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REPORT

of the

UNICEF ASSESSMENT MISSION FOR WATER SUPPLY PROJECTS IN THE OWAMBO REGION NORTHERN NAMIBIA

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1.INTRODUCTION

1.1. Background

In anticipation of Namibia's independence, the United Nations Children's Fund (UNICEF) is preparing a programme of cooperation with the Namibian Government in support of Namibia's mothers and children.

The adverse effects of nature, neglect and war have taken their toll on Namibia's population, most of which are living in the north. In that region infant and child mortality rates are thought to be particularly high.

Of Namibia's estimated present population of 1.7 million, roughly 60% live in the extreme northern part of the country and over a third of Namibia's population, estimated at some 600,000 people, live in the central part of the border area with Angola (the Owambo region).

Initial assessment of the conditions showed that the rural water supply situation in this area is very deficient. Due to the lack of access to clean drinking water for the population and its lifestock, diarrhoeal diseases and malnutrition are high and seem to contribute overwhelmingly to infant and child mortality and to low productivity in the farming economy.

In order to respond to the need to intervene in a rational way UNICEF-Windhoek requested assistance in assessing the water situations in the Owambo region and to define possible interventions to improve the water supply conditions in the entire region. Advice was also sought to formulate possible water supply and sanitation components to area-based development projects proposed for the area of Tsandi in central-west Owambo. As drought conditions were developing in early January 1990, proposals for an emergency response were added to the objectives of the mission.

The author was requested to assist the UNICEF-Windhoek office and agreement was made to schedule the mission from January 16 till February 8, 1990.

1.2. Purpose of the mission

The mission's objective was to assess the water supply situation in the Owambo region and to formulate possible interventions to support the incoming Government of Namibia in its tasks to improve access to safe water supplies for this region's population.

UNICEF's normal procedure is to prepare, in full collaboration with the Government, an accurate analysis of the situation of mothers and children and then to proceed to a programming exercise for a one year or a multi-year cycle. UNICEF will make commitments towards the implementation of a joint Government of Namibia-UNICEF Plan of Action, in terms of cash and material assistance and expertise.

The present mission is intended to contribute to the preparation of the Situation Analysis concerning the water supply situation in the Owambo region and to define common ground for the formulation of a water supply and sanitation component in the programme of cooperation.

The terms of reference for the mission are attached in Appendix I.

1.3.Procedure for the mission

The mission was undertaken during a 3-week period from January 16 till February 8, 1990.

The mission period was divided in three parts:

	Period	Activities
1.	17-20 January 1990	Briefings in Windhoek
2.	21-31 January 1990	Field visits in the Owambo region.
3.	01-08 February 1990	Additional meetings in Windhoek. Report preparation, report submission and debriefing.

The UNICEF-Windhoek office prepared a list of key institutions and people to meet both in the Windhoek area and in the Owambo region.

To obtain the necessary data the following procedure was used:

1. Coordination meetings and interviews with key people at the following offices: UNTAG, Swapo, Ovambo Administration, CCN/RRR and churches: Lutheran, Anglican and Catholic; the Rural Development Centre and UNHCR
2. Launch of a Water Inventory via SWAPO network
3. Discussions and collection of data at the Dept. of Water Affairs and at the Ovambo Administration
4. Field visits to specific projects
5. General field inspections and interviews with the population
6. Meetings with the tribal leaders with assistance from UNTAG district officers and RRR Committee.

A questionnaire was used to inventorize the type and number of water points per village, as well as the distance to the nearest water point during the dry season and possible projects to improve the water supply situation. The questionnaire was kindly prepared, multiplied and distributed by the Swapo regional office in Oshakati. Sufficient forms were distributed to each of the 4 sub-regional sectors. In each sector the forms were distributed among the 4-7 subdivisions ('wards'). At each of the in total 24 wards the forms were filled out with the assistance of sometimes a multitude of people. Due to time constraints, only a small percentage of the completed questionnaires was available for processing during the report preparation.

1.4.Acknowledgements

The author wishes to express his gratitude to all that have contributed to the completion of the mission. In particular I wish to thank Mr. Israel Shikongo of RRR-Ongwediva for giving his time to accompany me on all field visits in Owambo. Special thanks also to Mr. Simon Kaukungwa and staff of SWAPO-Oshakati for his assistance and cooperation with the preparation and follow-up of the field questionnaire. Also Mr. Mik Magnusson and staff of UNTAG Regional Office Oshakati and district staff, for all support given, in particular in the sharing all relevant information collected during the UNTAG monitoring of the drought and the support in the data collection via the questionnaire. The assistance and information sharing by Mr. Pedro Maritz and staff of the Department of Water Affairs in Windhoek and by Mr. Leon Nel in Oshakati was greatly appreciated as was the assistance and information sharing by Mr. Keith Morrow of the Owambo Administration.

2. DESCRIPTION OF THE OVAMBO REGION

2.1.General geographical conditions

The Owambo region is located in the central part of Namibia's border area with Angola in the North. The Etosha saltpan National Park borders in the South, Kaokoland in the West and Kavango in the East.

The surface area is 52,230 km2, which represents just 6.3% of Namibia's total surface area. The region's form is roughly trapezoidal extending 365 km E-W and 130 km N-S.

The area is located between the latitudes 17 20' - 18 30' South and 14 00' - 18 00 East. and is as such located in the lower tropics. Altitude ranges from 1,090 m. to 1,150 m. above sea level.

The topography of the region is virtually flat, with a small exception at Ruacana in the extreme northwest, where the terrain is rough. From Ruacana eastward, over a distance of some 350 km, the area is a slightly undulating plain, part of the Owambo Basin, with an extremely low gradient from east and west towards the center. Here, at Ondongwa, the plain reaches its lowest point, draining towards the Etosha Pan.

Climate

Rainfall is sparse, ranging from just over an annual total of 300 mm in the Southeast to almost 600 mm in the Northeast. The rains concentrate in the 6-7 months during period from October to April.

Due to the high year-round temperatures and dry winds the potential evapotranspiration is extremely high, on the order of 2,600 mm per annum.

These conditions throughout the ages, combined with the interior drainage system of the region (Cuvelai River) reduced runoff downstream towards the Etosha Pan to such an extent, that salinization of the region's subsoil took place and resulted in the creation of the Etosha saltpan at the lower end of the system.

Geology

The Owambo region is located in a sedimentary basin called the Owambo Basin, that extends into Angola and possibly continues into western Zambia. This basin has been filled with a succession of deposits with a total thickness of some 8,600 meter on top of a granite basement. Outcrops of the different sedimentary rocks, that occur in the subsoil are found on the southern and western rims of the basin. In the basin these rock formations are covered by a blanket of up to 600 meter thick unconsolidated deposits of the Kalahari Sequence. Underneath the Etosha Pan the sequence attains some 100 meters, whereas the maximum thickness is attained in the northeast, between Okongo and the Kavango River.

From some deep boreholes it has come to be known, that brines occur in the region's subsoil at depths as deep as 750 meters up to the upper formations. At two locations in the southeast, where the main road Ruacana-Oshakati-Ondangwa reaches the Etosha Pan, brines flow out of artesian wells. The artesian conditions are formed by a thick clay unit overlaying the aquifer.

Deep saline to briny groundwater has been tapped in boreholes drilled in the central area, located roughly between the latitudes 14 30' E.(just East of Olifa) and 17 00' E. West of 14 30' (some 25 km West from Okongo). The salts are thought to be evaporation products from the Cretaceous era till recent times.

The top formations in the Owambo Basin consist of white sand, greenish loamy sand and clay horizons (see Figure 2). Also secondary precipitates such as calcretes and silcrites occur in the sequence, which form hard nodules, lenses or horizons of greater extend

The sands occur more at the surface in the East (East of Ondangwa) and towards the South, while the clays are more at the surface in the western part (West of Ondangwa). When the rains come, they collect in numerous shallow depressions, where the

soil forms an impervious seal. Due to the high clay content infiltration takes place only very slowly. Evaporation
At depths varying between 3 and 10 meter, calcrete lenses of small and of larger extent occur in the sands.

The clay can reach a thickness of even 155 meters, as was found in a borehole at Ombalantu.

The Kalahari Sequence varies greatly in lateral and vertical extent. Very little detailed information is known to date and investigations are necessary to assess its potential for groundwater exploitation for the Owambo region.

2.2. Population

The area is densely populated by the Owambos, which are subdivided into 8 subgroups. In order of size these are the following: Uukwanyama, Ondonga, Uukwambi, Ombalantu, Ongandjera, Uukwaluudhi, Uukolonkadhi and Eunda. The Uukwanyama and Ondonga are by far the largest groups and account for 70% of the population. The Owambo settlement area extends into Angola. basically covering the drainage area of the Cuvelai River, coming from Angola in the north and draining into the Etosha Pan.

The last census took place in 1970. The population of Owambo was then 295,507 (excluding 52,034 that resided elsewhere).
The population was estimated in 1978 at 415,237. Assuming a net annual growth rate of 3.0%, the population in 1990 can be estimated at about 600,000. However, it is recognised that previous census data may be considerably undercounted.

The Department of Water Affairs assumes the population to be at 603,000. The distribution urban-rural at present and by the year 2000 is assumed to be as follows:

	1990		2000	
Rural	485,000	80.4%	608,000	76.0%
Urban	118,000	19.6%	192,000	24.0%
TOTAL	603,000	100.0%	800,000	100.0%

In this overview, urban population is defined as the population living in some 23 growth centers.

In 1978 the population was living on a surface area of 19,765 km2, while the total area of "Owamboland" covers 52,230 km2. The tendency is for the population gradually to spread over the entire area.

2.3.Subdivisions and tribal-administrative organization

On the eve of independence not much can be said about the administrative structure of the Ovambo region, since imminent changes are expected to be brought about. Up to now, however, no functional administrative subdivisions were made below the regional level.

Although much will change in terms of administrative organization, the tribal organization is likely to continue to have an importance. Up to now, land is owned by the chief or 'king' of the tribe or 'senior headman'-the next tier down in the hierarchy if there is no longer a king. This way land can be leased, but descendants do not inherit land. As land is of primordial importance in day-to-day life, the authority of the chief may retain significance. Also tradition by itself will have an important influence on the people's way of life for some time to come.

The rural population lives quite spread out in 'kraals' (compounds of huts). Although no villages as such have been formed, groupings of kraals are distinguished and these 'umukundas' can function as villages.

This subdivision in 'villages' could be very meaningful for the planning, implementation and maintenance of rural development projects.

These 'villages' can vary in size from 10 extended families to over 60. Assuming the average size of an extended family to be about 15 people, a small village may have about 150 people and larger villages can have around 1,000 people or more.

As each senior headman oversees a certain number of sub-headmen (or 'junior headmen'), and as each sub-headman oversees a number of villages ('umukunda'), it is possible to list all villages in the Owambo region. These lists were not available, but efforts to compile them will be very useful and data about each village's water supply will allow determination of the overall coverage of adequate water systems and necessary follow-up activities, and all other community-based activities. Prior consent from the tribal hierarchy is, however, a sine qua non for any development project under the present circumstances.

2.4.Socio-economic situation

It is beyond the scope of this mission report to go into detail concerning the socio-economic situation of the region. Yet, the most important features will be outlined, as they are of importance for water resource development.

The majority of the rural population is occupied with subsistance farming of food crops (mostly pearl millet) and raising of livestock. Families hold an average of 9.5 large animals (7.6 head of cattle and the remainder horses and/or donkeys) and 5.5 small animals (mainly goats, some have sheep and/or pigs) (Source: Administration for Ovamboland, January, 1990).

The present number of animals in the region is estimated as follows:

Cattle : 350,000 (in 1989 50,000 extra came with Angolan herders)
Donkeys: 100,000
Horses : 5,000
Goats +
Sheep : 380,000
Pigs : 6,000

Source: as above.

Because of the limiting physical conditions (frequent droughts, unfavorable water supply conditions), limiting colonial management and instability, the region's economy has in the last 10 years hardly improved for the large majority. In fact, unemployment is increasing rapidly, as a result of the recent influx of returnees and also as a result of the departure of the S.A. troops, that created employment. When the UNTAG forces leave the area, unemployment of the male population may surpass 50%.

Since the German colonial period the Owambo population was used as a labour force for other areas in the south (mines etc.). It is estimated, that today about 77,000 Owambo-speakers live outside the region. Many more are leaving the area at this time. Efforts are being made, notably by SWAPO, to develop new agricultural areas in the southeastern part of the region.

Improved water supplies will have an important impact on the region. Reductions in animal deaths and increase in milk production would improve the economy, if water were available at all times for the animals and for irrigation of grasslands. The availability of sufficient safe water all year round will reduce child mortality and will improve general health conditions, as people at present have to walk long distances to deficient water points or draw water from polluted sources.

3. ASSESSMENT OF THE WATER SUPPLY SITUATION

The water supply situation was assessed via direct observation, the use of a village-level questionnaire and via collection of key information from governmental and voluntary agencies, who are involved in the supply of water in the region.

3.1.General overview

The water supply situation for the majority of the rural population of Owambo is extremely bad.

During the wet season (from November or January to April) drinking water is directly taken from numerous pools of surface water, called 'oshanas'. These 'oshanas' are formed by the rains, due to the fact that the terrain is mostly flat and that the topsoil is impervious. Livestock drink from the same pools. The oshanas form breeding places for malaria mosquitos, leading to many cases of the disease. The water is heavily polluted and diarrhoeal diseases are rampant.

During the dry season from April to November (or January, during droughts), the oshanas dry up rapidly and the people dig pits in the oshana beds. The water level drops and deeper holes are dug, that collapse and have to be dug again. During the months of July to September the water has to be taken from deeper levels and the water becomes brackish or even saline.

When the pits have dried up or the water becomes too saline, the majority of the people have to obtain water from the main Owambo pipeline, at variable distances from their house, but distances of 30-40 km are not exceptional. Here masses of people and animals queue up to tap water from rudimentary public standpipe areas. Sanitary conditions are inadequate.

3.2.Review of the available water supplies

3.2.1.The Owambo Pipeline System

The Owambo pipeline system is the single largest water supply structure in the Owambo region. It is a 770 km canal-pipeline system, that was designed in 1965 to resolve the gigantic problem of providing a reliable, permanent supply of water to the growing towns of Oshakati and Ondangwa, the military camps, the airports, industry, hospitals, mission centres, water for irrigation, for cattle watering, etc.

However, from the onset no priority was given to the water needs for the rural population.

Construction of the pipeline-canal system started in 1968 and the main tracee was completed in 1973.

Water is pumped from the only permanent river in the region, the Kunene river in the extreme northwest at Ruacana.

A total amount of water equal to 0.4 m3/sec (34,560 m3/day) is pumped into the system and is distributed by gravity as far as the town of Oshakati on the main pipeline. and to the village of Okahao on the so-called 'south-pipeline'.

The water is chemically treated at Ogongo. The capacity of the plant is capable in the present set-up to purify about 0.8 m3/sec. At 11 centres additional water is used from 'oshanas'. Small treatment plants of 20-200 m3/day capacity purify the oshana water and add it to the system. They only work during the rainy season, when the oshanas are filled. These pump storage reservoir systems serve as additional water intake areas, in some cases as small autonomous systems, as for Elim, and in some cases as emergency back-up system, as for Oshakati.

Some 23 growth points are thus supplied with purified water. At each 'growth point' the water is pumped into a water tower, an elevated tank or a distribution reservoir. Reportedly at some 180 locations take-off points have been constructed to serve the rural population along the line.

Parts of the conduct (total length of some 150 km) were layed out as canals (see discussion in section 3.2.2.).

The system has been marginally extended in recent times. Presently an extension pipeline is being built to connect Ogongo on the main pipeline with Okahau on the southern pipeline.

The present length of the system is 770 km (680 km of pipeline and 90 km canal). The extension Ogongo-Okahau will add another 43 km, bringing the length of the pipeline to 813 km. This section is to be completed by February 1991.

A schematic plan of the Owambo pipeline-canal system is presented in Figure 3.

The scheme was originally designed to take water from the Calueque dam in Angola, located higher up on the Kunene River. Two pumps of a combined capacity of 6 m3/sec (518,400 m3/day) were installed by the S.W.A./Namibian Department of Works. A border agreement between the Union of South Africa and Portugal signed in 1926 formed the basis of this international agreement.

Due to the war between the R.S.A. and Angola, the Calueque intake was lost and the present Ruacana emergency pipeline was built. The dam also became damaged by bombing.

It is now certain that Angola will agree to independent Namibia to recommission the Calueque scheme. Plans are being made to have the scheme in operation by September, 1990.

Plans are also being made to increase the treatment capacity at Ogongo. Probably a larger treatment plant will be built at Oshakati. The new Master Water Plan for the Owambo region is in preparation. It is scheduled to be completed in March 1990.

Once the Calueque scheme is operational, the system can supply the estimated water demand for the year 2005:

So far no serious efforts were made to serve the rural population with water from this pipeline, although more than half of the population depends on this lifeline of water during the dry season. Provisional standpipes were reportedly installed at some 180 locations along the network. At inspection about 110 of these were operational. Recently about 20 circular basins have been built to allow animals to be watered. None of these take-off points can be considered adequate as public standpipes.

3.2.2.Canals

Parts of the Owambo pipeline-canal scheme are built as open canals. The main canal has a length of 90 km (Olushandja-Ogongo), is concrete-lined and is capable to convey 3.2 m3/sec. A small canal of 9 km supplies water from the main canal to the village of Elim. Another canal, presently not in use, is the canal between a former intake point of the system at Calueque, in Angola and Olushandja. This canal has a length of about 50 km, is concrete-lined and is capable to convey 6 m3/sec.
Integrated in the Owambo Pipeline are two canals.

The local population living on either side of the canals dip their buckets in the canal to fetch water. There are no provisions for supply of drinking water to the rural population, nor for the animals. Yet, not surprisingly, the canal is used as a public water supply system, which causes damages to the canal.

Another canal runs roughly between Ogongo and Oshakati. It is an old unlined canal, that was built to drain water from the oshanas to lead it to pump-storage dams for the water supply for Oshakati, before the pipeline was built. This canal is no longer maintained by the Department of Water Affairs. It does, however, serve as a source of water for the rural population, although it will likely dry up during the dry season. Again no provisions were made to serve the riverine population. As a consequence they serve themselves, as they have few other sources of water. The canal has a length of some 50 km.

3.2.3.Oshanas

During the rainy season, as a result of the poor infiltration capacity of the subsoil, numerous oshanas develop all over the Owambo region. As the rainy season progresses, different oshanas will interconnect, and similar interconnected oshanas from higher up in the Cuvelai-drainage system in Angola will flow down intothe area. feeding the oshanas lower down. The area then is one large braided river system of immense dimensions. In certain years the so-called 'efundja' or flood comes, meaning that virtually all oshanas interconnect and the area becomes flooded.

Naturally the rural population uses the oshanas for their water supply and for their animals. The water is scooped up from the oshanas and is used directly. As the water is not protected, it forms an enormous health risk. Water-borne and water-contact diseases are therefore rampant.

3.2.4.Shallow unlined pits

When the dry season starts, the oshanas dry up and, where no other water supplies are available, the people dig pits into the oshana beds, to tap the sweet water available in lenses on top of the brackish water in the subsoil, until they tap also the brackish water, as the dry season goes on.

Numerous such pits are dug in the course of the dry season. No lining is applied. Due to the flowing sand in the subsoil all these pits collapse and have to be dug out again. Some pits become bigger and bigger. They are deepened, until this is no longer possible or until the salty groundwater water underneath the fresh water lense is tapped. When the rains finally arrive all these pits are left, collapse and form a hazard for goats, that fall in them or rubbish collects in them.

3.2.5.Excavation Dams

The Administration's first approach, prior to the construction of the pipeline, was to build basins to store water from direct rainfall, supplemented by water from 'oshanas'.

Excavation dams or 'gat-dammen' were constructed simply by deepening oshanas and building up the walls on three sides with the excavated material. The basin formed would be lower than the original oshana and could drain other surrounding oshanas.

The basins were deepened to a limited depth in order not to tap the brackish water. The basins allow surface water to last longer into the dry season, as evaporation takes place from a smaller surface area.

About 60 large excavation dams with capacities of 6,000-15,000 m3 were built by the Department of Water Affairs during the period 1920-1965. In addition up to 250 smaller basins were constructed. They occur all over the central area of the region..

As no maintenance works have been done on these basins in the last 10-15 years, most excavation dam basins are to a great extent silted up.

3.2.6.Pump-storage dams

Another type of basin constructed by the Administration was elevated. The bottom was then deepened as well. Water was pumped in the basin from surrounding oshanas. Some 10-15 of these pump-storage dams ('pompstoor-dammen') are still in use, as in Elim and Oshakati.

Some 65 pump-storage dams were constructed by the Department of Water Affairs. Some others were constructed by the Owamboland Administration. They occur mostly in the central part of the region, but some occur also in the northeast.

Their capacity ranges between 6,000 (approx. 35mx50x3.5m) and 15,000 m3 (approx. 50mx85mx3.5m)

Also small treatment plants in which flocculents were used, were built at some pump storage dams. With exception of those that are still in use by the Department of Water Affairs, no maintenance works have been done in possibly 10-15 years.

The pumps of the systems that were abandoned are probably out of order and many of the basins have been silting up.

Several of these reservoirs were lined with concrete slabs. Schematics of the Pump storage dam are given in Figure 5.

3.2.6.Boreholes with motorpump,windmill or handpump

Underneath the entire most populated central area the groundwater is saline. However, where fresh groundwater occurs, in the extreme west and in the east of the region, this fresh groundwater is exploited.

Borehole drilling was undertaken by both the central administration and the Owamboland Administration. Most boreholes were drilled for the Owambo Administration, often contracted by individuals.

Up till 1978, 165 boreholes were reportedly in production. From 1978 to the present some 55 new boreholes were drilled and taken in production by the Ovamboland Administration. Some 50 are located in the south-east (Omatale) and were drilled in the period 1979-1989. Another 5 are located in the West and Northeast and were drilled in 1989.

No information could be collected on the number of unsuccessful boreholes and only sparse information is kept on the production of boreholes. Insofar as data were recorded, they are collected by the Department of Water Affairs in Windhoek. Chemical analyses were carried out on water samples from each of the boreholes. The data were compiled by the geohydrology section of the Department of Water Affairs in Windhoek and synoptic maps with iso-concentration lines were developed. So far no hydrogeological cross sections were made and little is known about the aquifers, their differentiation and their characteristics. No monitoring of static water level or water chemistry has been carried out.

A number of boreholes is taken out of production, because the water is unfit for human consumption. Some boreholes are in production, despite the fact that the water quality is unfit for human or animal consumption. Excessive concentrations of salts (mostly sodium chloride), sulphate, nitrate and fluoride occur in the groundwater in most of the region. The iso-concentration maps for total dissolved solids, fluoride, sulphate and nitrate are given in Appendix 5.

The borehole locations of 160 boreholes are given in Figure 4.

Static water level data from the boreholes were compiled and a contour map was produced for the main water table aquifer. Fresh groundwater flows in from the West and the East, and meets in the center underneath Oshakati and Ondangwa, where it mixes with salt and flows towards the Etosha Pan in the South.

Although 83 pumps were initially equipped with windmills, most of these have now been replaced by diesel pumps, as the performance of the windmills was not satisfactory. Windless days were reportedly too numerous. Some 10 windmills are still in operation.

Next to most boreholes, reservoirs have been built, ranging in size from 1.5 - 15 m3.

Only 124 boreholes are being serviced by the Administration at the moment, namely those south of the border in the southwest and the 50 in the Omatale area in the southeast. Some 95, located in the border area, have not been serviced for 10 years because of the war.

A few boreholes have been constructed by private organizations. Those that were identified during the mission are listed below:

* Catholic Mission

The Catholic mission in Oshikuku has a light drilling rig, shipped in from West Germany. Some 13 testholes have been drilled in the Oshikuku area, but all yielded brackish water unfit for human or animal consumption. No pumps were installed. The rig has not been mobilized in the last 6 months. It is capable of drilling to some 30 meters depth.

* Anglican Church

The Anglican Church also has a drilling machine, at Odibo, that has been out of order for some time. Apparently one borehole was drilled with this rig in Onekwaya. The borehole was, however, abandoned, because salty water was hit. No other data could be collected on boreholes drilled by this Steyn cable-tool rig, manufactured in Johannesburg, R.S.A. As the company reportedly has gone bankrupt, no spare parts can be obtained anymore.

In the context of a new water project a new cable-tool rig has been ordered from the R.S.A., a Prinsloo Harvester P.H. 505. The rig is capable of drilling to some 90 meters depth.

* Council of Churches of Namibia (CCN)

The CCN has in 1989 contracted out the drilling of one borehole at Omangete. The depth of the borehole is 28 meters and the borehole has been equipped with a monopump.

The water is reportedly fresh. No further details are known.

* Rural Development Centre (RDC)

This centre, constructed and operated by a private Namibian firm named WESDEV, has two drilling outfits. One is a Zimbabwean-made 'Vonder' rig, designed on the basis of appropriate technology. It is simply operated (labour-intensive operation) and in a few days a 10-15 meter borehole can be drilled. The other rig is a recently acquired a tractor-mounted power auger drill 'Super Rockdrill'.built in the R.S.A.

So far 6 test holes have drilled with the Vonder rig around Ongwediva and 1 borehole has been drilled for a client in Onalulago near Oniipa. All holes, with depths ranging between 6 hit saline water (Onalulago well: total dissolved solids was 4,250 mg/l).

With the power drill only 3 testholes were drilled around Ongwediva. All wells hit saline water.

No geophysical exploration prior to drilling is done in this programme. The RDC offers its services to clients, who pay a flat rate of R. 2,500. Three holes will be drilled. The risk is entirely the client's.

3.2.7.Hand-dug wells

3.2.7.Hand-dug wells

-Lined hand-dug wells with handpump or windlass with bucket:

An estimated number of 150 lined hand-dug wells have been constructed in the region to date. 44 of these were built by the Administration before 1978. The locations of these wells are not reported. They are all equipped with handpumps, but most if not all of these handpumps are out of order. Also most of the wells themselves are silted up or filled up by the people and do not now serve as sources of water.

*CATHOLIC MISSION, OSHIKUKU

Since 1983 some 62 hand-dug wells were lined with concrete rings supplied by the Catholic Mission in Oshikuku. These wells belong to individuals, who bought the rings and pump from the Mission at cost. Also the transportation of these items was paid by the 'clients'.

The wells are located in the following 30 villages:

Oshikushomunkete	4	Eparara	3	Oneeya	2
Okathitu	5	Omusheshe	1	Ongwediva	2
Okatana	1	Okathima	3	Epandulo	2
Oshinyadila	1	Oshulula	1	Eheke	1
Oneeya	3	Amutanga	4	Okarongo	2
Otshikushashipya	1	Etayi	1	Onandjamba	1
Ehafo	7	Omege	2	Oniipa	1
Omusimboti	2	Onembamba	1	Udhingero	3
Onakatambilili	1	Ondjondjo	2	Omagongati	4
Uukwanashikare	1	Iiputi	1	Uudhingero	1

Depths of the wells:

The depths of the wells range between 3.00 m. and 10.20 m. The average depth ranges between 6.00 m. and 7.00 m.

Water quality:

No exact data are known about the quality of these wells. In general they will turn more and more brackish towards the end of the dry season, as long as they still yield water. Some people know when they will hit brackish water and do not dig the well so deep. The well will then run dry sooner.

Most wells that become brackish, turn sweet again during the next wet season until the depth of the brackish water is reached again. However. when a well with sweet water is overpumped, brackish water will flow in sooner.

Yield:

No exact data are available on how long these wells yield water during the dry season. In general these wells all run dry.

*COUNCIL OF CHURCHES OF NAMIBIA

Since 1988 the Council of Churches of Namibia (CCN), from its center at Onpeetha has constructed 8 hand-dug wells, 2 of which were equipped with windmills and the remaining 6 equipped with hand pumps. The wells were constructed by CCN foremen, assisted by the beneficiaries, usually the Church members and villagers. The rings, pumps, transportation and services are provided free of charge to the beneficiaries.

The villages where the wells are constructed are the following:

VILLAGE	TYPE OF PUMP	EXTRA PROVISIONS	YEAR OF COMPLETION	DEPTH OF WELL
Oshitambi:	windmill	-	1986	10.5 m.
Okakwa :	handpump + watering trough		1986	15.0 m.
Onambango:	handpump + watering trough		1987	12.0 m.
Ouhongo :	windmill+15 m3 plastic tank + watering trough		1987	15.0 m.
Ongenga :	handpump + watering trough		1988	10.5 m.
Omatumba :	handpump + watering trough		1988	9.0 m.
Enongelo :	handpump	-	1989	9.0 m.
Onanadi :	handpump	-	1989	6.0 m.

Four other hand-dug wells are under construction. These are located in the following villages:

Onangubu :	-	-	1990
Okumukwa :	-	-	1990
Okambebe :	-	-	1990
Onangali :	-	-	1990

All wells are located in the area between Elim and Engela in the center-north and reportedly yield fresh water. Progress is, however, very slow. The CCN water section consists of 3 Coordinators, each covering an area in the Ovambo region. However, a single pick-up truck has to be shared among the three. Start-up delays must have contributed to the slow start. For the current year funds are available for the construction of 30 wells and the installation of pumps, handpumps or windmills.

* ANGLICAN CHURCH

In the past a water supply scheme was working at the Anglican Mission center and hospital in Odibo in the central-north, just east of Oshikango on the Angolan-Namibian border. The scheme was operated by the Department of Water Affairs.

3.2.8.Rainwater collection systems

Few rainwater collection systems are constructed in the rural areas, as gutters are expensive. Major systems have therefore only been built at mission compounds (churches and hospitals).

3.2.9.Water reservoirs and supply by truck

Tanks of galvanized sheet metal are used by many cattle farmers. The tanks have a capacity of about 3 m3. The cost is about Rand 900. Their life time is only about 5 years, as the thin sheeting material corrodes.

Also plastic tanks are used here and there. They are more expensive than galvanized sheet metal. For 3 m3 the price is about R 1000. They do not corrode, but can easily get perforated.

The Catholic Mission in Oshikuku builds tanks of concrete rings. To date it has supplied concrete rings to built 132 water reservoirs. Each reservoir is built of 2 to 6 concrete rings of a height of 0.60 each, that are stacked upon each other. The reservoirs are based on a concrete foundation and are best buried in the ground. Water is hauled in barrels from the pipeline and pumped into the reservoirs. The rings are supplied at cost: R 50 for dia. 1.50 m and R 70 for dia. 1.60 m. Transportation is charged at R 1 per km. for 6 large diameter rings or 8 small diameter rings.

The reservoirs once installed are filled with water. This is normally collected from the Owambo pipeline and transported in barrels by pick-up truck. However, only very few people can afford this type of arrangement.

Due to a lack of water during the period November-mid January, truck transportation was done by the Department of Water Affairs to supply water from Oshikuku to the village of Elim. Also the UNHCR complemented water in this way for the returnee reception center in Odibo.

4.EVALUATION OF UNMET NEEDS AND ADDITIONAL WATER POINT REQUIREMENTS

In order to evaluate the water supply coverage of the population, criteria must be defined as to what will be considered as an adequate water supply.

4.1.Criteria for an adequate rural water supply

4.1.Criteria for an adequate rural water supply
-Access to safe water

The latest UNICEF policy is to consider a person to have access to potable water, when the person lives 1000 meters from a protected water point, delivering 20 liters per day per person living in the defined range, with the water quality conforming to the W.H.O. standards. It is further desirable that one water tap serves a maximum of 200 people.

-Coverage

Coverage is defined as the percentage of the urban, rural or total population of a country, region etc. having access to safe drinking water as defined above.

-Livestock

Animals should be kept out of public water supply points proper (by bush or tree fences or other efficient low-cost fences). In traditional watering places, such as rivers, lakes and oshanas, special provisions should be made to reduce contamination of the water sources and to reduce cross-contamination among the animals.

4.2.Drinking water coverage in the Owambo region

Based on the criteria presented above, it is estimated that only about 20% or roughly 125,000 people of the Ovambo region population presently has access to an adequate source of safe water.

This estimation assumes that 22,000 people in the rural areas have more or less adequate access to the 110 functioning standpipes of the Owambo pipeline system and 21,000 are served from boreholes and hand-dug wells, plus an additional 82,000 people in the urban areas. The numerous people using non-official pipeline connections have not been included in the estimation.

4.3.Requirements for additional drinking water points

Based on the projected population growth, the Owambo population will reach at least 800,000 people in the year 2000. In order to provide access to safe water for each of them, adequate water points will need to be constructed for some 675,000.

Assuming the average number of people in a radius of 1,000 meters around each water point to be around 200, a total of 3,400 new waterpoints would have to be created and/or existing ones upgraded. In addition water points have to be created at public gathering places, such as market places, health centers, schools, churches, bus stations etc. Assuming that another 1,000 of these will be needed by the year 2000, the total of rehabilitations or new constructions of water points needed is estimated at 4,400.

5.RECOMMENDATIONS

5.1.Strategy

The rural areas of the Owambo region have not yet gone through a stage of development, when most African countries were going through this process in the 1970's. A start has to be made now to make up for this set back in development.

Water supply is crucial to this development and it is crucial to improve the health conditions among which those of the children, the most delicate group of society. Water is finally crucial to improve the economic environment, most notably through improving cattle raising and agriculture as they form the traditional occupations in the region, through improving the ecological conditions, as they are rapidly degrading and through creation of new work opportunities, as unemployment has come to a staggering 50% plus. It is therefore of prime importance that priority will be given to rural water supply.

The physical conditions in the Owambo region are not directly favorable to develop reliable, low-cost community-based water supply systems.

Yet, as UNICEF supports this type of approach, the strategy here presented will identify the potential of this option.

Large-scale pipeline systems do not fit in this philosophy. Yet, the Owambo pipeline is there and special efforts can be made to integrate the pipeline in the community-based approach to supply drinking water to the rural population.

Two parallel approaches are recommended to add 4,400 reliable public water points to the Owambo population by the year 2000, as follows:

1. UNICEF assistance to the Department of Water Affairs in the upgrading of the take-off points of the Owambo pipeline to transform them into true public standpipe areas.
   A social mobilization component should go hand in hand with this activity, to create awareness of the importance of keeping the standpipe area clean and to take responsibilities for the upkeep of the constructions and the taps.

   Upgrading of existing standpipes can be done directly for some 70 areas, while 55 other points in the pipeline can easily be transformed in public standpipe areas (from communication with DWA-Ochakati). Studies should be done to see how the pipeline can provide more public take-off points, possibly up to 550 by the year 2000 (less than 1 standpipe per kilometer/from communication with DWA-Windhoek).

2. UNICEF assistance to the Department of Water Affairs (Rural Water Supply section) in the exploitation of oshanas and shallow groundwater, particularly in the populated areas away from the pipeline. These projects are true community-based rural development projects and they involve the construction of dams and hand-dug wells with handpumps.

   This project exploits the three positive factors in the Owambo region's physical conditions: sandy soil, that is favourable for digging wells, the surplus of water during the rainy season and the quasi-impermeability of the top soil, that allows the construction of dams and reservoirs without liners. More fresh water lenses should be present in the subsoil, than may seem. Especially under higher elevations in the ondulating landscape, as fresh groundwater will build up higher in those places, than in depressions (Ghyben-Herzberg relationship). To determine these locations, geophysical surveys need to be done.

   The community should be involved in these activities right from the planning phase on. Then, dam sites and wells can be dug by intensive labour or by using heavy equipment. The first option would provide much-needed employment and would bring cash or food (food-for-work) to the local population.

   At least 3,000 hand-dug wells with good yields (10-20 m3/day) would be needed for communities, schools, clinics etc to reach the objectives for the year 2000. In possibly 500-700 locations excavation dams or pump-storage dams would need to be made. The reservoirs thus created, should be layed out in a way that cattle can be given water via direct pipes (gravity flow), connected to the reservoirs. Watering troughs should then be built and fed by these supply pipes from the reservoirs.

   The reservoirs then serve to supply water to the livestock and serve to recharge fresh water to the dug wells, constructed nearby.

   In the case of pump-storage dams, water can be piped down by gravity to slow-sand filtration tanks, which purify the water for human use. No hand-dug wells are needed with such a set-up and large schemes can be designed to supply communities of several thousands of people. In a number of African and Asian countries slow-sand filtration schemes are now operational. For expert advice the International Reference Centre (for the International Water and Sanitation Decade) in The Hague, the Netherlands should be contacted.

The foregoing two (2) approaches apply basically to the ent densely populated section of the Owambo region, as the ph conditions are strikingly the same, with only minor in the geology, drainage-intensity and infrastruct

In addition to the interventions described above, also boreholes can and should be upgraded and new ones should be drilled to contribute to the water supplies to the rural population (and livestock). Although deep groundwater is only of good quality in the extreme northwest (Ruacana) and the extreme east, exploitation of these resources should be planned in those areas. As there are now some 150 potentially good boreholes, by rehabilitation of those, that need it and by drilling new boreholes in strategic locations, a total number of 600 well-spaced production wells by the year 2000, seems possible.

No direct UNICEF involvement is needed, as the DWA and the Diocesan Water project have sufficient capacity to construct production boreholes in the indicated areas.

5.2.Project Proposal

No emergency interventions are proposed to alleviate the effects of the drought. Rainfall in January started late, but attained near-normal to normal depths. The problems of drought in the Owambo region are chronic. The type proposal formulated hereafter tries to approach the problem of water deficiency in a structural way, aiming at a better access to water all year round for man and livestock, attainable in the next 10 years.

The project and further similar projects presented here is suggested to be undertaken jointly with the Department of Water Affairs and the Health Department:

Proposal for Tsandi area water supply and sanitation components in integrated area-development approach

Population	:	20,000 (Uukwaluudhi tribe)
No. of returnees	:	3,000
No. of villages	:	44
Health problems cited by the people	:	diarrheas, malaria ad worms
Hospitals	:	1
Schools	:	2 (primary and secondary)
Churches	:	7 (4 ELCIN,2 Anglican,1 Catholic)

The population suffers as a result of a very deficient water supply situation.

Yet, the so-called "south pipeline" from Olusjandja to Okahau/Ongandjera traverses the populated northern part of the area. Tsandi has a pump-storage dam with a small treatment plant as a back-up for the pipeline. The water from the pipeline and pump-storage dam, when it is operating during the rainy season, is pumped to an elevated tank, from where it is distributed to 5 clients: the hospital, 2 (secondary) schools, the ELCIN mission centre and to the tribal office. From these centres, families living in the neighbourhood are supplied with water, along with the institution itself. Approximately 6,000 people have access to the pipeline water.

No public standpipes have been constructed off this pipeline. The pipeline could serve a great majority of the population, if public standpipes were constructed at strategic locations.

In addition the Oshona Etaka, a major oshana, crosses the area. Six excavation dams (Omaumba, Am Hole, Uuwale, Okalyambanda, Ombaadhiya and the Etaka No.2 dam) and one pump-storage dam (Tsandi dam) have been built in this oshana. There are 4 other dams in the area, draining smaller oshanas in the northeast (Okathitu Muutha), in the northwest (Ilyateko) and in the center-south (Iikokola). Yet, these reservoirs and dams were built in the 1960's and most have been silted up considerably.

Plans were made, by the Owamboland administration to use the natural oshana system and widen it and build a canal, that would connect in the north with the canal from Olushandja. The Oshona Etaka canal would then be fed by the water from the Kunene River.

In order to address the needs about 110 additional water points, 2 per village and (88) and 22 at public gathering places need to be created.

Recommended approach: (1) make a survey of the excavation dams; assess if they can be rehabilitated Also identify locations for new reservoirs, while the location of the villages and their specific water needs are also assessed.

(2) Plan a geophysical survey to locate fresh groundwater mounds.

The Diocesan Water Project in Odibo is planning to order geophysical equipment (resistivity and/or EM) and to train a team in doing the measurements. Link up with the DWP, oder the same equipment (standardization) and arrange for training of a DWA/Unicef geophysics team.

(3) Establish with the tribal, church and Swapo ward coordinators, village water committees in priority villages. Discuss the options of labour-intensive excavation work.

Contact the World Food Programme in Windhoek on the 'food-for-work' option. Excavation work should be done in the dry season: July-November.

(4) Plan the construction of the lined hand-dug wells to take place in the same period (June-November).

Link up with the Catholic Mission in Ochikuku. Decide on how many wells will be dug and if the present capacity of concrete ring construction of the mission is sufficient or if it has to be stepped up: more molds, more teams to be trained etc.) and decide on the procurement of a project 4x4 truck with a crane. Study the well construction techniques used and improve the operation. Develop exchange of ideas with Diocesan Water Project, who are starting up a hand-dug well construction project in Odibo.

The best 'state-of-the-art' technique for hand-dug wells should be applied: rings should have edges to fit each other, no-fines concrete for horizontal inflow, gravel or no-fines bottom to prevent sand to flow in the well and damaging the pump, safety precautions, dewatering while deepening the well till 2 meters below the lowest water table (saltwater interface permitting) etc.

(5) Decide on the type of handpump, that will be used in Namibia (standardization). Study performance of the Zimbabwan-made Blair pump, which is selected for use in the Diocesan Water Project. At the same time, decide on transferring knowledge on pump maintenance by the villagers themselves and on the distribution and cost-sharing arrangements for spareparts.

(6) Ask information and advice at the IRC in The Hague about slow-sand filtration technique. Possibly an IRC consultant should be retained, who would supervise the construction of a unit at a pump-storage dam site, possibly in Tsandi.

(7) Select favorable locations for public standpipes off the Olushandja-Okahau pipeline and submit to the planning and design sections of the Department of Water Affairs for the determination of the feasibilty at the selected locations.

(8) Co-design, with consultation of the beneficiaries, notably the women, a lay-out of a typical public standpipe area serving 1,000 people and livestock, determine a cost-estimate for the materials and decide on the cost-sharing arrangement for the construction of one or two standpipe areas and start-up construction. Possibly some 20 standpipes could be constructed to serve the Tsandi area population.

(9) Identify suppliers and procure the equipment and materials needed, well in advance of the time they are needed.

(10) After the village water committee is established and active, consider enlarging the scope to include all health issues in the village. Through training of the members of the new village haelth committee, motivate and instruct the committee members on the construction of household VIP latrines, compost pits for garbage disposal, soakpits etc., adapted to the flooding conditions during the rainy season.

(11) Construct demonstration VIP latrines, compost pits and soakpits for households.
Link up with the Catholic Mission for the development of pre-fab squatting plates and toilet bowls and promote full village coverage with household latrines.

(12) Consider launching a VIP school latrine construction programme, combined with health education at the schools: teacher training, teacher to student, student to parent etc. to support also the household sanitation programme.

The Tsandi area WATSAN project can serve as a pilot project, showing a model for the approach. Because the villages in the central Owambo region all encounter the same water and sanitation problems, the chances for a multiplication effect are excellent.

LIST OF FIGURES

Figure

LIST OF FIGURES

THE OWAMBO REGION

FIGURE 1

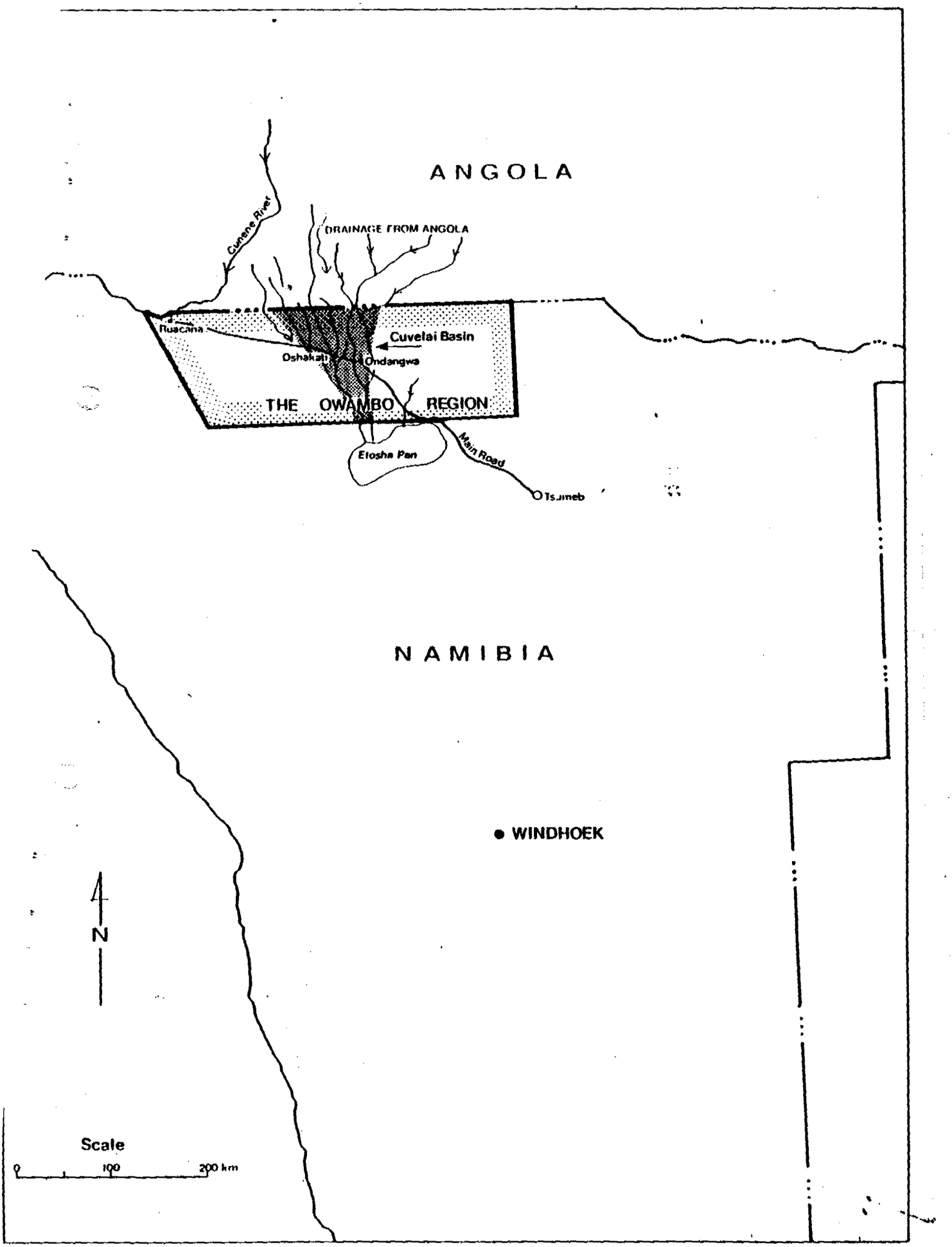
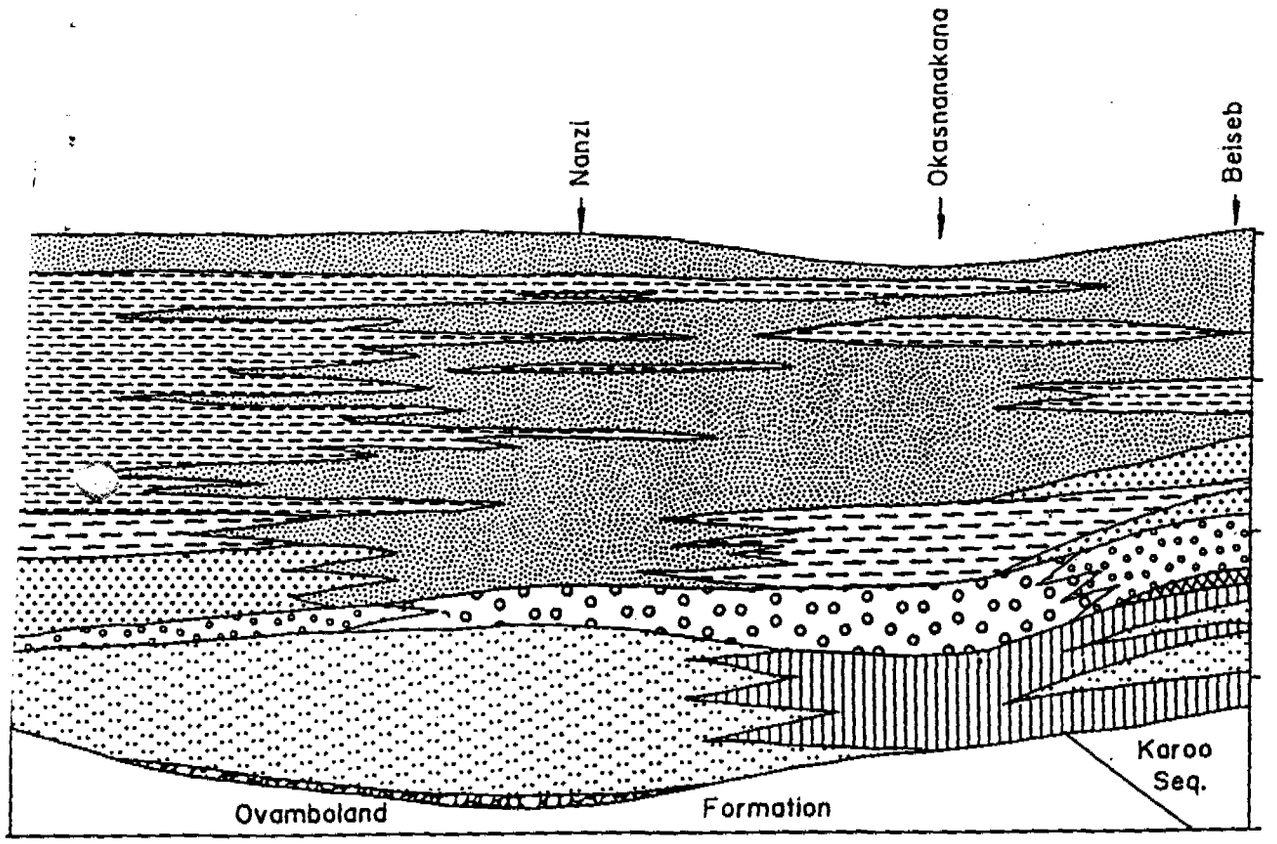


FIGURE 2



LEGEND

Light green to white calcareous sand, clayey sand, calcrete and dolcrete nodules in places

Light green clay, sandy clay, limestone lenses

Red clay, sandy clay

Red sand, clayey sand

Light green to white gritty, conglomeratic sand, locally clayey

Red gritty, conglomeratic sand, locally clayey

Red semiconsolidated sandstone, calcareous

Red slumped shale, with angular sandstone fragments

Red shale or clay, sandy in places, local sandstone and limestone lenses

Red conglomerate, calcareous, clayey

Andoni Formation

Olukonda Formation

Beiseb Formation

Nanzi Formation

Kalahari Sequence

FIGURE 3 A SCHEMATIC OVERVIEW OF THE OWAMBO PIPELINE SYSTEM

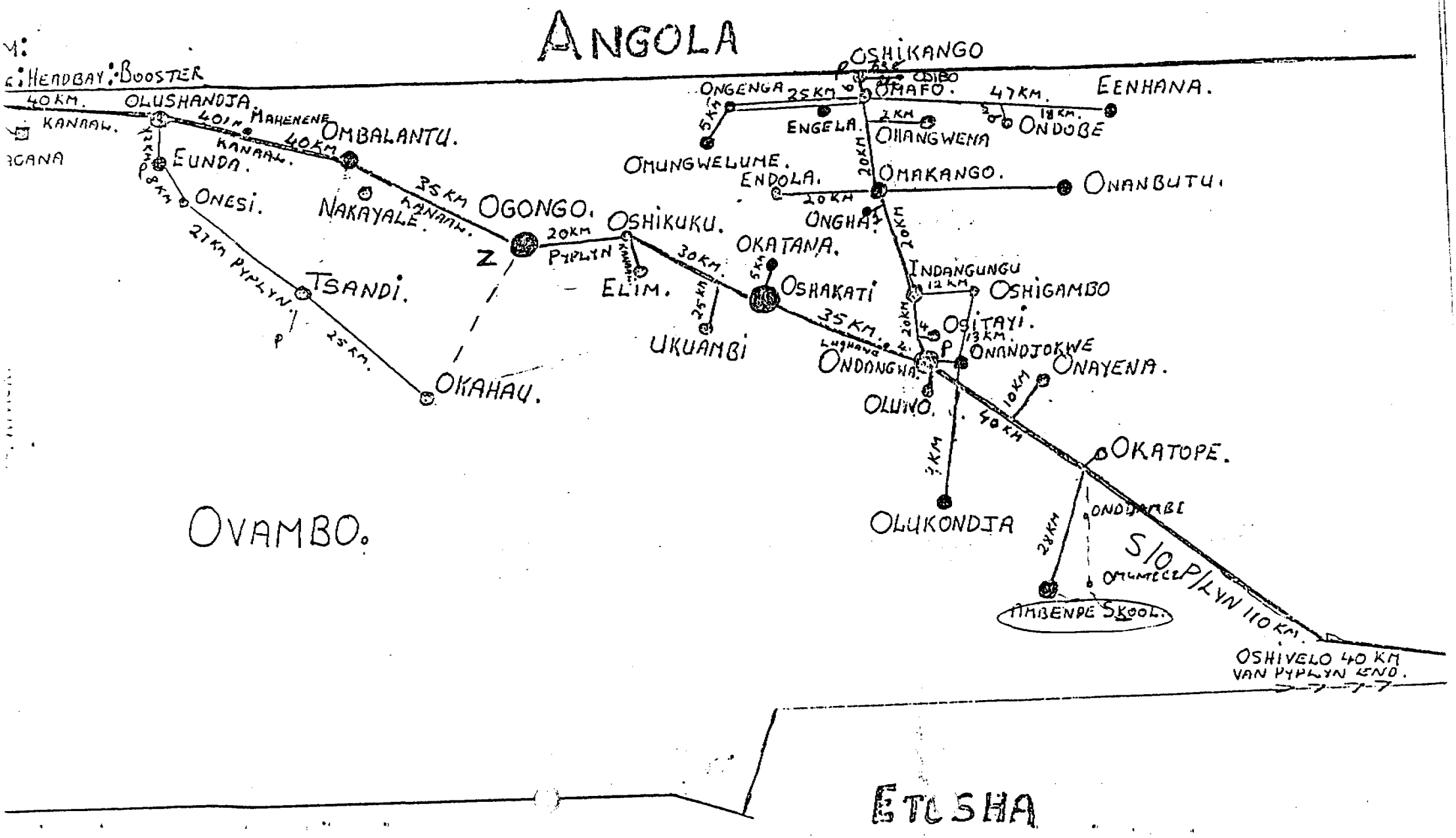


FIGURE 3 B TRACEE OF THE OWAMBO PIPELINE SYSTEM

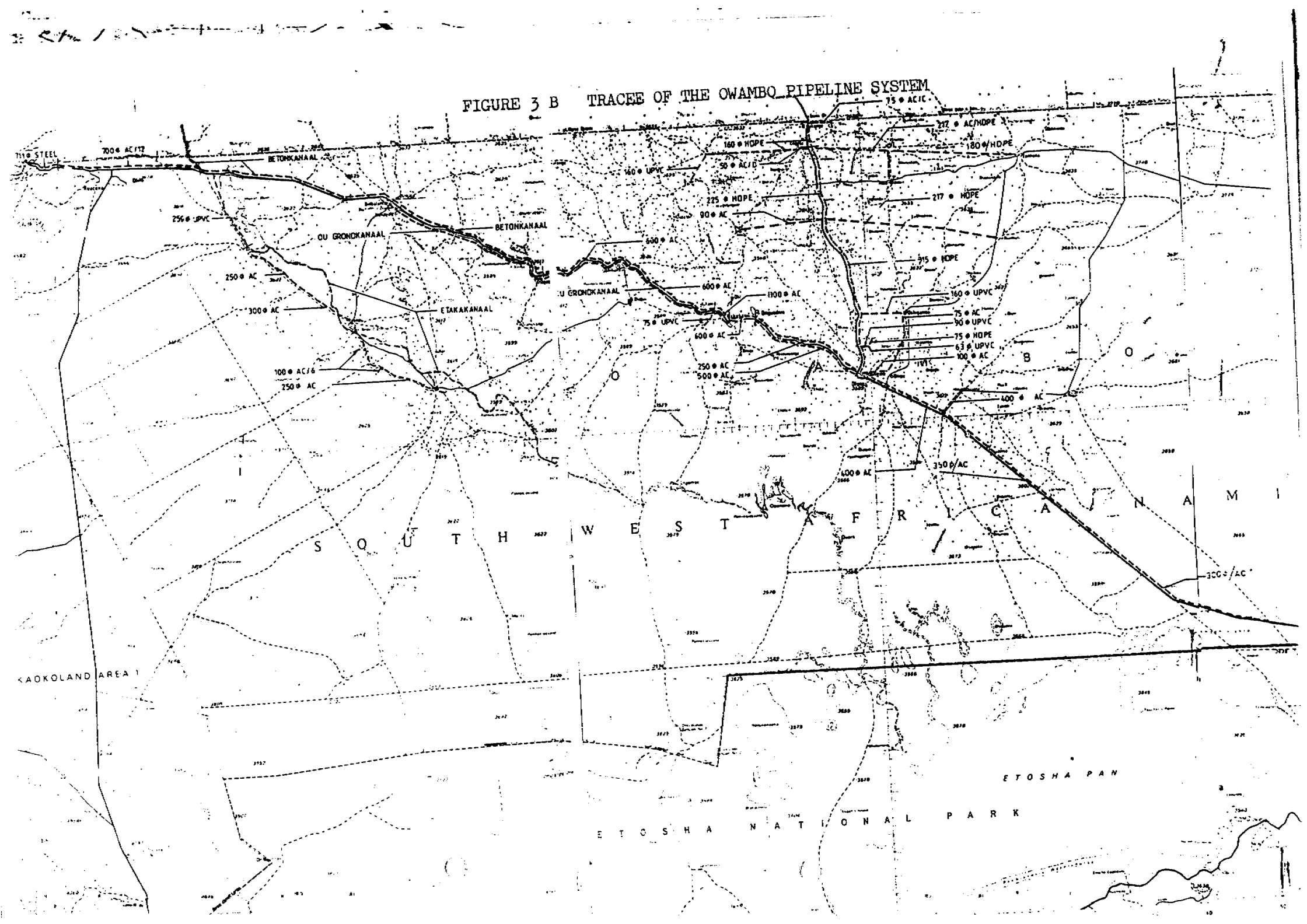


FIGURE 4. MAP SHOWING BOREHOLE LOCATIONS AND DAM SITES (1978)

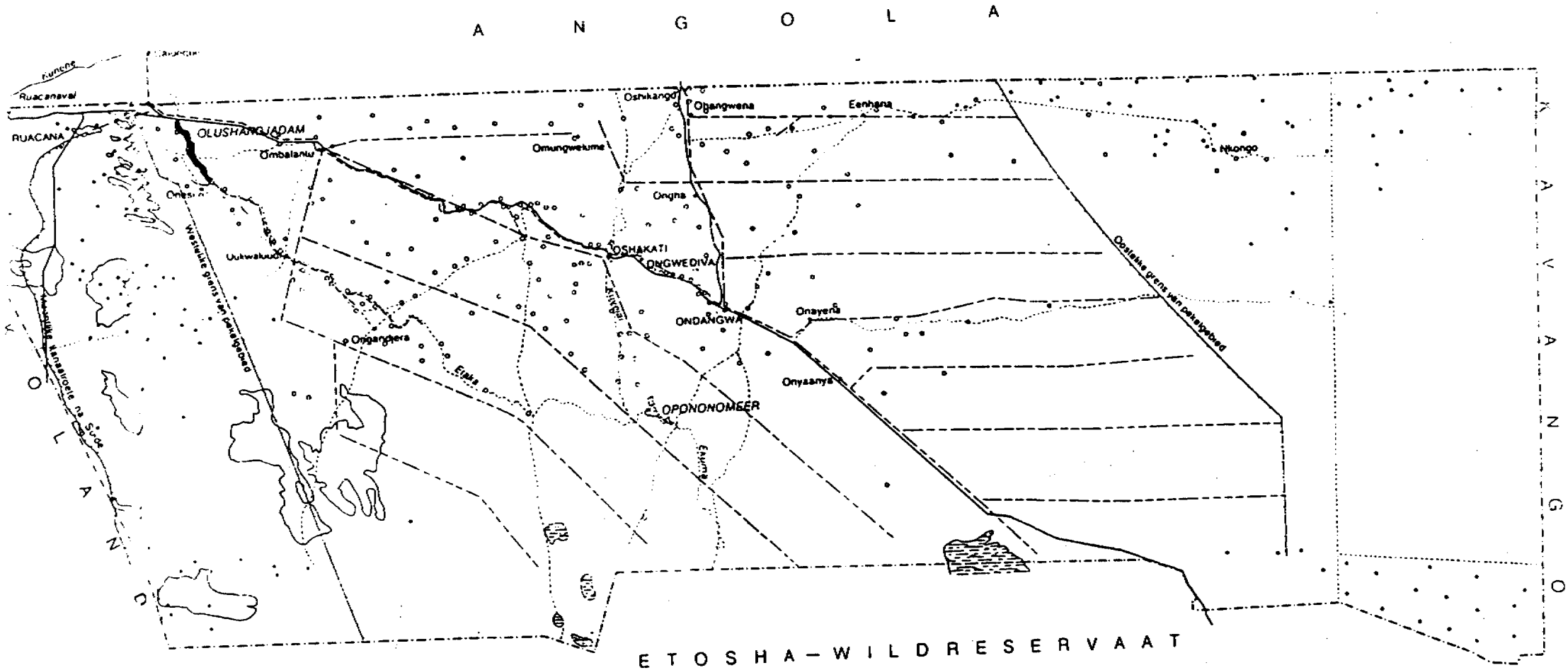
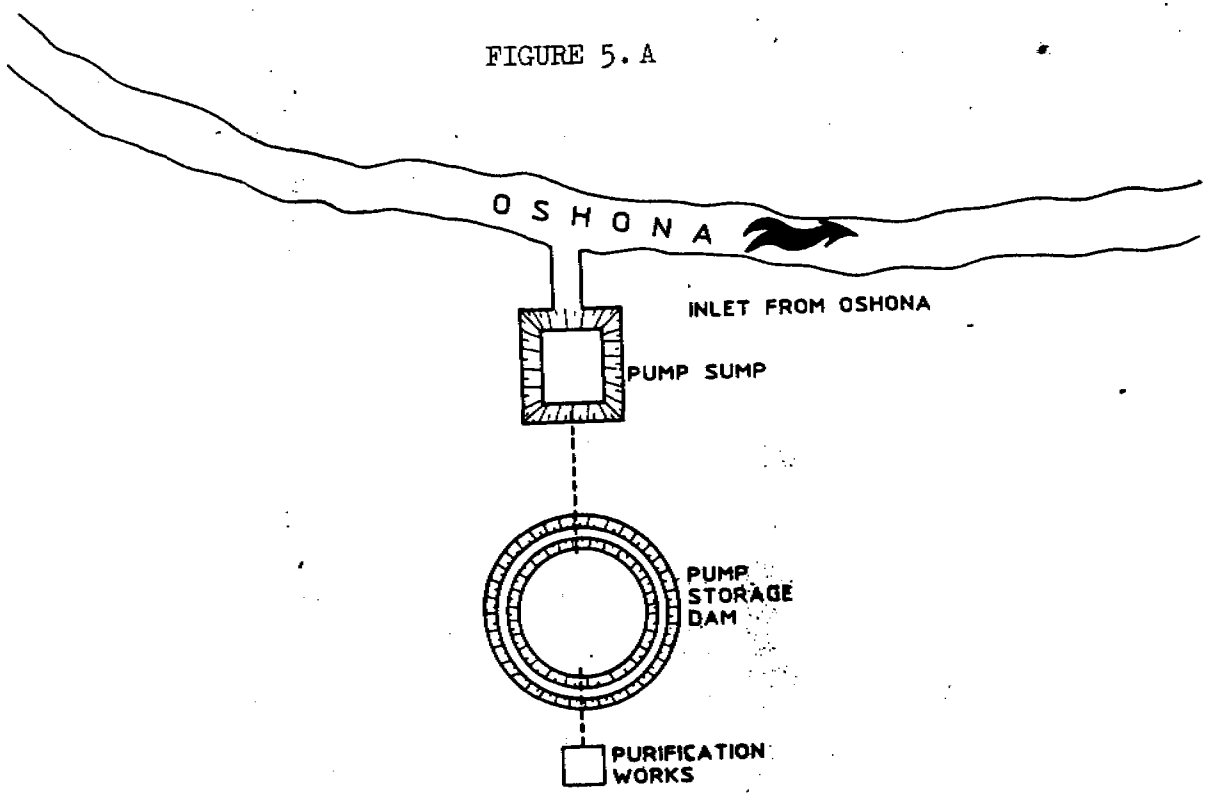


FIGURE 5.A



PLAN OF PUMP SUMP AND PUMP STORAGE DAM

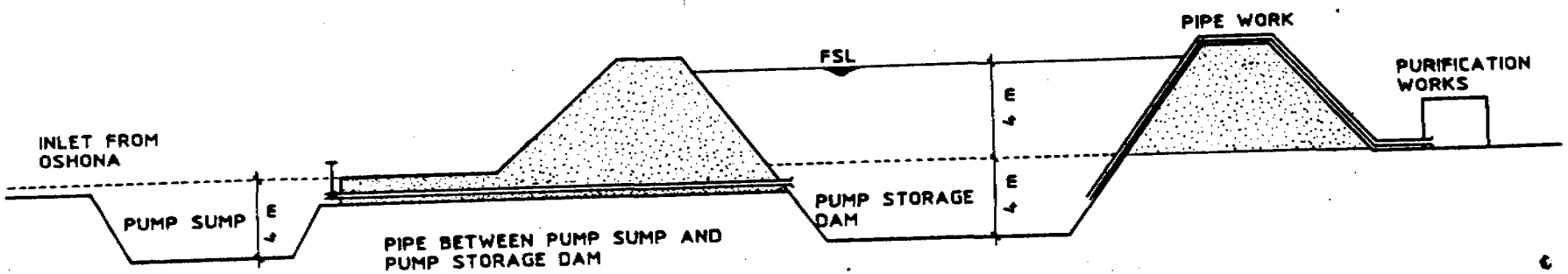
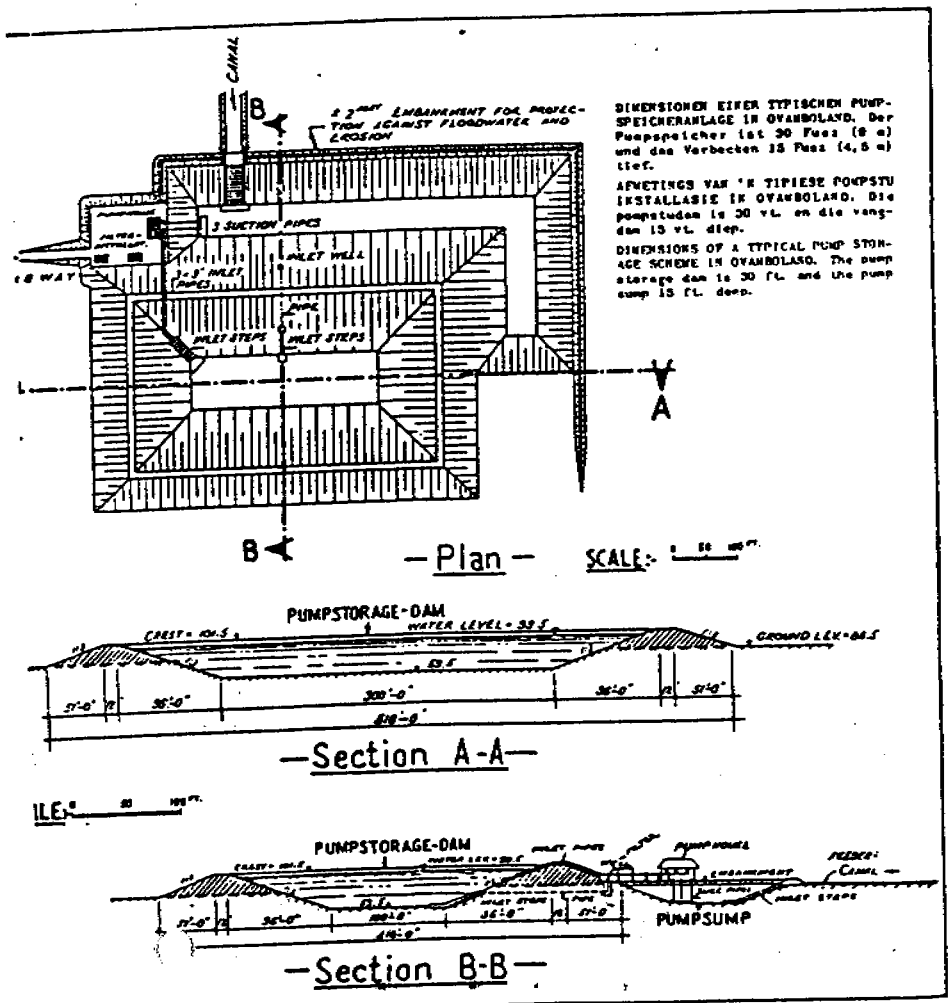


FIGURE 5. B SCHEMATIC OF PUMP STORAGE DAM

THE CANAL PROJECT IN DETAIL

July 1961, 70 miles of the first section of the canal had been completed. e records of the Water Affairs Branch from which the following details are ken, refer to an earlier stage of the work, namely when a section of 50 miles s completed. According to this, 6 of the 12 bridges for people, animals and ght vehicles had been built at intervals of 3 - 4 miles, and 5 of the 12 posed sluices were finished, each with a footbridge. When the sluices are en water flows through them to fill up the dams below. When they are closed ter dams up in the canal above for irrigation. At high flow water runs over e spillways 6 inches deep and flows into the oshanas south of the canal lnging them their share of the water.



DIMENSIONEN EIER TYPISCHEN PUMP-SPEICHERANLAGE IN OVAMBOLAND. Der Pumpspeicher ist 30 Fuss (9 m) und das Vorbecken 15 Fuss (4,5 m) tief.

AFMETINGS VAN 'N TIPIESE POMPSTU INSTALLASIE IN OVAMBOLAND. Die pompstudam is 30 vt. en die vangdam 15 vt. diep.

DIMENSIONS OF A TYPICAL PUMP STORAGE SCHEME IN OVAMBOLAND. The pump storage dam is 30 ft. and the pump sump 15 ft. deep.

APPENDIX I : TERMS OF REFERENCE MR. HANS D. SPRUIJT

Under the overall guidance of the Programme Section, UNICEF Windhoek:

1. Make an overall assessment of the current drinking water supply situation in rural areas of Ovambo, in the context of an actual or potential drought situation. This will include
   - a description of present sources of drinking water,
   - a description of any possible deterioration or change therein in the next few months and
   - prospects for improvement of community water supplies in the medium-to-longer term.

2. As a result of 1., make recommendations for consideration by UNICEF Windhoek and others, of possible measures and projects in the short and medium term, for improvement of rural water supplies in Ovambo on a relatively low cost, labour-intensive basis. Such projects will be described and technically detailed to the extent possible given the time limitations. The projects may be presented in a 'model-type' form, with indications of the sub-regions or locations where they would be applicable.

3. Make a review for UNICEF Windhoek of existing relatively low-cost rural water supply projects in Ovambo, carried out by Church bodies and the Rural Development Centre in particular, with attention to technologies used and their potential for replication or wider applicability.

4. Provide inputs based on the above for the planning and future implementation, with the RRR Committee of the Council of Churches in Namibia of the water component of an area-based project in Tsandi, subregion of Ovambo. This should include sanitation and health education elements.

5. A visit to Katatura may be added if time allows, to assess the water and sanitation in certain locations there.

Field visits will be preceded by discussions with Church/RRR representatives in Windhoek an a review of available litterature. A mission report will be provided to UNICEF-Windhoek before departure.

Visits in Ovambo will be made in conjunction with the UNTAG Regional Office (Mr. Magnusson) in respect of TOR No.1 above and with Church/RRR representatives in respect of the other Terms of Reference.

CCN	Mr Joseph Tatileni, Regional Coordinator, Water Section NW area Mr Johannes Hashoongo, Regional Coordinator, Water Section, Northern Area
RRR (ONGWEDIVA)	Mr Israel Shikongo
RURAL DEVELOPMENT CENTRE, ONGWEDIVA	Mr John Brown Mr Dave Rimmer
CATHOLIC MISSION, OSHIKUKU	Br. Gerhard Wiessemmuller
Anglican Church	Mr. Micheal Hishikushitja Director of St Marys Mission Odibo
Diocesan Water Project	Mr. Andrew J. Cook, Manager

APPENDIX 2

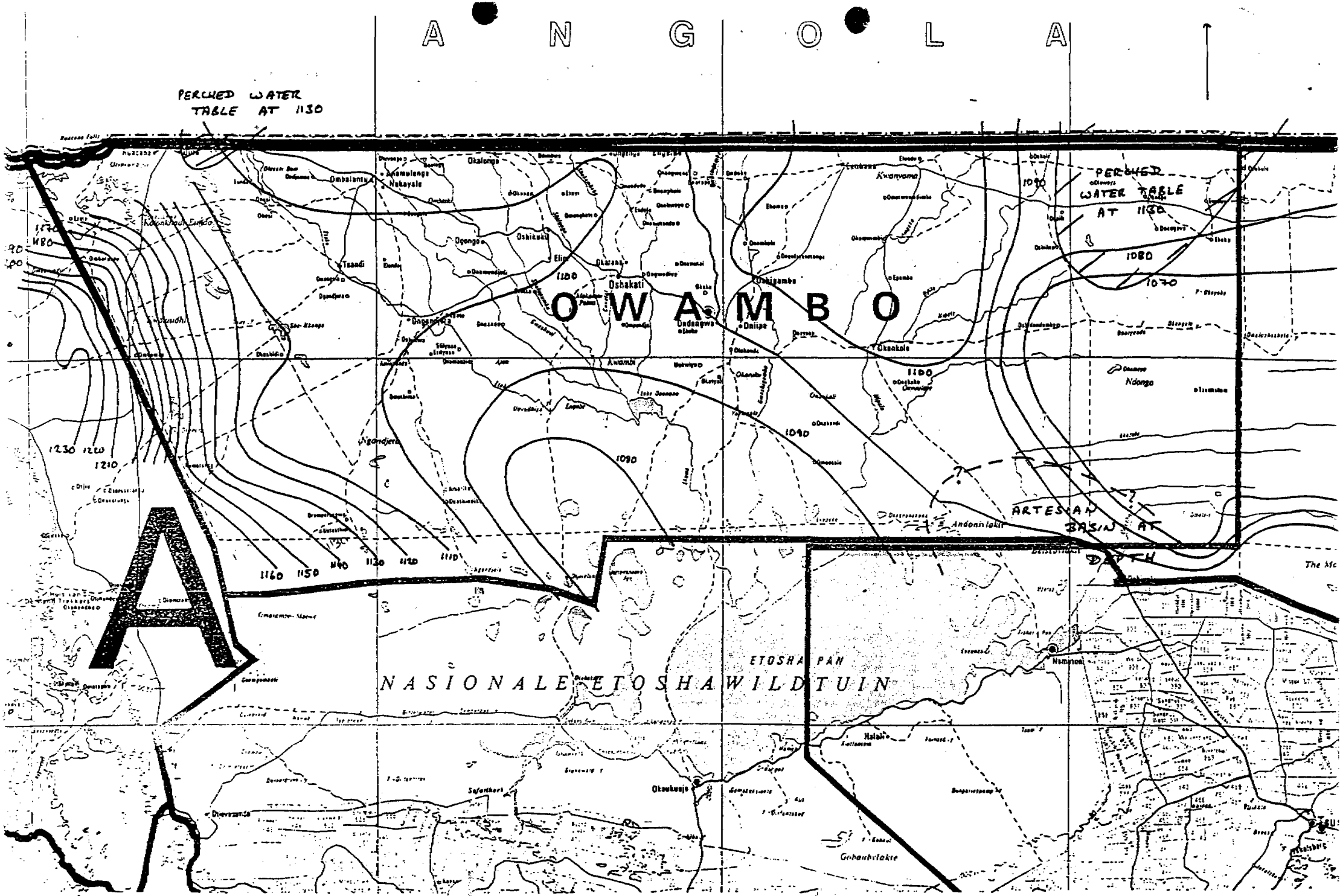
PERSONS VISITED

WINDHOEK

UNICEF:	Ms Shahida Azfar, Representative Mr Richard Morgan, Programme Officer Mr Jun Kukita, Project Officer Mr Macharia Kamau, Project Officer
RRR:	Mr Bert Lichtenberg, Coordinator Mr Richard Luff, Construction Engineer
CCN:	Mr Aloyisius Boys, Head of Water Desk
ANGLICAN CHURCH:	Mr Vincent Ndakalaku, Diocesan Secretary/Treasurer Diocese of Namibia
CATHOLIC CHURCH:	Father Noordkamp
DEPT. OF WATER AFFAIRS:	Mr Pedro Maritz, Secretary Mr Edwin Barbour, Head Geohydrology Mr O. Aldrich, Chief of Planning Mr Gregoire Lubovski, Planning Engineer Mr Nigel Hoad, Geohydrologist
GROUNDWATER CONSULTING SERVICES (PTY) LTD	Mr. Richard G. Fry, Director

OVAMBO REGION

UNTAG - OSHAKATI	Mr John Rwanbuya, Regional Director Mr Mik Magnusson, Regional Director Ms Pamela Maponga, District Officer
OHANGWENA	Mr Sergej Zelenev, District Head
OMBALANTU	Mr Brain Kelley, District Head
RUACANA	Mr Levon Debelian, District Head
UNHCR - Oluno	Mr Azfahar
SWAPO - OSHAKATI	Mr Simon Kaukungua, Oshakati Head of Centre Mr Nicky Nashandi, Head of Administration Ms Mathilde Namupa Nanyembu, Deputy HeadofAdministration
OVAMBO ADMINISTRATION (ONDANGWA)	Mr J Blaauw, Secretary Mr Keith Morrow, Snr. Agriculture Research Officer
TRIBAL AUTHORITIES	King Eliphas Kauluma, Ondonga King Taipoopi, Tsandi


A N G O L A
PERCHED WATER TABLE AT 1130
PERCHED WATER TABLE AT 1130
O W A M B O
ARTESIAN BASIN AT DEPTH
NASIONALE ETOSHAWILDTUIN
ETOSHA PAN
Namutoni
Okaukuejo
Halali
Gobabistakte
Andoniaki
Ndonga
Kwanyama
Ondangwa
Oshakati
Oniipa
Okaakole
Oshigambo
Ogongo
Oshikuku
Okalongo
Ombalantu
Nakayale
Tsandi
Ongandjera
Amumbi
1080
1090
1100
1110
1120
1130
1140
1150
1160
1170
1180
1190
1200
1210
1220
1230

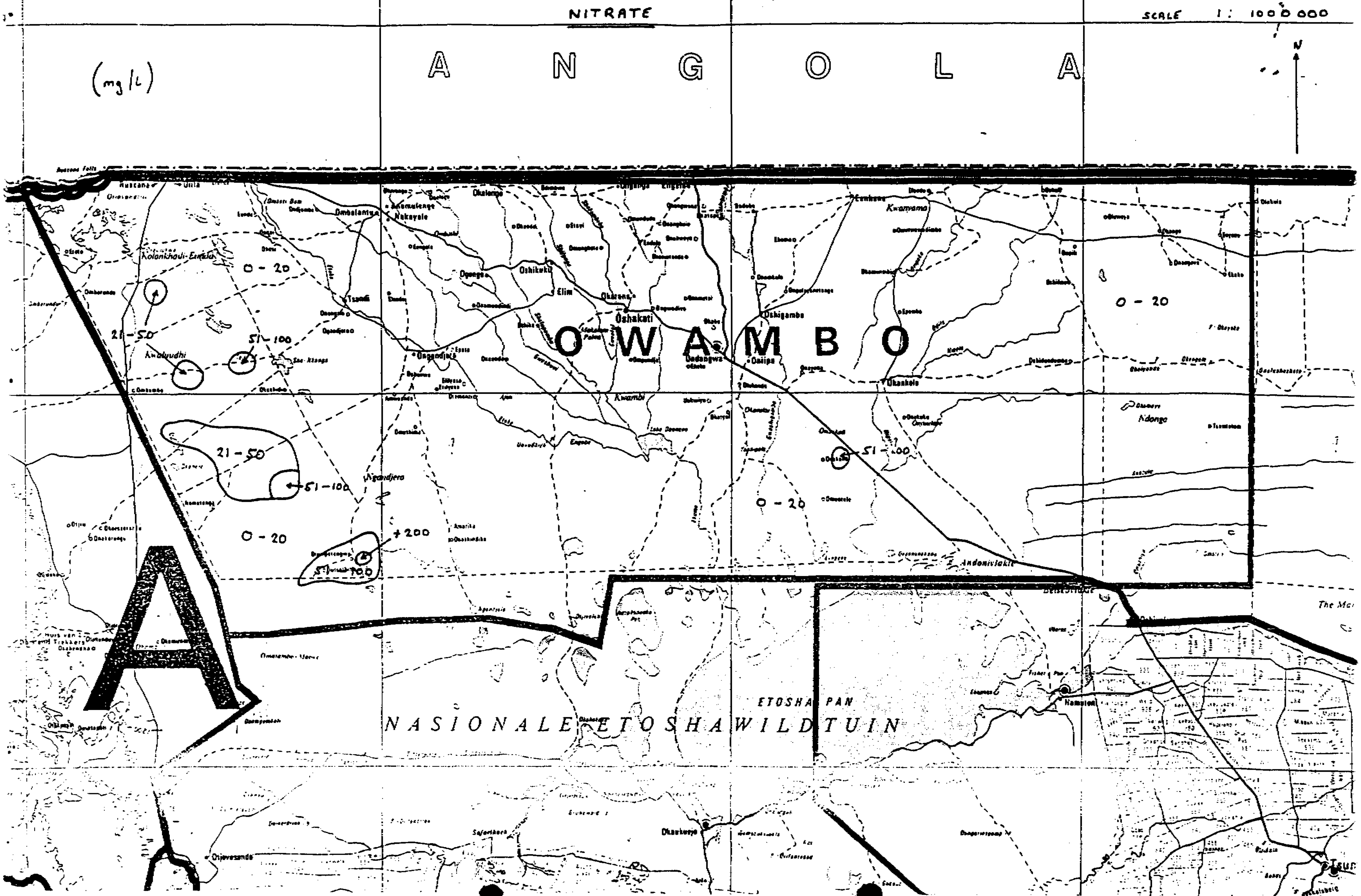
APPENDIX 4

Estimation of the number of people having adequate access to drinking water from the Owambo Pipeline System.

Using the criteria presented in section 4.1., an estimate was made of the number of safe water points and the number of users in the Owambo region as follows:

TYPE OF WATER POINT PROVIDING SAFE WATER ALL YEAR ROUND	OFFICIAL ESTIMATE	EST.NO. IN WORKING ORDER	EST.NO. OF PEOPLE SERVED
Official public take-off points off the Owambo pipeline			
-Urban areas* hospitals,schools,homes)		1500	82,000
-Rural areas(standpipes)	180	110	22,000
-Total			104,000
Non-official connections off the Owambo pipeline			
-Urban areas		400	(20,000)
-Rural areas		150	(80,000)
-Total	hundreds		(100,000)
Boreholes equipped with motorpumps, windmills or handpumps	220	(100)	20,000
Hand-dug wells equipped with handpump		100	1,000
		ROUGH TOTAL:	125,000

* Urban population: Population in the 23 growth centers of Owambo region


NITRATE
SCALE 1: 1000 000
(mg/L)
N
ANGOLA
OWAMBO
0 - 20
21 - 50
51 - 100
21 - 50
51 - 100
0 - 20
+200
100
51 - 100
0 - 20
0 - 20
A
ETOSHA PAN
NASIONALE ETOSHAWILDTUIN
Oshakati
Ondangwa
Oshikuku
Okalongo
Ombalantu
Tsandi
Elim
Oshigambo
Ongandjera
Ngandjera
Kwanyama
Ndonga
Kwambi
Andonivlakte
Namutoni
Okaukuejo
Otjovasandu
Ruacana

(mg/L)

SULPHATE

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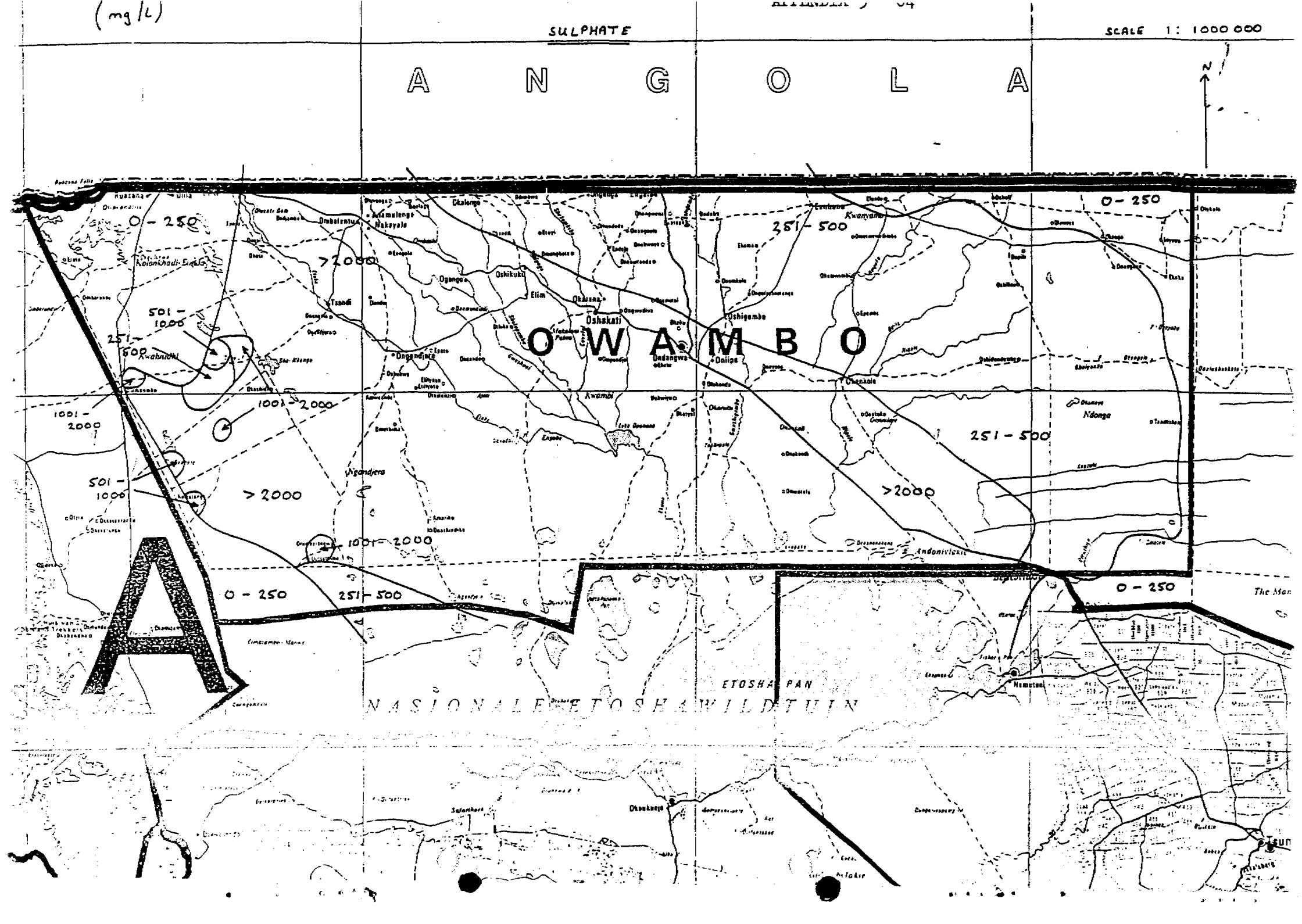

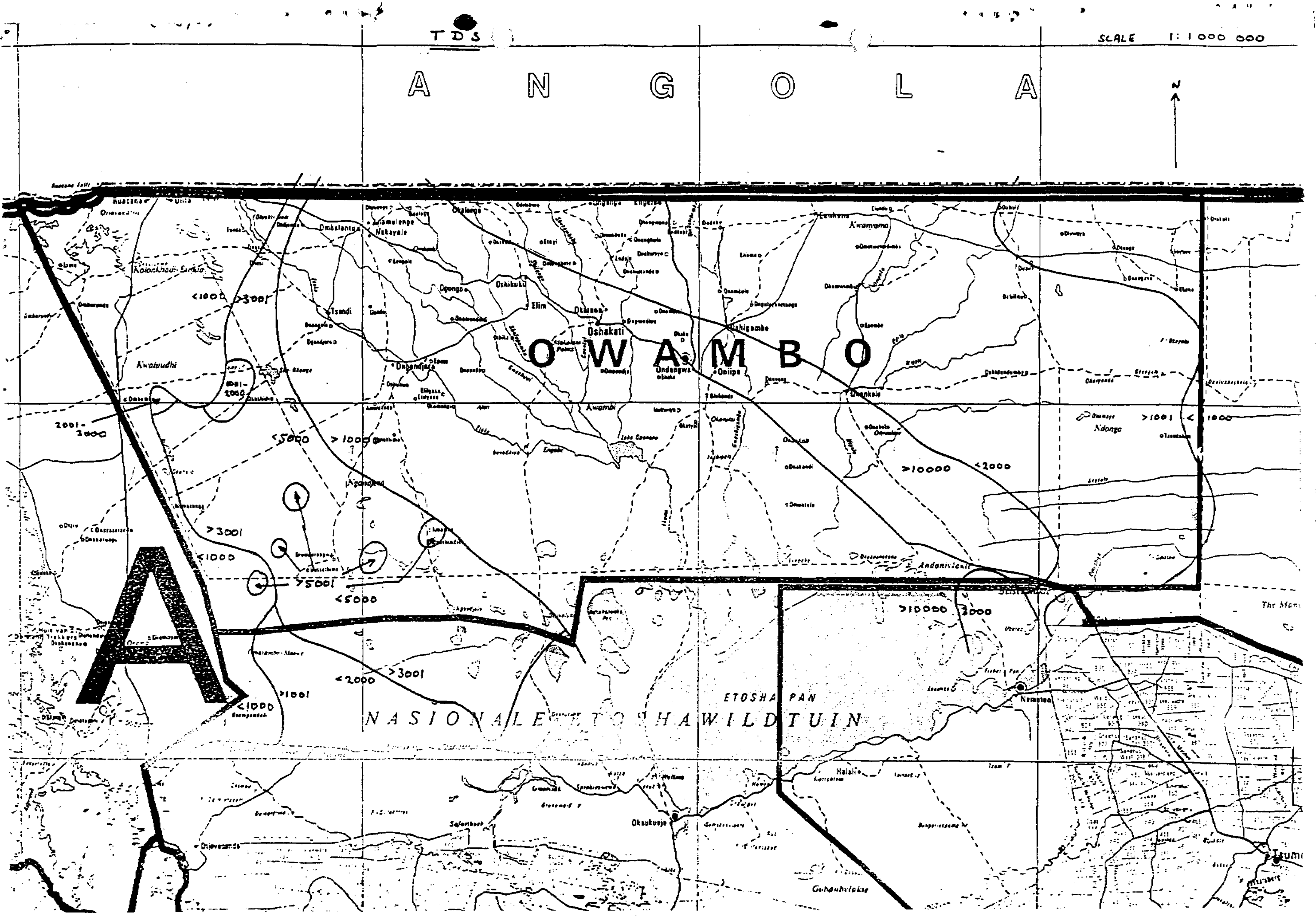
TDS
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O W A M B O
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NASIONALE ETOSHAWILDTUIN
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Ondangwa
Oniipa
Okatana
Tsandi
Ogongo
Oshikuku
Elim
Okalongo
Ombalantu
Nakayale
Ruacana
Kwaluudhi
Ngandjera
Kwambi
Ndonga
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Namutoni
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2001-3000
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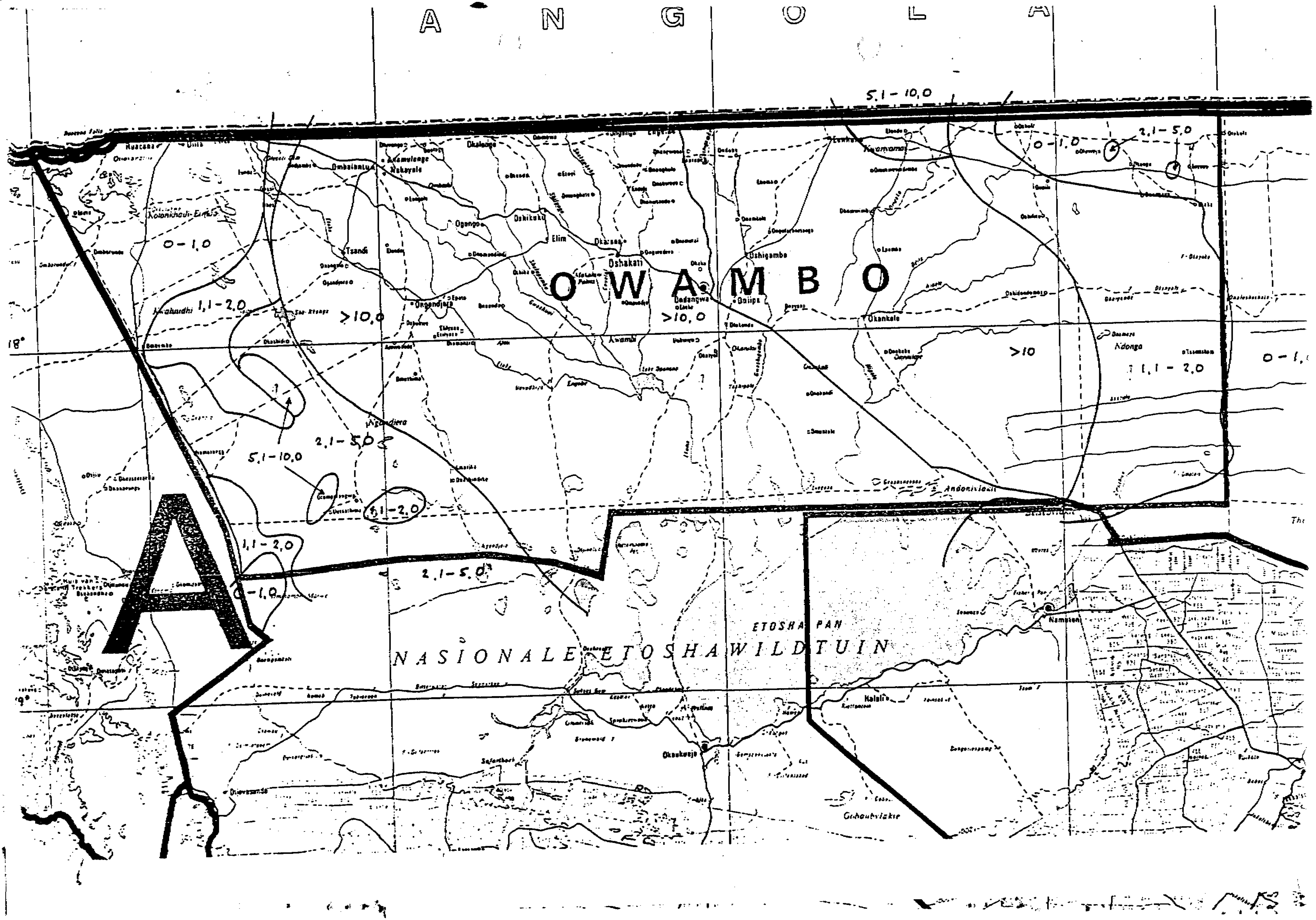
A N G O L A
O W A M B O
NASIONALE ETOSHA WILDTUIN
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0 - 1,0
1,1 - 2,0
>10,0
>10,0
>10
1,1 - 2,0
0 - 1,
2,1 - 5,0
5,1 - 10,0
1,1 - 2,0
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2,1 - 5,0
0 - 1,0
Ombalantu
Okalongo
Oshikuku
Elim
Ogongo
Tsandi
Oshakati
Ondangwa
Oshigambo
Okankolo
Ndonga
Agandjera
Andoni vlakte
Namutoni
Halali
Okaukuejo
Gobaub vlakte
18°
19°
A