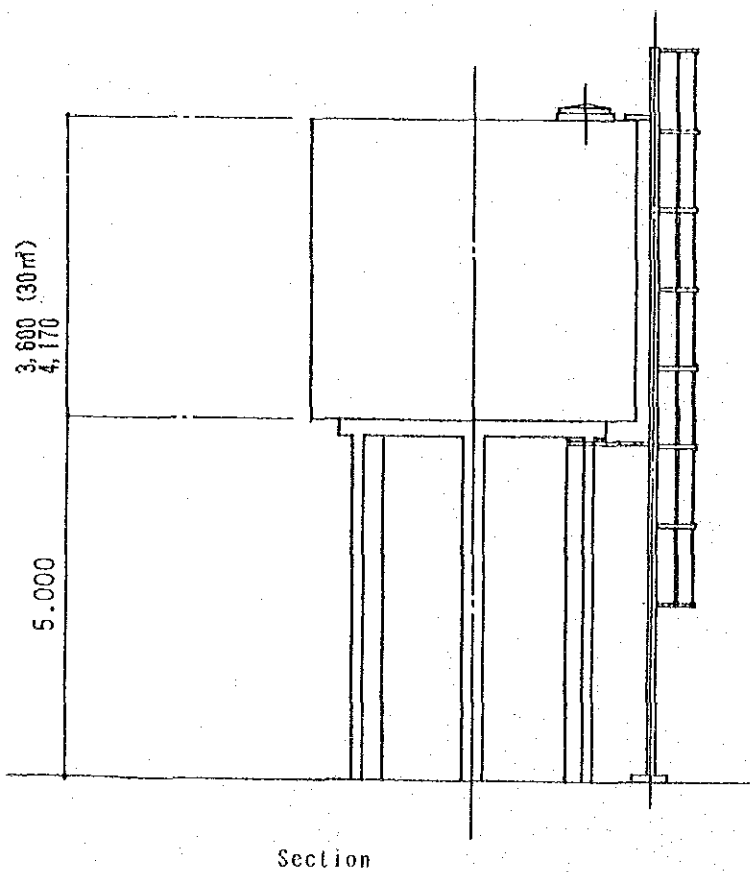


Front

Generator Room

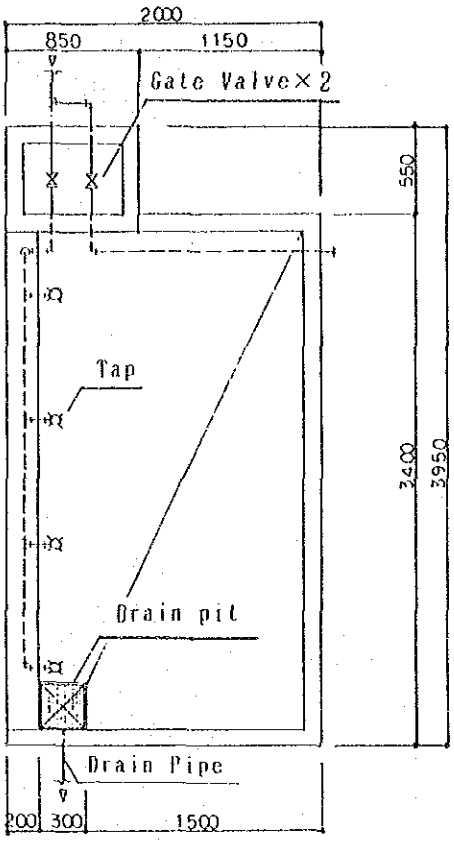


Plan

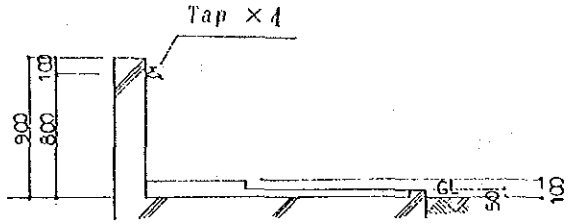


Section

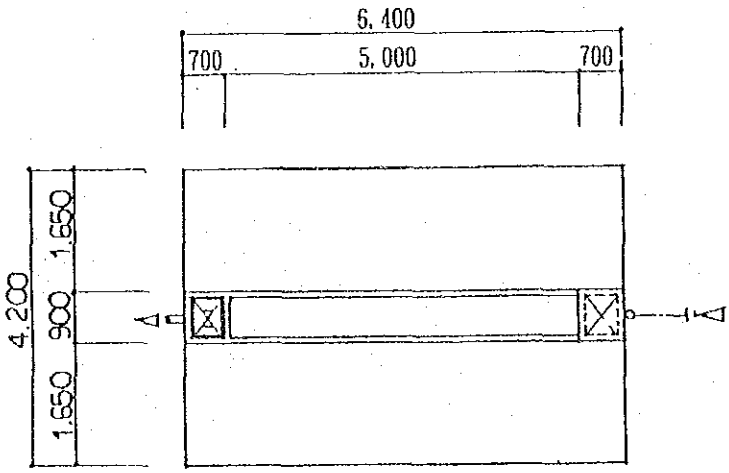
Elevated Water Tank



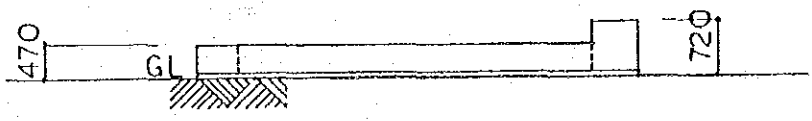
Public Stand for People



Section

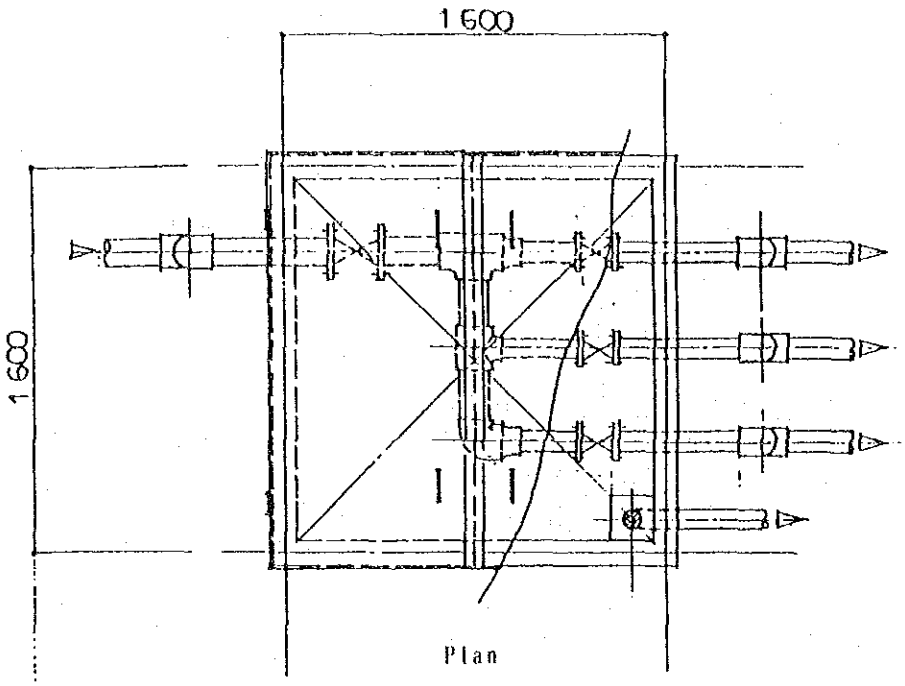


Plan

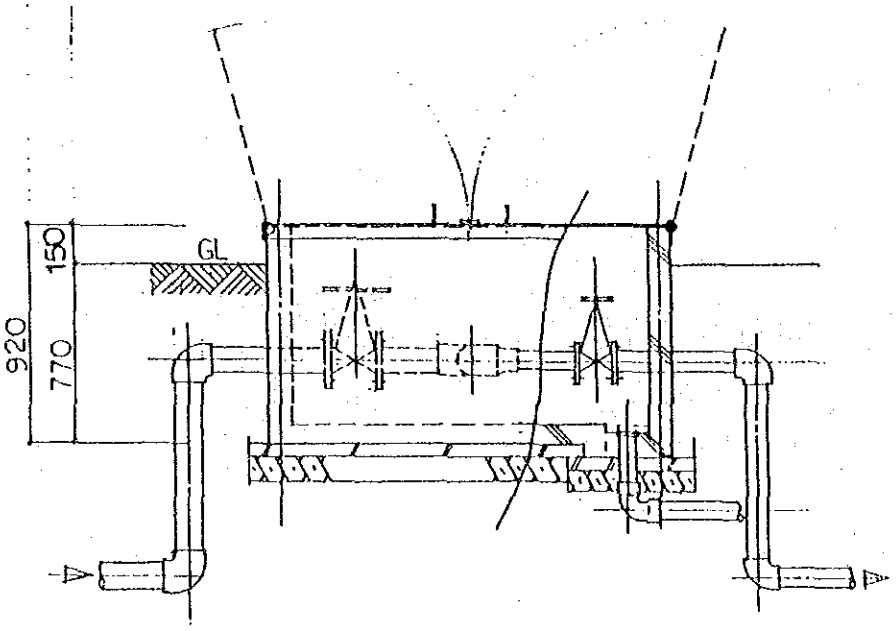


Section

Drinking Trough for Animals

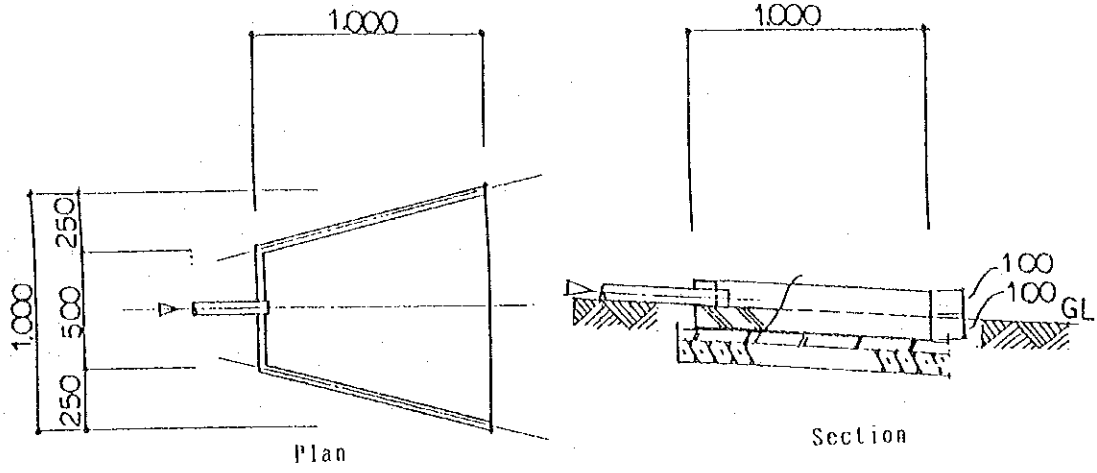


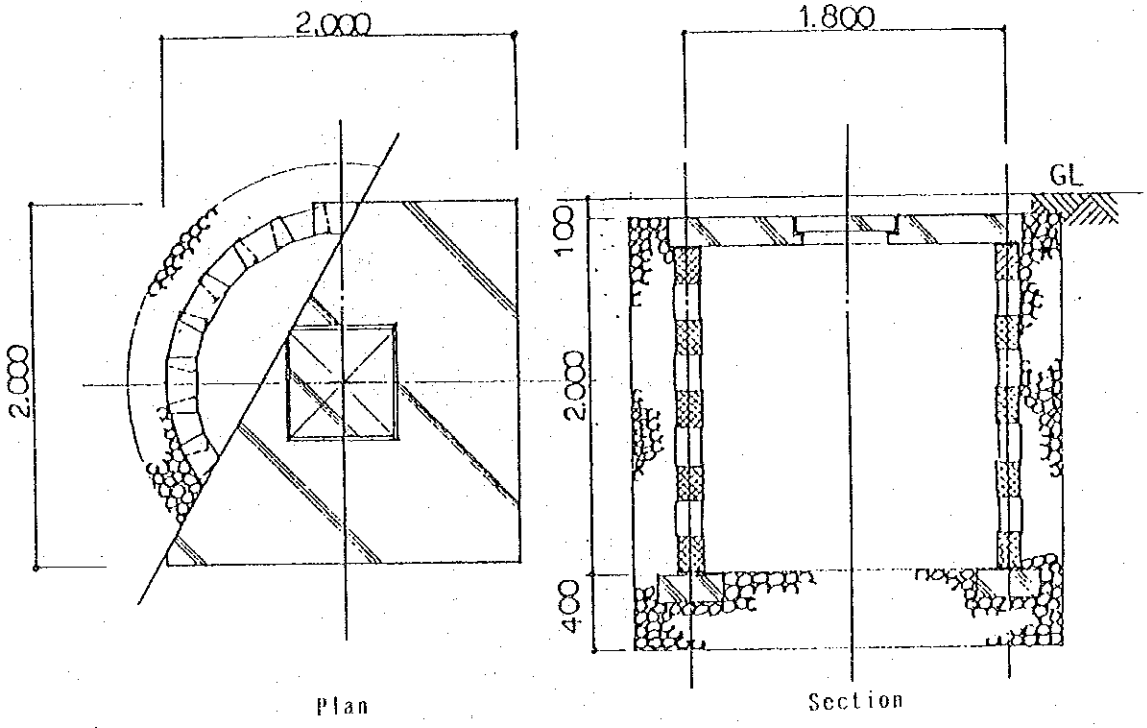
Plan



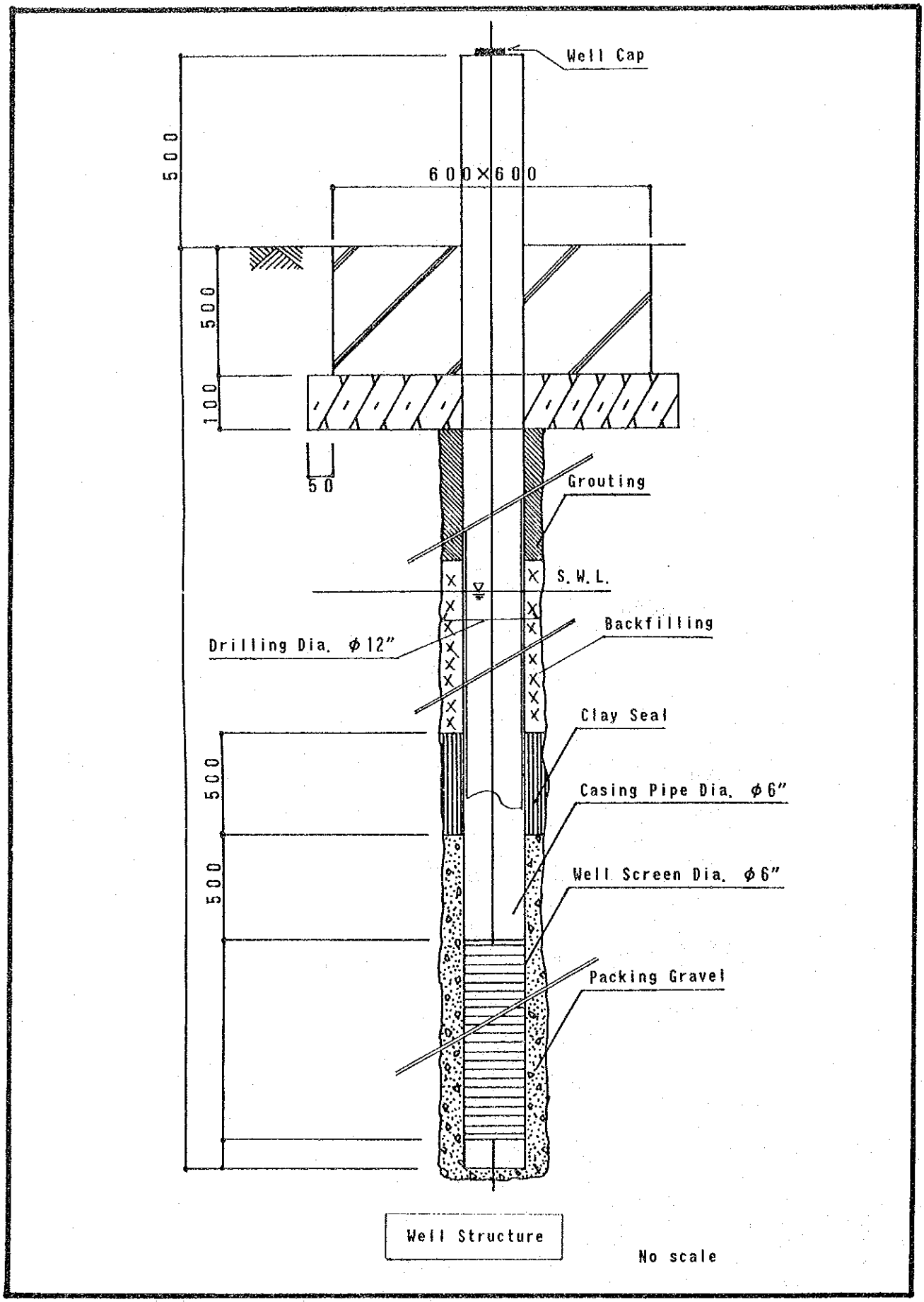
Section

Valve Box


1,000
1,000
250
500
250
1,000
Plan
1,000
100
100
GL
Section


2,000
2,000
Plan
1,800
GL
100
2,000
400
Section

Drain pit



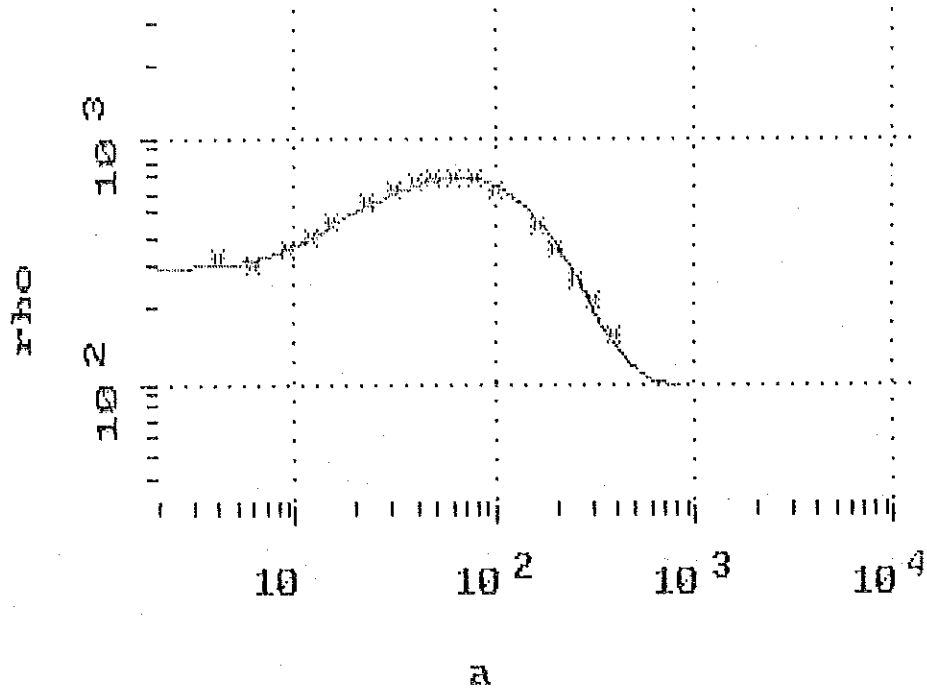
Well Structure

No scale

APPENDIX 6 GEOELECTRIC PROSPECTING

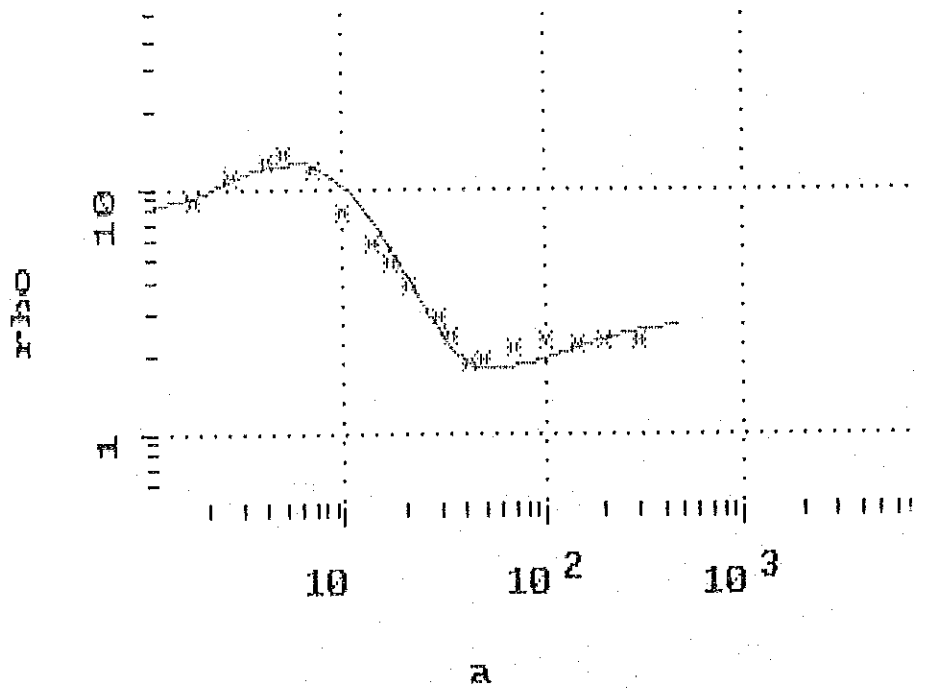
Fass Omar Sahor Area

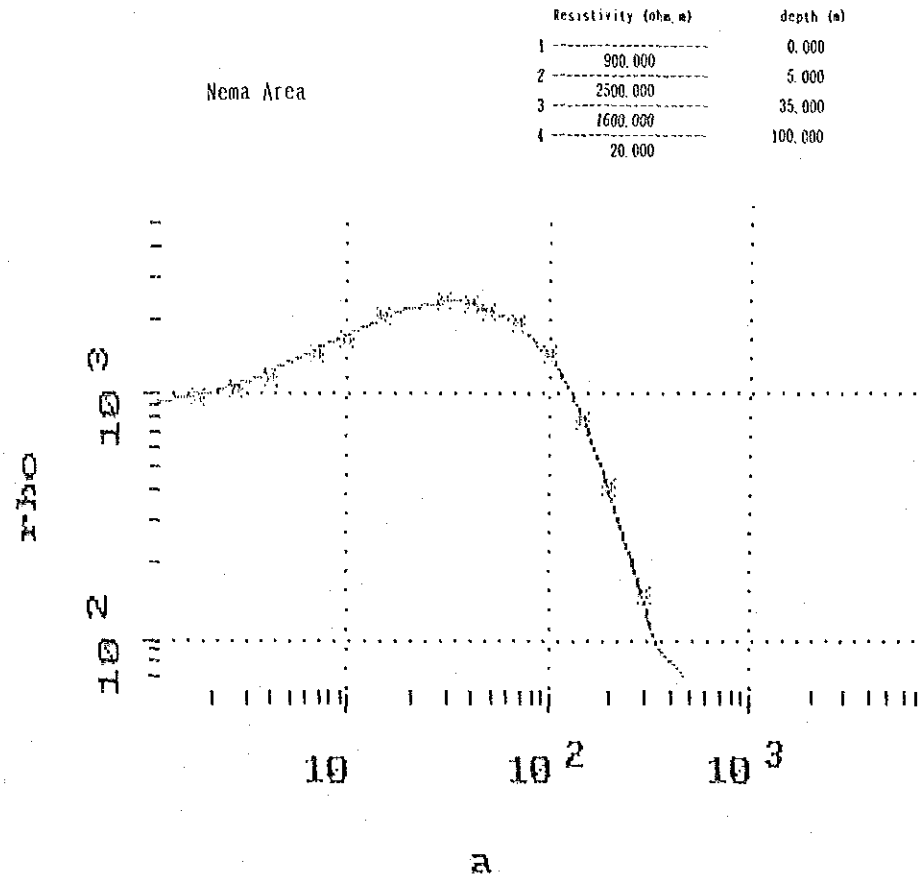
	Resistivity (ohm.m)	depth (m)
1	300.000	0.000
2	800.000	9.000
3	1000.000	25.000
4	300.000	80.000
5	80.000	150.000

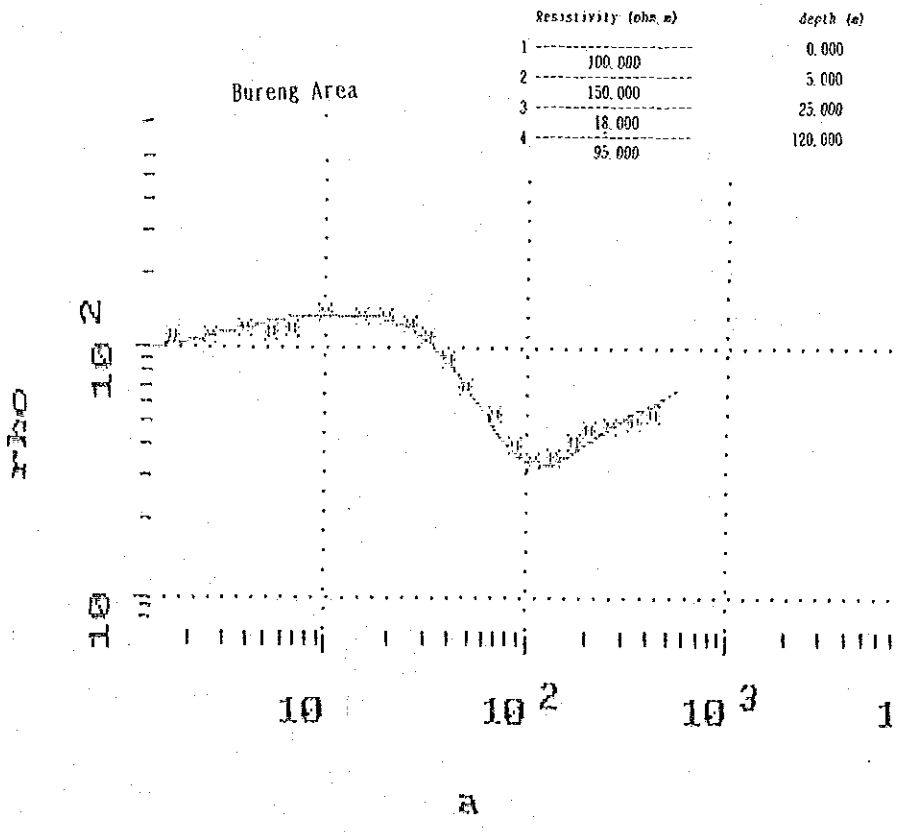


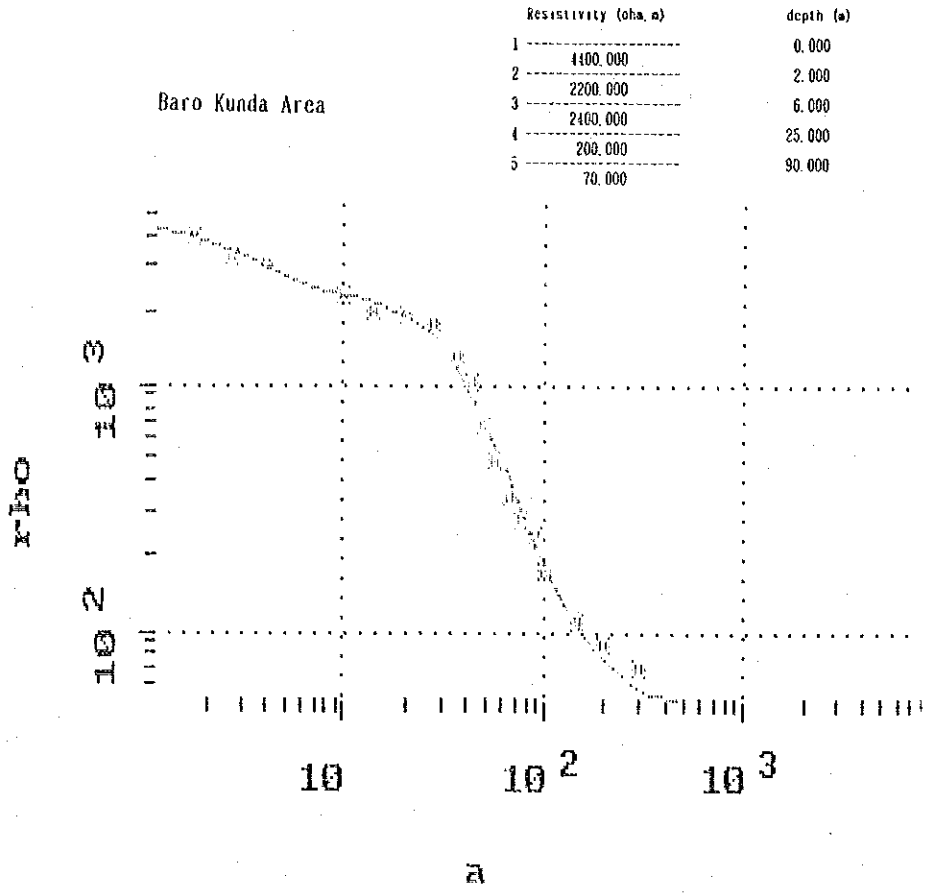
Jali Area

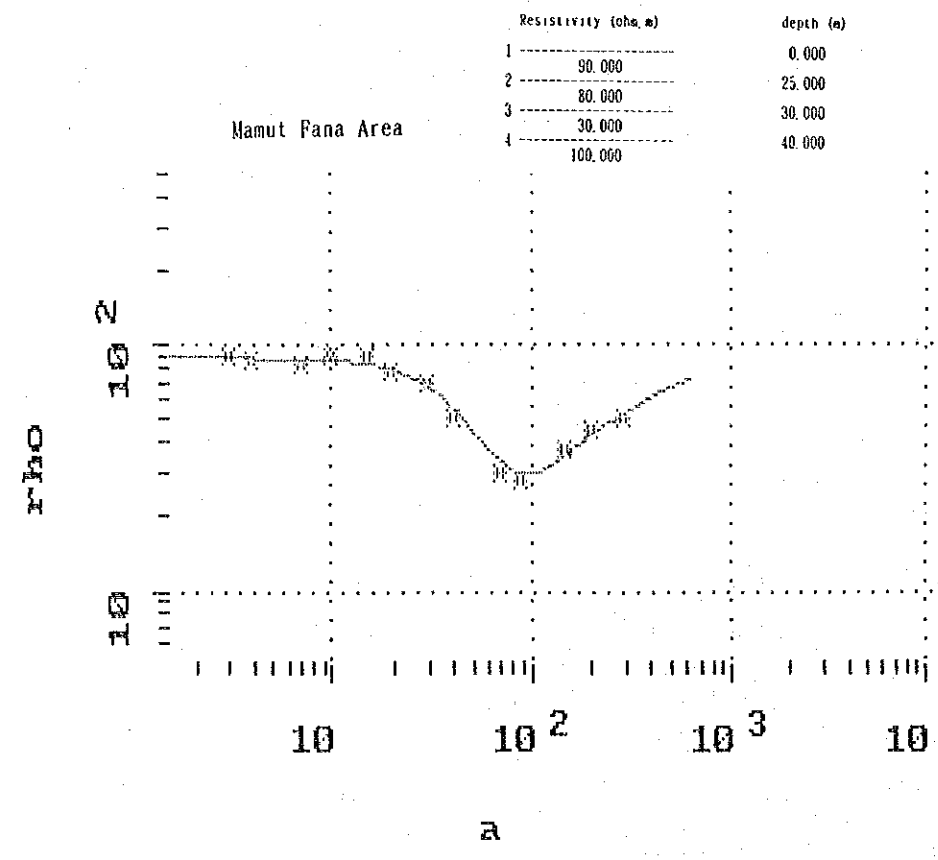
	Resistivity (ohm.m)	depth (m)
1	9.000	0.000
2	15.000	2.000
3	0.690	5.500
4	3.500	40.000




Nema Area
Resistivity (ohm.m)
depth (m)
1
900.000
0.000
2
2500.000
5.000
3
1600.000
35.000
4
20.000
100.000
rho
10 3
10 2
10
10 2
10 3
a


Bureng Area
Resistivity (ohm.m)
depth (m)
1
100.000
0.000
2
150.000
5.000
3
18.000
25.000
4
95.000
120.000
rho
10 2
10
10
10 2
10 3
1
a


Baro Kunda Area
Resistivity (ohm.m)
depth (m)
1
4400.000
0.000
2
2200.000
2.000
3
2400.000
6.000
4
200.000
25.000
5
70.000
90.000
ρ-ohm
10 3
10 2
10
10 2
10 3
a


Mamut Pana Area
Resistivity (ohm.m)
depth (m)
1
90.000
0.000
2
80.000
25.000
3
30.000
30.000
4
100.000
40.000
ρ-ohm
10 2
10
10
10 2
10 3
10
a

JICA